An Analysis of Patient Outcomes When Applying the Total Motion Release® Technique to Treat Patients with Patellofemoral Pain Syndrome: 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

in the

College of Graduate Studies

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by

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AUTHORIZATION TO SUBMIT DISSERTATION

This Dissertation of Marcie Fyock, submitted for the degree of Doctor of Athletic Training with a major in Athletic Training and titled "An Analysis of Patient Outcomes when Applying the Total Motion Release® Technique to Treat Patients with Patellofemoral Pain Syndrome: 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 Dissertation of Clinical Practice Improvement (DoCPI) is the culminating project in the Doctor of Athletic Training program. The DoCPI is used to highlight an athletic trainer's advancement into scholarly practice. Included in this document are a Plan of Advanced Practice (PoAP), which contains an analysis of current practice, professional goals, strengths and weaknesses, and a plan for goal attainment. The PoAP was developed to identify specific steps needed to develop into an advanced practitioner and a strong educator. Clinical growth, understanding of action research theory and practice-based evidence are provided through the creation of several manuscripts, including an original applied clinical research project. An action research strategy was used to assess the application of the Total Motion Release® technique for treatment of Patellofemoral Pain Syndrome. This DoCPI illustrates evidence of scholarly development and progress towards advanced clinical practice in athletic training.

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DEDICATION

To my parents (Randy and Patti), who have demonstrated the true meaning of support and unconditional love. Words cannot express how much you mean to me and I hope that I have made you proud and continue to do so.

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CHAPTER 1

Narrative Summary

The Doctorate of Athletic Training (DAT) program at the University of Idaho was created to offer working professional athletic trainers an opportunity to pursue a terminal post professional degree with a clinical focus. Doctor of Athletic Training students are prepared to pursue advanced athletic training practice by receiving training in innovative patient care practices through concurrent didactic teaching and applied residency experiences (Nasypany, Segmiller & Baker, 2013). Serving as evidence of advanced professional practice, each Dissertation of Clinical Practice Improvement (DoCPI) is individually created as evidence of progress towards advanced clinical practice.

Historically the Doctor of Philosophy (PhD) degree was considered the model for doctoral work (Willis, Inman & Valenti, 2010). While a traditional research-focused dissertation is structured to prepare students to continue in an academic or research field, many doctoral students will instead pursue professional clinical practice and therefore a traditional PhD may not allow students to expand their knowledge, skill and expertise with the goal of improving a real world problem (Willis et al., 2010). In the 1970's doctoral programs began to emerge that aimed to prepare students for professional practice (e.g., doctor of education, doctor of nurse practice), resulting in the professional practice dissertation (PPD). Generally, a PPD integrates coursework, research and clinical experiences, resulting in a culminating dissertation that addresses real world problems grounded in theoretical knowledge (Willis et al., 2010). Similar to the PPD, the DoCPI includes the creation of practice-based evidence (the process of collecting research on one's own clinical practice), reflection of patient care provided, evidence of an advanced clinical focus area(s) and original applied research manuscript (Nasypany et al., 2013).

An essential component of the DAT philosophy and fundamental to the creation of the DoCPI is Action Research (AR). Action research is a method used for improving practice through action, evaluation and critical reflection. Scholarly reflection or reflective practice is commonly used in healthcare and allows the clinician to analyze and learn from his or her clinical practice and then based upon the evidence gathered, changes in practice can be implemented (Koshy, Koshy & Waterman, 2011). Action research may help practitioners identify problems in their clinical practice and develop strategies to improve their practice (Vellenga, Grypdonck, Hoogwerf & Tan, 2009). Students utilize an AR philosophy by identifying clinical issues or problems worthwhile of solving (e.g. best course of treatment for ankle sprains). Following a systematic review and reflection of the current literature on the chosen focus area, a plan to improve the problem is formed. Once the plan is put into action, outcomes are gathered, analyzed, and following reflection modifications can be made and reassessed (Koshy et al., 2011). Importantly, the AR process is a continuous cycle of action, assessment, critical reflection and implementation of changes, with the goal being to continually refine methods, data and interpretation in light of the understanding developed earlier in the cycle (Koshy et al., 2011). Reflection, both in action and later to evaluate actions, is a distinguishing element of AR and is distinctive from conventional research (Vellenga et al., 2009). Clinician's, who collect, analyze and reflect upon patient outcomes can evaluate the care provided, change components of the care and continue to learn from clinical practice outcomes. The cyclic process of AR, repeated as often as necessary to advance clinical practice, facilitates generation of new knowledge with enhanced understanding that can be disseminated with stakeholders (e.g., patients, health care practitioners) who may benefit (Koshy et al., 2011).

Essential to advanced clinical practice is the translation of promising results from clinical trials and day-to-day patient care (Schmittdiel, Grumbach & Selby, 2010). Translational research is described as investigations that incorporate aspects of both basic and applied research and is often referred to as "bench to bedside" research (Hurley et al., 2011). Translational researchers seek to close the gap between research and practice in order to ensure beneficial patient care techniques actually reach the patient (Woolf, 2008). Advance practitioners who participate in translational research are better prepared to provide effective patient-centered care (PCC). Advance practitioners use evidence-based medicine to guide clinical decisions while simultaneously collecting practice-based evidence (PBE), demonstrating a commitment to an evidence-based practice (EBP) (the combination of patient values and clinical expertise with research evidence) (Manspeaker & Van Lunen, 2011).

Evidence-based practice (EBP), as defined by Sackett (1996) is "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of the individual patient. It means integrating individual clinical expertise with the best available external evidence from systematic research (Sackett, Rosenberg, Gray, Haynes & Richardson, 1996). Historically, the research dissemination process has been slow to influence clinical practice, taking on average, 17 years for information to reach the clinician and benefit patient care (Green, 2008). The current flow of information will only work in a limited fashion, clinician's risk being governed by an evidence-only approach if clinical expertise is not also included in the decision-making process. Furthermore clinicians desire more evidence from patient populations like their own and conducted in real time similar clinical practice (Green, 2008). It appears a balance between basic science and the application of the research (PBE) is warranted. As suggested by Green and Ottoson (2004), "if we want more evidence-based practice, we need more practice-based evidence". Engaging in PBE may solve the lapse between research and practice and notably, PBE is more relevant, uses authentic patients and provides immediate feedback to the clinician.

Practice-based evidence (PBE) is described as the process in which a clinician conducts clinical practice research by using and analyzing purposeful interventions grounded in established scientific theories (Nasypany et al., 2013). Stated another way by Swisher (2010) as: "In the concept of Practice-Based Evidence, the real, messy complicated world is not controlled. Instead, real world practice is documented just as it occurs, 'warts' and all" (pg. 4). In alignment with the DAT, I recognized that evidence is not limited to randomized control trials, but rather the accumulation of the best evidence to answer the clinical question and in doing so I avoided the risk of my clinical practice being governed by an evidence-only approach. This approach has allowed me to focus on providing PCC through a balanced collection of both disease-oriented evidence (DOE) and patient-oriented evidence (POE) during clinical residencies. Disease-oriented evidence provides insight into the physiology of the injury (e.g., range of motion) while patient-oriented evidence consists of measures that are of direct interest to the patient (e.g., quality of life) (Hurley et al., 2011). Utilizing both DOE and POE, I am able to compare against the best available research evidence to guide my clinical decisions. Clinicians who embrace a PCC philosophy also function as translational researchers by producing PBE, comparing against the best available evidence and when appropriate disseminating information to the profession.

Embracing a PCC philosophy requires a structured plan to cultivate advanced practice. My plan of advanced practice (PoAP) is described in Chapter 2 of this DoCPI and captures my perspective and journey as a DAT student. In creating my PoAP, I developed a well-constructed plan that laid the foundation for growth in identified focus area(s), continued professional development and potential research pursuits. The PoAP includes a detailed analysis of my current clinical competence (i.e., knowledge, experiences, strengths, and weaknesses), goals for future professional development (i.e., area of intended focus, plan of improvement for identified weaknesses, career goals), a thorough plan for obtaining these goals and athletic training clinical philosophies. The PoAP is a structured plan of study for the duration of the DAT program and for the next 5-10 years of clinical practice. Chapter 2 is an example of an honest appraisal of my professional knowledge and my clinical skills prior to starting the DAT program. I used thorough self-reflection to develop quantifiable goals to add depth to my knowledge and clinical skills, which began with the pursuance of an advanced practice degree. My primary area of focus within the PoAP is expanding my clinical skills in the area of treatment and rehabilitation of athletic injuries. For example, a goal in my PoAP, described in Chapter 2, was to expand my clinical skills. I accomplished this by completing the Advanced Track Seminar: The Back Pained Athlete with Dr. Stuart McGill.

Future goals are also outlined providing evidence of my commitment to advanced practice beyond the DAT.

Chapters 3 and 4 are evidence of my depth and breadth of knowledge, development of a chosen focus area of advanced clinical practice, creation of a scholarly project and ability to disseminate outcomes to a broader audience. Chapter 3 contains evidence of a scholarly product in a manuscript titled "Treating Patients with Patellofemoral Pain Syndrome Using Regional Interdependence Theory: A Critically Appraised Topic," exploring patellofemoral pain syndrome interventions and outcomes. The *a priori* design and use of AR philosophy to determine effectiveness of Total Motion Release® as an intervention to treat patients with patellofemoral pain syndrome illustrates evidence of my ability to incorporate PBE and EBP into my clinical practice, produce athletic training scholarly research and progress towards advanced practice. The documented patient outcomes from this *a priori* investigation are presented in manuscript in Chapter 4.

The DAT experience has had a direct impact on my abilities as a clinician, educator and researcher and I share my perspective through my individual DoCPI. In each chapter I provide comprehensive evidence of my transformation into a clinician on the path towards advanced practice. Details of my journey using an AR philosophy, becoming a reflective clinician and evolving of my clinical practice are shared. Advancement of my foundational knowledge in my clinical focus area is evident in a review of literature and a scholarly product. The culmination is a DoCPI that highlights the impact the DAT program has had on my clinical practice, future patient care and scholarly development.

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CHAPTER 2

Plan of Advanced Practice: Developed April 22, 2016

Advanced practice involves a combination of clinical experience, foundational knowledge and an aspiration to develop and improve clinical expertise. An advanced practitioner is accomplished at reflecting on patient outcomes and forming new clinical philosophies (Nasypany et al., 2013). Through continuous reflection and self-evaluation an advanced practitioner is able to improve clinical practice, and disseminate peer-reviewed findings to other health care providers. Attaining advanced practice is a journey that requires time and a carefully constructed plan. An essential aspect of my progression towards advanced practice involves developing a Plan of Advanced Practice (PoAP). Following honest self-reflection, I identified strengths and weaknesses in my clinical practice, which included: inadequate foundational scientific knowledge, and limitations in scholarly activity and research capabilities. I developed a well-constructed PoAP, which included actions with measurable goals that have guided my progression. In this section I share my professional PoAP, which illustrates my path towards becoming an advanced practice clinician in my clinical focus areas of musculoskeletal assessment, treatment and rehabilitation.

Reflection on Prior Clinical Competence

Professional Development and Experience

My exposure to the athletic training profession occurred in junior high school when I met the athletic trainer at the university in my hometown. During this time period athletic trainers were not readily employed in the secondary school setting and I had no exposure to the profession until this encounter. I began to shadow the athletic trainer and quickly knew athletic training was a career path I was interested in exploring. As I began to apply to college, I sought out institutions that offered athletic training as an undergraduate major. I attended Slippery Rock University of Pennsylvania (SRU) where I was accepted into the CAATE (Commission on Accreditation of Athletic Training Education) accredited Athletic Training Program (ATP). The program at SRU had a strong reputation for high academic standards, clinical experiences and professional development. One aspect of the ATP I appreciated most was the mentorship I received from the ATP professors and clinical athletic trainers. Many of the professional behaviors observed help create the framework for my professional development not only as a student enrolled in the ATP but also as I moved forward as a professional. I was expected to act and behave at the highest level of professionalism, whether I was in the classroom, a clinical setting, or a social setting. Professional competence was one of the most noteworthy skills I learned during my professional education. I still speak of the professional development opportunities I experienced as a student (e.g. communication of the daily injury and athlete participation status to the coaching staff), and I emphasize similar experiences for the students I teach today.

My professional education was quite structured; courses were completed in a sequential and organized fashion with corresponding clinical exposures to compliment the didactic curriculum. Beginning semester one of my sophomore year I was assigned to a specific sport (i.e., clinical rotation) in which I was responsible for providing athletic training services while under the supervision of an athletic training clinical staff member. I would describe the supervision as loose; athletic training students (ATSs) assigned to specific teams were expected to appropriately deliver healthcare to the patient population as the primary provider. My duties included equipment transport and set up, evaluation and treatment decisions, presentation of patient cases to the team physician, practice and event coverage, communication with coaching staff and administrative duties. I was assigned many responsibilities as an ATS and I placed tremendous value on the practical experience I was gaining. Often, I was the primary provider of health care with patients from initial evaluation through treatment and return to play. Within this model, I was able to engage in critical thinking, develop clinical-decision making skills and professional growth, all while being supported and mentored from the athletic training staff.

During my final semester, I was encouraged to obtain a clinical rotation off-campus in a setting in which I may seek future employment. I choose Westminster University, a Division III University where I would be directly assisting the head athletic trainer with all major athletic training responsibilities. The head athletic trainer was providing medical care for over 350 student-athletes and I quickly fulfilled the role as his assistant. I was a hard worker, dependable, displayed initiative and was able to work independently. I was responsible for the organization of pre-participation physicals, evaluation of injuries, taping and wrapping, modality application, stretching and event set-up and coverage. Following my experience at Westminster University I felt prepared to transition to the next phase of my professional development, my graduate assistantship. At the time of my professional development, a graduate assistantship was the expected transition into professional practice. I believed a career as an intercollegiate athletic trainer was my future and a graduate assistantship was the next step in reaching that goal. I would be able to refine my clinical skills while under the guidance and mentorship of an experienced athletic trainer as a graduate assistant AT. At no time did I consider attending graduate school for scholarly opportunities; rather I viewed the experience as a necessary action to obtain employment in the intercollegiate setting.

I applied for and attended Syracuse University as a graduate assistant athletic trainer. In this role I served as the head athletic trainer for women's volleyball and women's field hockey. I worked autonomously and often alone in the athletic training clinic and while I became self-reliant I would soon recognize the downside of a perceived independent practice. Arriving at Syracuse University, I felt prepared in performing the entry-level skills of taping and wrapping, event coverage, musculoskeletal examination, modality application and rehabilitation design, but over time I realized the confidence I had developed while at SRU was waning, specifically regarding clinical-decision making. I became uncertain that my choices were improving patient-care and rather than seeking out assistance I relied on my limited knowledge and understanding to guide my decisions. I had hoped to mature, both as a clinician and professional during my graduate assistantship, but the mentorship and feedback I sought was not present, and therefore my clinical learning became self-taught. In spite of these obstacles I worked hard to complete my coursework while gaining professional experience. After two years, I completed a thesis and fulfilled the requirements of a Master of Science in Exercise Science. Educationally, courses directly related to athletic training were limited with a majority of content related to skeletal muscle physiology and metabolism, yet my focus was on gaining additional experience as an athletic trainer and at the time, was far more valuable to me.

Shortly after completing my graduate degree I accepted the position of assistant athletic trainer at Clarion University of Pennsylvania. My primary sport coverage responsibilities included women's volleyball, women's soccer, men and women's basketball, men and women's swimming and diving, women's softball and baseball. In addition, I was responsible for medical insurance administration of student-athlete injury related claims. Unbeknownst to me when I applied for the position, Clarion University offered a joint Bachelor of Science in Athletic Training degree with California University of Pennsylvania. I would also be responsible for teaching six credit hours each semester and would eventually assume the role of program coordinator of the academic program during my time at Clarion University. Initially, I was more than willing to work the long hours and numerous daily responsibilities. I enjoyed working hard to provide care of my patient population and felt professionally stimulated. The mentorship I received from the head athletic trainer (immediate supervisor) at Clarion University has undeniably had the greatest influence, both on my clinical and professional practice. Under his guidance I was able to explore alternative theories to musculoskeletal injury evaluation and treatment, improve my communication skills, gain administrative and leadership experiences and grow as a both a professional and a person. While I felt I had a wonderful mentor, my clinical practice grew stagnant and I realized my clinical practice competence was not at an acceptable level.

Rationale for Pursing a Doctor of Athletic Training Degree

I chose to pursue a doctoral degree as a manner of advancing both my clinical practice and my career in athletic training education. I desired to be valued as a clinician and educator, but needed to fill in the gaps in my knowledge and clinical experience.

However, I felt limited by what I considered to be inappropriate degree options; I was looking for a degree that would not only improve my standing as an educator but one that had a direct impact on my clinical practice. I learned of the University of Idaho Doctorate of Athletic Training (DAT) program, which matched my desire to focus on improving patient care, pursuing applied research and expanding my education. My discovery of the DAT program came at a pivotal time, I had recently made a career change and felt the DAT program fit with my professional and personal goals while continuing to work full-time. Professionally, I wanted to become a more advanced clinician and educator with the focus, training, and mentorship available in the DAT program. Personally, I desired to be a part of a unique DAT program in which I had the potential to influence the athletic training profession.

Reflection on Current Clinical Competence

Professional Knowledge

Becoming an Advanced Practitioner requires establishing a sound knowledge base in areas of clinical focus. In order to rate my knowledge and clinical competence I need to define the levels of competence that I will use. I use a three-level scale to rate my knowledge: "novice" corresponds to the knowledge of an entry-level athletic trainer, "intermediate" corresponds to an athletic trainer with a broad knowledge base, who's clinical reasoning focuses on patient-oriented evidence, and "advanced" corresponds to expert knowledge in a specific area of athletic training.

I consider myself to be professionally proficient; I value continuing education and consider myself to be ahead of my peers in patient care competence. I complete advanced coursework, attend conferences and work to incorporate my new found knowledge into my patient care. As I have progressed through the DAT, I recognize the importance of strong foundational knowledge and documentation of clinical outcomes to assess clinical competence. Prior to the DAT program many of my clinical decisions lacked intent and were personal preferences rather than sound foundational AT knowledge and evidence. I did not recognize this limitation until I began the DAT program. As such, I have investigated a variety of patient care topics and supporting theories, pursued continuing education, presentations and analysis of research, promoting further depth of knowledge. I use this knowledge in conjunction with my practice-based evidence to guide clinical decisions. When I first applied to the DAT program, I believed my professional knowledge to be at a intermediate level in many areas of AT. Over the course of the DAT program, I have advanced my pedagogical skills modeling the best evidence, improved my clinical skills through application of innovative patient care paradigms and developed scholarship through evaluating patient outcomes and disseminating my findings. Consequently, I rate my current professional knowledge as slightly above intermediate.

Professional Strengths

As a professional I have worked diligently to improve my skills and enhance my strengths. The focus of the DAT program is to create a foundation for the improvement of clinical practice. Critically analyzing and assessing my strengths has been valuable in creating this foundation. Reflection provided me with a deeper assessment of my current clinical practice and I was able to identify positive areas within. Identifying my strengths has allowed me to build a personal and importantly, measureable path towards the goal of advanced practice. The following list highlights my current professional strengths, including a description of how each has influenced my path towards advanced practice.

Competence in Athletic Training Education

My key strengths in the area of athletic training education are competence in CAATE administrative policies and use of evidence-based practice in the classroom. My knowledge of CAATE administrative policies have grown over the course of my career and I have increased my knowledge regarding clinical site administration, student advisement within the degree program, completion of self-study materials and compliance with CAATE established standards. In my current position at George Mason University, I continue to expand my administrative knowledge as the professional athletic training degree transitions from a Bachelor of Science to the Master of Science.

The emphasis of evidence-based practice in my DAT coursework has translated well into my role as an educator and I have emphasized this in both my lecture (incorporating current literature) and laboratory (incorporating scientific theory) classes. The enhanced pedagogical strategies (i.e. incorporating primary literature) are being applied with success as evident in student grades, course evaluations and peer course reviews. Students have demonstrated an improved ability to locate and interpret primary literature and I believe I prepare them well to answer clinical questions using an evidence-based approach. Given my background and experience I rate my current knowledge of CAATE administrative polices as advanced and my current competence as an educator as intermediate.

Regional Interdependence (RI) Approach to Assessment and Treatment

I have developed extensive clinical competence in the Selective Functional Movement Assessment (SFMA) and Total Motion Release Technique (TMR®). The SFMA is a movement assessment designed to capture patterns of posture and function for comparison against a baseline (Cook, 2011). I have become skilled at identifying dysfunction quickly and efficiently and have gained confidence in my clinical reasoning and decisions using the SFMA system. While improving my competence utilizing the SFMA I moved away from a pathoanatomic and tissue healing only approach to patient care to a model that includes a balance of anatomy, biomechanics, and neurological and physiological elements. I am able to effectively assess global movement patterns for pain and dysfunction, apply an appropriate intervention strategy, and re-assess for improvement through the utilization of the SFMA. I have been able to apply this theory and techniques to my clinical practice and rate my knowledge as intermediate.

I have made the greatest advances in my knowledge of TMR® technique and theory. Total Motion Release® technique functions as both an assessment and treatment system of improving body motion imbalances as reported by the patient (Dalonzo-Baker, 2014). One of the benefits of TMR® is the combination of a global assessment to identify the source, rather than the site of pain and a matching treatment aimed at eliminating dysfunctions within the body. In TMR®, patients use a 1 (no dysfunction, pain or asymmetry) to 100 (complete dysfunction, pain or asymmetry) scale to describe the movement quality of the particular TMR® screening (Dalonzo-Baker, 2014). Six motions are assessed for asymmetry, compared bilaterally and the motion with the greatest imbalance is identified and treated first (Dalonzo-Baker, 2014). Unlike traditional treatments, the patient's good side is treated first with a combination of repetitions or holds (Dalonzo-Baker, 2014). I have found TMR® technique provides an opportunity to observe the body move as a unit of interconnected parts, and following treatment witness changes in one area of the body having a potential affect on other areas. Total Motion Release® is a technique I use to eliminate pain associated with movement patterns and improve patient care; an approach I have built my rehabilitation philosophy upon. The time I have spent studying, applying and reflecting on the TMR® technique has been valuable. I find patients responded favorably to the technique and my patient outcomes support a regional interdependence model of evaluation and treatment (presented in Chapter 4). Based upon my coursework, applied research and clinical experience using TMR® I rate my current knowledge as advanced.

Positional Release Therapy

Positional Release Therapy is an example of an intervention that I have gained extensive knowledge and experience utilizing. Positional Release Therapy (PRT) is a manual therapy technique that is used to resolve pain and tissue dysfunction through the correction of musculoskeletal and neurological imbalances (Speicher & Draper, 2006). Positional Release Therapy is the opposite of stretching; the body and tissue are placed in positions of comfort, allowing the neurological system to be manipulated, interrupting the pain-spasm-pain cycle, thereby resetting the normal resting tissue length (Speicher & Draper, 2006). Following a global assessment of soft tissue to identify dominant trigger points, a trigger point is stimulated with light sensory touch and the neural signal created by pain and inflammation is interrupted, decreasing neural activation at the spinal cord (Speicher & Draper, 2006). Positional Release Therapy is a manual therapy tool I use to treat dysfunction, eliminate the pain associated with movement patterns and improve my patient care; an approach that I have built my patient care philosophy upon. I have been able to successfully use PRT in my clinical practice and rate my current knowledge as intermediate.

Assessment and Treatment of Patients diagnosed with Patellofemoral Pain Syndrome

I have gained substantial knowledge of PFPS as a result of my continuing education, patient outcomes, and a thorough review of literature. I understand PFPS as a global dysfunction rather than an isolated anatomical injury and as such, I have become better equipped to identify, treat and address the driver of symptoms rather than treating the symptoms alone. I have made considerable advances in understanding the published literature (development of manuscript presented in Chapter 3) with the understanding that I recognize l need to continue to stay abreast of new evidence in order to increase my knowledge regarding patellofemoral pain syndrome. I rate my current knowledge of PFPS gained through the literature review, clinical observations and patient outcomes as intermediate. I believe my applied research findings will add to the literature on patellofemoral pain syndrome.

Public Speaking

As a scholarly practitioner, I have shared my primary areas of focus at the both the state and national level. At the state level I was selected to speak at the 2015 Virginia Athletic Trainers' Association Annual Meeting & Symposium where I presented the Regional Interdependence Theory and Relationship to Pain. I was also invited to speak at the National Athletic Trainers' Association (NATA) Clinical Symposia and AT Expo in 2014 and 2015. Both years I presented a learning lab session at the on the Regional Interdependence Theory and Movement Systems Evaluation. The professional presentations described were new to me and provide evidence of my growth and progress towards advanced practice and the ability to disseminate scholarly information. Based upon my experiences I rate my current competence as intermediate.

Areas For Improvement

A necessary component to advance my clinical practice is the ability to identify, understand, and improve my weaknesses. I believe I have and will always have room for advancement in both my clinical practice and professional life. To expand my knowledge and improve as a clinician I have identified the following areas of improvement.

Foundational Science Knowledge

I have expanded my clinical practice to include new strategies and interventions to improve patient-care. In doing so I have identified gaps in my foundational knowledge. I have worked to create a better understanding in the areas of advanced anatomy, pain theories, muscle imbalance theories, motor control theories, physiology of healing, and research models. In order to strengthen this area, remaining up-to-date of content as related to my clinical practice will be essential. Highlighted in Table 2.1, I have identified content areas that I believe will improve my professional practice.

Collection of Patient Outcomes

The combination of detailed patient outcomes and critical analysis of my methods are essential to improving patient care. Prior to the DAT, I did not use a formal method of patient outcome collection; as such my clinical decisions were not grounded in sound clinical reasoning. I recognize that my ability to develop as an advanced practitioner could be improved by following a structured plan and performing each evaluation with consistency. To strengthen this area I have applied an organized approach to patient outcome collection and I will continue to work and develop practices that will foster success in this area.

Publication in Peer-Reviewed Journals

My publication record is an area of improvement I recognized and addressed by researching, writing and submitting a manuscript for publication. To date I have been lead author on one manuscript describing my research findings: "Treating Patients with Patellofemoral Pain Syndrome Using Regional Interdependence Theory: A Critically Appraised Topic," accepted for publication in the *International Journal of Athletic Therapy & Training* (presented in Chapter 3). In the future I must continue to disseminate my patient outcomes to further advance the areas patellofemoral pain syndrome, patient outcomes, regional interdependence and Total Motion Release® technique.

Awareness of New Clinical Practice Interventions

As an aspiring advanced practitioner, I have only begun to emulate advanced practice; my competence will be developed from a balance of continual reflection on my patient care, making well-informed changes that will continue to improve my clinical practice and sharing what I discover through dissemination of my practice-based evidence. As such, I recognize that I must continue to have an awareness of and desire to learn new and innovative clinical practice interventions. As I progressed through the DAT program I began to identify areas of my clinical practice that were lacking and took steps to strengthen this area of weakness. As highlighted in Table 2.1, I have demonstrated openness to new clinical practice interventions, including actions I have taken to improve in each.

Path to Advanced Practice

My path to advanced practice is guided by individualized philosophies of clinical practice, education and research pursuits. I have given careful thought to the development of each philosophy and use these to frame my current and future practices in the clinic and the classroom. I have utilized many of my philosophies to structure my PoAP, which I will use as a guide in the pursuit of advanced practice. The following represent my current philosophies:

Patient Care Philosophy

I strive to be a patient-centered care clinician and that begins by treating the "whole person" both physically and emotionally. It is my goal to resolve pain, improve function and better my patient's quality of life. I believe in using evidence-based practice and sound clinical reasoning to guide my clinical decisions. My clinical practice is reflective in nature; I respect and learn from past clinical decisions and use them to guide future clinical decisions. My patient is my focus and it is my goal to be competent in a variety of techniques in order to meet their specific needs. I strive to improve patient outcomes but also to inspire my peers and students to value a patient-centered clinical practice.

Rehabilitation Philosophy

My rehabilitation philosophy embraces the regional interdependence model, by focusing on movement patterns and imbalances throughout the kinetic chain. Following Vladimir Janda's approach to muscle imbalance in which imbalance leads to altered movement patterns or dysfunction (Page, Frank & Lardner 2010), my goal is to identify altered movement patterns and specific muscle weaknesses in order to correct the motor pattern. I believe an interaction exists between the skeletal system, muscle function and central nervous system causing compensatory motor patterns. I treat muscle imbalance and pain as a global dysfunction with the goal being to change pain and dysfunction cycles. I am a believer that the source of pain lies remote to the location of pain, integrating global assessments into my clinical practice affords me the opportunity to view the whole movement system not just the segment in question. In my experience using this approach I *have achieved positive patient outcomes (presented in Chapter 4), which makes this method my choice for evaluation and basis for treatment and rehabilitation of injuries.*

Teaching Philosophy

I am an educator that accepts the significant responsibility I have to my students. Each student brings a unique and challenging intellectual complexity to the classroom. I strive to utilize all of my energy into being an organized, respectful, and knowledgeable instructor, with the ability to adapt to the specific needs of any student. I hope to lead by example and become a mentor and a role model that they may choose to emulate. I work to instill a sense of professional responsibility, an appreciation for scholarly activity and present a model for a patient-centered clinical practice. I do this by practicing and teaching an evidence-based practice; I share evidence from the literature and apply it to coursework as a means of improving their clinical competence. I share the importance of a reflective practice, a model for collection of patient outcomes and the support to develop their personal path towards professional development.

Area of Advanced Practice

With my athletic training philosophies as guides, I have identified a series of goals that I will utilize to become a more proficient and skilled clinician and educator. The goals have been chosen to insure appropriateness to improving patient care while being diverse to meet the evolving athletic training profession and my personal interests. I have developed these goals to reflect my areas of clinical practice improvement (evaluation of dysfunction in the regional interdependence model, developing a greater knowledge base, measures of clinical proficiency, expanding clinical skill set and producing and publishing scholarly research) and my educational philosophies. In the following list I describe specific focus areas of my PoAP and my reasons for inclusion.

Evaluation of Dysfunction in the RI model

The RI model has become a constant in my clinical practice. The RI model reinforces the value of global assessments, such as SFMA and TMR®, because an evaluation focused on determining the cause of pain provides the clinician with information to apply a treatment aimed at correcting the dysfunction. Working towards clinical competence in the SFMA and TMR®, I have observed significant improvements in my clinical decisions and patient outcomes.

Expand Foundational Knowledge Base

My clinical competence in global assessment models have improved but I recognized that weaknesses in my understanding of complementing theories such as motor control and clinical reasoning may hinder my ability to pursue advanced practice to its fullest. I strive to be a clinician who makes informed and clinically effective decisions and in order to do so continually pursuing advanced content learning opportunities will be beneficial to my professional future.

Use of Manual Therapy in Treatment of Musculoskeletal Dysfunction

The assessment models I use aim to identify global sources of dysfunction and pain, allowing me to appropriately select a treatment options that match individual patient conditions. I realize each patient requires a unique approach to treatment and if one technique does not improve outcomes, I can reflect and correct or apply a new treatment that may be more beneficial. Being clinically competence in a variety of interventions will improve my athletic training practice (e.g., Mulligan Technique, Primal Reflex Release Technique, MyoKinesthetic System, Reactive Neuromuscular Training Technique). As I gain knowledge of the theory of each and subsequent application I am then able to utilize my time as a clinician to improve proficiency in each. I believe these additional interventions are a necessary component in the pursuit of advanced practice.

Professional Scholarship & Research

Currently research produced by athletic trainers is limited, however the clinical AT is in a unique position to provide practice-based evidence that may be used to determine highly effective treatment and intervention choices. I have continued to improve in this area within my DAT progression and I recognize working to produce and disseminate research within the AT profession will be beneficial to my professional future.

Strategies for Success as an Educator

It is my responsibility to provide the student with current and accurate information, build a foundation of professional and scholarly responsibility and willingness to practice patient-centered care. As I have progressed through the DAT, I have been exposed to new content, clinical skill and scholarly behavior; in turn this has created greater opportunities for the students I teach and overall improvement as an educator. I believe continuing to improve in this area will be beneficial to my professional future.

Contribute to Development of ATP Students

I believe I must model the behavior I wish to see reflected in my students; therefore I believe in demonstrating proper use of practice-based evidence and clinical reasoning. The DAT program provided an opportunity for me to improve my clinical practice and I am now in a position to offer a unique perspective on course content and delivery method that will develop students as clinicians who practice patient-centered care. I believe continuing to improve in this area will be beneficial to my professional future.

Serve in Leadership Position in AT Profession

Our profession has a limited number of clinicians trained at the doctoral level (i.e., Ph.D., Ed.D.) and given the recent changes in athletic training education an opportunity exists for me to advocate for continued progress within the profession. I believe the AT profession will continue to evolve as we have more advanced practice clinicians from which to model advanced practice.

Presented in Table 2.1, I outline the specific areas of focus contained in my PoAP and include a detailed mechanism highlighting past, current and future planned accomplishments within each.

Table 2.1. Goals related to focus areas and objective measures

Goals Supporting Areas of Focus	**Timeline**
Evaluation of Dysfunction in the Regional Interdependence Model	
• Northeast Seminars video series- FMS & SFMA	Completed 2012
• Read "Assessment and Treatment of Muscle Imbalance: The Janda Approach" book (Page, Frank & Lardner, 2010)	Completed 2012-ongoing review
• Read "Movement" book (Cook, 2011)	Completed 2013-ongoing review
• Complete SFMA coursework, attend conference	Completed 2014
• Incorporate SFMA into clinical practice o SFMA Patient Outcomes	Ongoing
• Audit SFMA conference	Completed 2014
• Complete SFMA certification exam	Summer 2016
• Complete SFMA Level 2 conference	Fall 2016
• Incorporate SFMA 4x4 Matrix into clinical practice o SFMA 4x4 Matrix Patient Outcomes	Following Level 2 Course
• Watch "Assessing Movement: A Contrast in Approaches & Future Directions" DVD	Completed 2015-ongoing review
• Read "The Science Behind Total Motion Release" (Moseley, 2007)	Completed 2013
• Complete TMR coursework: Levels 1,2,3	Completed 2015
• Incorporate TMR into clinical practice o TMR Patient Outcomes	Ongoing
Expand Foundational Knowledge Base	
• Read literature on Pain Neuromatrix	Completed 2013-ongoing review
• Complete Audible Collection: *The Mindbody Prescription: Healing the Body, Healing the Pain*	Completed 2014-ongoing review

book (Sarno, 1999) • *Healing Back Pain: The Mind-body Connection* (Sarno, 2010)	
• Read *Total Recovery* book (Kaplan & Beech, 2014)	Completed 2015
• Read *Motor Control: Translating Research into Clinical Practice* book (Shumway-Cook & Woollacott , 2007)	Fall 2016
• Read *Motor Learning and Control: Concepts and Application* book (Magill & Anderson, 2013)	Fall 2016
• Read *Clinical Reasoning in the Health Professions* book (Higgs, Jones, Loftus & Christensen 2008)	Winter 2016
• Read *Low Back Disorders: Evidence-Based Prevention and Rehabilitation* book (McGill 2016)	Summer 2016
• Incorporate theory content into clinical application as appropriate	Ongoing
Use of Manual Therapy in Treatment of Musculoskeletal Dysfunction	
• Read "Positional Release Therapy & Treatment of Musculoskeletal Dysfunction" book (D'Ambrogio & Roth, 1997)	Completed 2013-ongoing review
• Complete PRT *Spine & Pelvis* course	Completed 2013
• Complete PRT *Chronic Somatic Conditions* course	June 2016
• Incorporate PRT into clinical practice ○ PRT Patient Outcomes	Ongoing
• Read "Anatomy Trains" book (Myers, 2008)	Completed 2014-ongoing review
• Complete *Anatomy Trains for Movement Therapists* workshop	May 2016
• Read "Manual Therapy: NAGS, SNAGS, MWMS etc. book (Mulligan, 2010)	Completed 2013/2014
• Northeast Seminars video series: Mulligan concept	Completed 2013/2014
• Incorporate Mulligan technique into clinical practice ○ Mulligan Patient Outcomes	Ongoing
• Participate in Advanced Track Seminar: *The Back Pained Athlete* with Dr. Stuart McGill	Completed 2015
• Complete *Myokinesthetic System Lower Body Home Study*	Purchased April 2016

• Attend 1 new workshop per year
  ○ Upper body Myokinesthetic Course
  ○ Lower body Myokinesthetic Course
  ○ Instrument Assisted Soft Tissue Course
  ○ Dynamic Neuromuscular Stabilization Course
	Yearly – dependent upon course offering

• Incorporate intervention techniques into clinical	Following attending

practice o Collect patient outcomes	course
Professional Scholarship & Research within Clinical Focus Area	
• Meet with David Thacker- U of Idaho English Professor	Completed 2013-2014
• Meet with Director George Mason U Writing Across Curriculum	Completed 2014
• NATA Learning Lab- RI: Looking Beyond the Location of Pain by Assessing Movement Dysfunction	Presented 2014
• VATA Annual Symposium Presentation- RI: Looking Beyond the Location of Pain	Presented 2015
• NATA Learning Lab- RI: Looking Beyond the Location of Pain by Assessing Movement Dysfunction Specific to Cervical-Thoracic Shoulder Region	Presented 2015
• Critically Appraised Topic Manuscript- Treating Patients with Patellofemoral Pain Syndrome Using RI Theory	Accepted for Publication November 2015
• Complete DAT	Fall 2016
• Complete Dissertation	Fall 2016
• Submit for publication- initial case series for patients with patellofemoral pain using TMR®	Fall 2016
• Present research findings on the use of TMR® for treatment of patellofemoral pain at state, district, national conferences	TBD by conference deadline
• Continue to collect and analyze patient outcomes	Ongoing
• Reflective Practice	Ongoing
Strategies for Success as an Educator	
• Evaluation by Center for Faculty and Teaching Excellence	Completed 2015
• Implement strategies and resources made available from George Mason U	Ongoing
• Participate in Writing Across Curriculum Workshop: Commenting Strategies	Completed 2015
• Attend Innovations in Teaching & Learning Conference- George Mason U	Fall 2016
• Attend 1 workshop yearly	Yearly
• Implement strategies learned and measure outcome	Following attending workshop
Contribute to Professional Development of Athletic Training Education Students	
• Complete Doctorate of Athletic Training degree	Fall 2016
• Develop course "*Post Rehabilitative Therapeutic Interventions*" for MS Athletic Training	Fall 2016

• Instruct "*Post Rehabilitative Therapeutic Interventions*" course	Spring 2017
• Use strategies & approaches from Center for Teaching & Faculty Excellence to assess student outcomes	Concurrently with course offering
• Obtain academic release to develop clinical practice setting at SMART lab	Fall 2017
• Offer evaluation and rehabilitation services as ATC at SMART lab	Upon course release
• Serve as Faculty Advisor to student body association	Yearly
Serve in Leadership Position in Athletic Training Profession	
• Apply to serve as a CAATE site visitor	Completed Spring 2016

Goals for Professional Future

Prior to enrolling in the DAT I enjoyed my role as an assistant athletic trainer; however, I now feel I would be a more valuable clinician as a result of my improved clinical reasoning, clinical capabilities in evaluation and treatment and understanding of pain and injury. My primary goal of obtaining a doctorate was to improve patient care and I feel that I have met that goal. The addition of comprehensive and global assessments as well as multiple treatment interventions has fueled my desire for continued improvement.

I believe the AT profession needs athletic trainers who can successfully combine patient outcomes with evidence and clinical experience. Students need educators and preceptors who conduct patient care research and disseminate results through presentations and publications. I believe the DAT has prepared me to serve in both of these roles. As the profession evolves, I hope to continue in my current faculty position in a professional Master of Science athletic training program at George Mason University. In addition, I hope to offer evaluation and rehabilitation services to the public sector and serve as a preceptor at the Sports Medicine Assessment Research & Testing (SMART) laboratory on the George Mason campus. Under my guidance, students would be able to apply theories and skills they have learned in the classroom in actual clinical practice while receiving guidance and mentorship. In this role I will continue scholarly activity beyond the DAT and share my knowledge with upcoming professionals.

Justification of the Plan of Advanced Practice

The PoAP was created to provide direction to my unique path of advanced practice and also my future professional development. Personally I have used the PoAP to shape my philosophies of clinical and educational practice, impacting patient outcomes in my clinical setting and success as an educator. While in the DAT, I worked towards advanced practice by integrating current evidence and patient outcomes into evaluation and treatment strategies. I analyzed, reflected and disseminated my results in the form of scholarly products. I also recognize these actions were instrumental to my success in the classroom; the curriculum of the DAT including my PoAP positively influenced the development of my students. I share more relevant information and provide my students the tools to integrate practice-based evidence. On a larger scale, I believe the PoAP may serve as a future model of clinical practice for the athletic training profession. Clinicians, educators and preceptors striving towards advanced clinical competency would be better prepared to serve the needs of the patient and athletic training student. Patients would receive patient-centered care approach built upon evidence driven clinical reasoning and athletic training students would benefit from an educator who is committed to their own advanced practice path.

The PoAP is not exclusive to my time in the DAT program; rather it will continue to share my professional future. My goals, area of clinical focus, knowledge and skill will change, the AT profession will evolve, and as such my PoAP will continue to evolve. I have made great progress with my PoAP, and I am excited to continue using the PoAP as a model of change for my practice. As I move into professional life after the DAT I feel fortunate to have been a student in the DAT program and a part of the movement to advance the AT profession.

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CHAPTER 3

Treating Patients with Patellofemoral Pain Syndrome Using Regional Interdependence Theory: A Critically Appraised Topic

Fyock M, Seegmiller J, Nasypany A, Baker R. Treating patients with patellofemoral pain syndrome using regional interdependence theory: A critically appraised topic. *Int J Ath Train Ther. 2016; 1-8.*

Key Points:

Research suggests both proximal upper extremity factors as well as distal lower extremity factors play a role in the development of patellofemoral pain syndrome.

Patellofemoral pain syndrome may benefit from a multifaceted approach to evaluation and treatment.

Regional interdependence based interventions can produce clinically significant changes in patient-based outcome measures.

Clinical Scenario

Many athletic endeavors involve combinations of complex movement patterns that display both athleticism, efficiency of movement and artistic impression. The musculoskeletal system is under significant stress during both practice and competition or performance. Because of this, an athlete may be susceptible to overuse and chronic injuries.[1] Due to the nature of athletics, athletes may continue to train through pain, which contributes to compensation and dysfunction.[1] Athletics may be viewed as a complex series of movements that involve significant strength, flexibility, stability and cardiovascular endurance.[2]

Patellofemoral pain syndrome (PFPS) is a common pain disorder experienced by both young and adult patients.[3,4] Females appear to be 2.33 times more likely to develop PFPS as compared to males.[5,6] It has been reported that PFPS accounts for 25-40% of all knee problems seen in a sports clinic.[5] Teitge[7] surveyed physical therapists, primary care physicians and sports medicine physicians to establish how many patients they see with patellofemoral pain (PFP). Of the 57,555 patients seen, 1,782 presented with anterior knee pain (AKP), of which 303 were coded as PFPS.[7.8] The diagnosis of PFPS is made based upon the presence of anterior or retropatellar knee pain in the absence of other specific pathology.[9] PFPS may be aggravated by activities such as, squatting, ascending and descending stairs, prolonged sitting and repetitive activities such as running.[10]

The source of PFPS is multifaceted, and once factors that have a direct relationship to pain (ligament tear, acute trauma, arthritis, joint replacement) are ruled out, a large percentage of patients remain with what is termed "idiopathic patellofemoral pain". [11] The following factors that are thought to contribute to the development of PFPS; quadriceps weakness, excessive foot pronation, forefoot kinematics, increased Q angle, patella alta, iliotibial band and vastus lateralis tightness, malalignment of the femur (excessive hip adduction and/or hip internal rotation), imbalance in the quadriceps musculature and weakness of the proximal hip musculature.[10,12-14] According to a consensus statement from the 3rd International Patellofemoral Pain Research Retreat, new research has added to the consensus that proximal upper extremity factors and distal lower extremity factors play a significant role in the development of PFPS.[10] The PFPS consensus statement represents updated knowledge of PFPS that will allow clinicians to evolve their knowledge and integrate findings into their clinical practice.[10]

The regional interdependence model is defined as the notion that, “a patient’s primary musculoskeletal symptom(s) may be directly or indirectly related or influenced by impairments from body regions and systems regardless of proximity to the primary symptom(s)”.[15] Sueki and Chanocas[16] described the importance of RI when understanding how the body attempts to restore homeostasis following injury and disruption to the set physical parameters of the body.[16] The alterations or compensations the body goes through will remain long after the injured tissue has healed, and, more often than not, if the true cause of the compensation is not discovered the body will continue to remain in an unequal state.[16] It is difficult to ascertain how the RI concept fits into the current medical model. The causes behind this uncertainty are twofold. First, clinicians are expected to determine a diagnostic label, and, second, not all musculoskeletal pain will allow for such clear-cut diagnosis. [15] Traditional diagnoses, which exclude the RI model, may limit subsequent treatment options if and when a more detailed evaluation is performed. [15] Also, clinicians may be labeling musculoskeletal pain without there being clear and precise signs and symptoms. The importance of screening the proximal and distal joints to the site of pain cannot be emphasized enough; without thorough evaluation valuable information regarding dysfunction may be missed and injury mismanagement will occur.[17] In accordance with the RI theory, many researchers have found that there is a strong relationship between pain location and subsequent dysfunction in unrelated structures, for example the torso and knee. [2,18-21]

Traditionally, PFPS has been treated by an intense focus on the knee. While this once was a logical tactic, current research has provided a strong foundation as to why expanding upon a localized evaluation should be considered along with traditional methods for treatment of any pain exhibited.[15,22] The RI concept may allow clinicians to provide a more comprehensive approach to evaluation and subsequent treatment.

Focused Clinical Question

Is there current evidence to suggest patients suffering from PFPS will benefit from treatment approaches away from the knee specifically, neuromuscular re-education to the proximal hip musculature or manual therapy techniques applied to the lumbopelvic hip complex?

Search Strategy

A computerized search was completed was completed in February and March 2014. The search terms used were:

- Patellofemoral Pain Syndrome (PFPS)
- Anterior knee pain (AKP)
- Neuromuscular reeducation
- Regional Interdependence

The criteria for study selection were as follows.

Inclusion Criteria

- Published in the last 12 years (2003-current)
- Limited to the English language
- Studies involving subjects who currently have symptoms of PFPS
- Studies using interventions aimed at musculoskeletal regions proximal or distal to the knee

- Studies using neuromuscular re-education techniques

Exclusion Criteria

- Studies investigating treatment options directed at knee
- Studies investigating knee pain not associated with PFPS

Results of Search

Summary of Search, Best Evidence Appraised, and Key Findings

- The search of the literature provided 35 possible resources (Figure 3.1)
- Three sources were identified as textbooks
- Seven studies met the inclusion criteria

Figure 3.1 Summary of search history

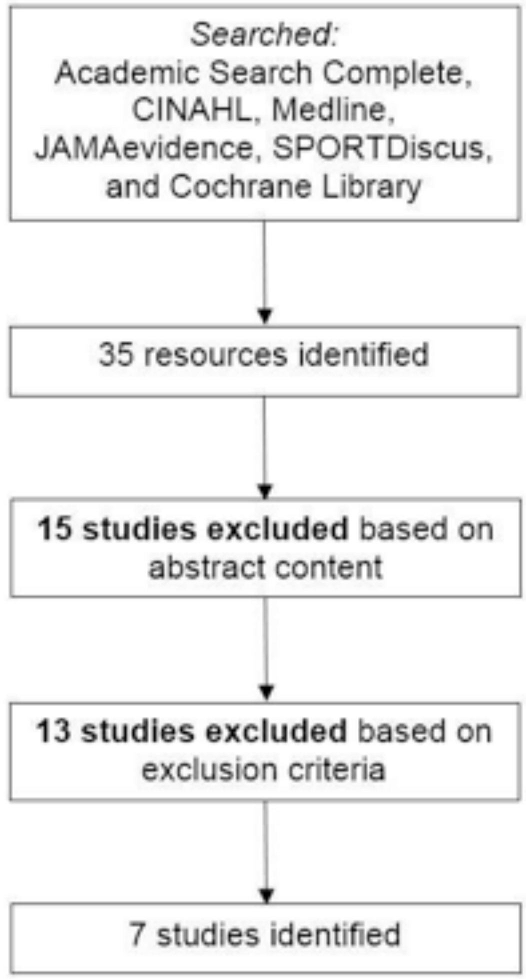

Table 3.1. Characteristics of Studies Utilizing Neuromuscular Re-education Techniques

	Study Authors			
	Cibulka & Threlkeld-Watkins[13]	Boling et al.[23]	Welsh et al.[2]	Dolak et al.[24]
Study Title	Patellofemoral Pain and Asymmetrical Hip Rotation	Outcomes of a Weight-Bearing Rehabilitation Program for Patients Diagnosed with Patellofemoral Pain Syndrome	Rehabilitation of a Female Dancer with Patellofemoral Pain Syndrome: Applying Concepts of Regional Interdependence in Practice	Hip Strengthening Prior to Functional Exercise Reduces Pain Sooner than Quadriceps Strengthening in Females with Patellofemoral Pain Syndrome: A Randomized Clinical Trail
Study Participants	15-year-old female with 8-month history of right AKP	14 subjects with PFPS; 14 healthy controls	17-year-old female with 1-year history left AKP	33 females with PFPS; ½ received hip strengthening and 1/2 received quadriceps strengthening
Inclusion/Exclusion Criteria	None reported	AKP with activity, no trauma, pain with compression of patella pain with palpation of facets, 30 min of exercise 3´/week, evidence of knee pathology, symptoms present for <2 months, history of subluxations	None reported	AKP during two activities, insidious onset of symptoms, pain with compression of pain with palpation of patellar facets, symptoms present for < month, history of knee surgery, history of patella dislocation or subluxation, any other significant injury to lower extremity
Outcome Measures	*Collected:* Pain rating, WOMAC, hip medial rotation ROM *Measured:* Initial evaluation, 14 days, and 6 months following intervention	*Collected:* VAS, FIQ *Measured:* Pretest, posttest each week of intervention	*Collected:* VAS, muscle strength, LEFS, PSFS *Measured:* Initial, 1 week, 2 weeks, 3 weeks, 4 weeks, 6 weeks	*Collected:* VAS, LEFS, isometric strength of hip abduction/hip external rotation, knee extension *Measured:* Baseline, 4 weeks, 8 weeks, 3 months
Intervention	Strengthening exercises for hip abduction/internal rotation, contract-relax stretch into medial rotation	6-week weight-bearing strength program, quadriceps/hip abductor musculature	6-week proximal hip musculature strengthening program	Hip strengthening group, quadriceps strengthening group, for a total of 8 weeks with reassessment at 4-week point
Results	Pain: 6/10 to 0/10 WOMAC: 24% to 0% Hip ROM: 35° to 60°	VAS: 4.85 to 1.92 FIQ: 10 to 14 Significant improvement in VL vs. VMO timing differences pretest vs. posttest	VAS: 8/10 to 0/10 Hip strength/knee flexion/extension: 4/5 to 5/5 LEFS: 49/80 to 74/80 PSFS: 3.7/10 to 8.7/10	VAS: hip = 4.6 to 2.4 to 2.4; quad = 4.2 to 4.1 to 2.6 All subjects LEFS: 56.5 to 63 to 67.6 Post hoc analysis of strength: hip group significant increase
Level of Evidence	4	3	4	4
Support for the Answer	Yes	Yes	Yes	Yes

Abbreviations: AKP= anterior knee pain; PFPS= patellofemoral pain syndrome; WOMAC= Western Ontario and McMaster University Osteoarthritis Index; ROM= range of motion; VAS= visual analogue scale; FIQ= Functional Index Questionnaire; LEFS= Lower Extremity Functional Scale; PSFS= Patient Specific Functional Scale; VL= vatus lateralis; VMO= vastus medialis oblique

Table 3.2. Characteristics of Studies Utilizing Manual Therapy Techniques

	Study Authors		
	Iverson et al.[25]	Cookson[18]	Vaughn[19]
Study Title	Lumbopelvic Manipulation for the Treatment of Patients with Patellofemoral Pain Syndrome: The Development of a Clinical Prediction Rule	Atypical Knee Pain: The Biomechanical and Neurological Relationship Between the Pelvis, Hip and Knee–A Case Report	Isolated Knee Pain: A Case Report Highlighting Regional Interdependence
Study Participants	49 subjects	31-year-old male with 2-week history of right AKP	25-year-old female with 4-week history of right AKP
Inclusion/Exclusion Criteria	18–50 years of age, clinical diagnosis of PFPS, pregnancy, nerve root compression, point tenderness along joint lines or patellar tendon, positive special tests	None reported	None reported
Outcome Measures	*Collected:* NPRS, GRC, isometric hip strength, isometric knee strength, hip internal rotation AROM *Measured:* NPRS following 1 of 3 functional tests, GRC following intervention	*Collected:* VAS *Measured:* Pretreatment, posttreatment	*Collected:* VAS, Lysholm Scale *Measured:* Pretreatment, posttreatment, 1 week posttreatment
Intervention	Lumbopelvic manipulation technique	Right side SI manipulation, supine long-axis hip mobilization, supine posterior proximal tibia manipulation	Pubic symphysis mobilization utilizing muscle energy technique, right side SI manipulation
Results	22/49 subjects had 50% or greater NPRS improvement; 17/22 of success subjects met criteria for improvement on NPRS and GRC	VAS: 7/10 to 0/10 1 week post VAS: 0/10	VAS: 6/10 to 0/10 Lysholm Scale: 79 to 100
Level of Evidence	2b	4	4
Support for the Answer	Yes	Yes	Yes

Abbreviations: AKP = anterior knee pain; PFPS = patellofemoral pain syndrome; NPRS = Numerical Pain Rating Scale; GRC = Global Rating of Change Questionnaire; AROM = Active Range of Motion; VAS = visual analog scale; SI = Sacroiliac.

Clinical Bottom Line

There is moderate evidence suggesting favorable outcomes following interventions aimed at musculoskeletal regions away from the location of AKP, supporting the RI approach. The studies provided reported improvements in patient-based outcomes, which included the visual analogue pain scale, LEFS (Lower Extremity Functional Scale), GRC (Global Rating of Change), PSFS (Patient Specific Functional Scale), Lysholm, and Western Ontario & McMaster University Osteoarthritis Index (WOMAC). In all of the seven studies evaluated, the researchers reported improvements when evaluating patient-based outcomes when using one or more of the patient-reported outcome measurement tools. The four studies utilizing rehabilitation intervention[2,13,23,24] and the three studies[18,19,25] utilizing manual therapy techniques were found to demonstrate improvements in patient pain perception as well as functional capabilities (see Tables 3.1 and 3.2).

Strength of Recommendation

There is Level C evidence to support improvements in short-term outcomes for patients using either rehabilitation intervention focused on proximal hip musculature or manual therapy technique applied to proximal lumbopelvic hip complex as evaluated by subjective patient-reported outcomes and clinician-based outcome measures.[26] The recommendation of Level C was given because the included studies contain level 4 evidence, defined by the Oxford Centre for Evidence-Based Medicine (CEBM) as case series, poorly designed cohort-studies and poorly designed case-control studies.[26] Level C represents difficulty in making a recommendation or decision for or against a particular treatment.[26]

Implications for Practice, Education and Future Research

Anterior knee pain has consistently been found to be one of the most common injuries reported by patients.[2,4,12,27,28] It has been reported that female athletes are more likely to suffer from AKP compared to male counterparts.[3] This is especially concerning as research has found females more often demonstrate knee valgus and hip internal rotation as compared with men and previous research has demonstrated a correlation between excessive femur adduction, internal rotation, and PFPS.[2] PFPS and AKP are common orthopedic conditions occurring in approximately 1 of every 4 individuals.[2,12]

As the clinician evaluates patients, rather than focusing on a single anatomical structure, it is recommended to expand upon examinations focusing only on the site of pain (i.e., anterior knee) and to include identification of other factors or regions that may be contributing to the patient's complaint of AKP.[15] The RI model of assessment may be an effective strategy to guide the clinician to observe remote regions, the subsequent movement patterns at a functional level, and identify successful interventions.[15,17]

Current and previous research has focused on multiple approaches to the treatment of PFPS. These interventions include strengthening of the hip musculature and quadriceps, and manual therapy aimed at improving patient's pain.[4] Although these two treatment choices have been critically reviewed, no one recommendation has been made and therefore a "gold standard" does not exist. A case study regarding the interdependence of hip and knee was presented by Welsh et al.,[2] where a RI approach was taken regarding the rehabilitation protocol for a female patient diagnosed with PFPS.[2] Welsh et al. initiated a five-week home exercise program focusing on proximal hip musculature activation as well as functional movements. The patient's strength, range of motion, and pain were assessed initially and weekly thereafter. Initial deficits in the kinetic chain (the kinetic chain represents a coordinated and sequenced activation, mobilization and stabilization of body segments to produce dynamic activity) included genu valgus with squatting as well as single leg squatting motions. At the conclusion of the 5-week home exercise program the patient's visual analog scale improved from 8/10 to 0/10, and the patient no longer demonstrated kinetic chain dysfunction.[2] In another example of successful intervention of anterior knee pain, Cookson treated AKP with hip and SI (Sacroiliac) manipulation with resulting elimination of pain and a return to pain-free running.[18] The importance of hip and SI involvement should not be overlooked in those suffering from knee pain, especially when there is no structural damage to the knee .[18] The knee appears to be related to more than just the torso and hip, and Vaughn demonstrates the spine's role.[19] Vaughn investigated the effects of a RI approach to evaluation of AKP in a female patient who was currently training for the Boston Marathon. Upon palpation of the pelvic girdle a posteriorly rotated innominate was noted on the right side. Based on these findings the author chose to perform mobilizations to the pubic symphysis utilizing two techniques. The techniques were (1) muscle energy techniques to the pubic symphysis and (2) thrust manipulation to the innominate bone. One week following the treatment the patient reported no pain and full running capabilities. The author concluded that while this is one case of cause and effect it does support the concept of RI when evaluating AKP.[19] PFPS has proven to be challenging to treat and the evidence demonstrates that it may be a multi-factorial issue; clinicians are not successful when they attempt to link PFPS to a single structure, but clinicians begin to see improvements when PFPS is evaluated and treated with an RI approach. The goal of this critically appraised topic (CAT) was to evaluate the evidence of treating PFPS from a RI approach so that clinicians could determine if this approach was applicable to their clinical situations based on analysis of patient and clinician-oriented evidence.

An important aspect of the CAT is the level of clinical practice evidence that has been provided by the included studies. The studies included in this CAT were rated according to the CEBM, which has designated categories that directs clinicians in answering clinically relevant questions.[26] Three of the four clinical studies that used a rehabilitation intervention were deemed level 4 because they were case studies, while one was deemed level 3b because it was an individual case control study. Two of the three clinical studies that used manual therapy as an intervention were level 4 because they were case studies, while one was deemed level 2b because it was an individual cohort study. The level of evidence and subsequent grade of recommendation are important aspects to the clinical decision making process. A large number of the included studies were case studies and while this may be considered a weakness, the outcomes reported by the authors demonstrate successful intervention with respect to both patient-reported outcomes and clinician-based outcome measures.

Currently there is no gold standard for the treatment of PFPS. The evidence presented in this CAT demonstrates that an RI treatment approach may be beneficial in improving patient outcomes when treating PFPS. While a majority of the evidence presented was single patient case studies, the clinical evidence still supports the need for clinicians to recognize a regional approach to PFPS. The studies included in this CAT provide clinical evidence to support both lumbopelvic hip complex rehabilitation and proximal manual therapy as effective means of eliminating pain associated with PFPS as well as improving patient perception of function. Higher quality of evidence, such as case-controlled studies and cohort studies that demonstrate consistent patient and clinician-based outcomes should be performed. This CAT should be reviewed in two years in order to update the clinical evidence that may change the bottom line for the clinical question.

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Chapter 4

An Analysis of Patient Outcomes When Applying the Total Motion Release® Technique to Treat Patients with Patellofemoral Pain Syndrome: An Applied Clinical Research Project

Context: Patellofemoral Pain Syndrome (PFPS) is a common complaint affecting both young and adult physically active individuals. Controversy exists over the exact etiology and as such, treatment may be challenging for clinicians. Novel treatments such as Total Motion Release® (TMR®) are recommended to provide immediate improvements on pain and mobility. ***Objective:*** To assess the clinical outcomes of patient's diagnosed with PFPS who were treated with TMR® technique in an outpatient clinical setting. ***Design:*** A Priori Case Series. ***Participants:*** Five patients [N=5 (3 females, 2 males), age 35.4 ± 8.65 years] diagnosed with PFPS. ***Intervention:*** TMR® was applied twice a week over the course of four weeks for a total of 8 treatments. ***Main Outcome Measurements:*** The Numerical Pain Rating Scale (NPRS), the Disability in the Physically Active (DPA Scale), the Lower Extremity Functional Scale (LEFS), the Patient Specific Functional Scale (PSFS) and the Modified Star Excursion Balance Test (mSEBT) were administered to identify patient-reported pain and function. ***Results:*** The use of TMR® to treat PFPS resulted in reduction in pain across all subjects. Over the course of eight treatments improvements in measures of function (DPA scale, LEFS, PSFS and mSEBT) were also found. ***Conclusion:*** The results of this case series provide evidence to support the use of TMR® in addressing pain and dysfunction as a result of PFPS. Based on these results, clinicians may consider the use of TMR® to treat patients with a chief complaint of PFPS.

Keywords: Patellofemoral Pain Syndrome, Total Motion Release, Outcome Measures

Patellofemoral Pain Syndrome (PFPS) is a common complaint by both young and adult patients, accounting for 25-40% of all knee problems seen in sport clinics.[1] Traditionally, diagnosis of PFPS is made based upon the presence of anterior or retropatellar knee pain, often occurring during the motions of squatting, ascending and descending stairs and prolonged sitting.[2] Patellofemoral pain syndrome has a multifaceted etiology and current studies assessing the accuracy of clinical tests for PFPS, have not identified a single clinical test ideal to diagnose PFPS. Currently the exact etiology of PFPS is not well understood. Researchers have identified several factors thought to contribute to the development of PFPS, which include quadriceps weakness, excessive foot pronation, patella alta, iliotibial band and vastus lateralis tightness, malalignment of the femur (excessive hip adduction and/or hip internal rotation), imbalance in the quadriceps musculature and weakness of the proximal hip.[3-6]

Traditionally, patients diagnosed with PFPS have been treated with a primary focus on the knee and while this was once appropriate, the highlighted trends in research support a more global (i.e., whole body) approach.[6] Further, the focus of previous research related to treating PFPS has been multidimensional.[2-6] Interventions commonly recommended to treat PFPS include patellar taping, strengthening of the hip musculature and quadriceps, manual therapy and foot orthoses.[2] Based on the current available literature there appears to be no isolated intervention that has an absolute impact on the resolution of PFPS symptoms, and more importantly long-term resolution. Researchers investigated the effects of a proximal strengthening program on patients classified with PFPS and observed improvements in outcome measures anywhere between 2, 6, and 9-week intervals.[1,2,4] Witvrouw and colleagues[6] noted that while therapeutic exercise continues to be the common intervention choice of clinicians, most effects are short-term while 40% of patients do not feel they fully recovered one year following treatment. Researchers that investigated the effects of sacroiliac joint manipulation on PFPS highlighted immediate changes in muscle inhibition of the quadriceps muscle group but did not perform follow up to determine long term effects.[7] Based on this evidence it is important to investigate the effects of intervention strategies that primarily focus on a global approach to treatment.

Total Motion Release® is a technique utilized to evaluate and treat body motion imbalances and is related to the concept that the body is a unified system striving to maintain a dynamic center of gravity.[8] In TMR®, patients use a 1 (no dysfunction, pain or asymmetry) to 100 (complete dysfunction, pain or asymmetry) scale to describe the movement quality of the particular TMR® screening movement.[8] In a traditional TMR® treatment, six motions (Appendix A) are performed by the patient: 1) arm raise, 2) bent arm wall push-up, 3) trunk twist, 4) single-leg sit to stand, 5) leg raise and 6) weight-bearing toe touch.[8] Each of the six motions are performed by the patient, self assessed bilaterally (using 1-100 scale), and compared bilaterally. The motion with the greatest imbalance (e.g., trunk twist right – 20, and trunk twist left – 80 is a 60 point imbalance discrepancy and if greater than the other 5 motions) is identified and treated first.[8]

Unlike most patient care strategies, the patient's good side (i.e. side scored lowest right vs. left) is treated with a combination of repetitions (e.g., 2 sets of 10 repetitions) or isometric holds (e.g., 2 sets of 20 second holds).[8] Once initial treatment is completed the patient re-evaluates the motion and based on the results a determination will be made to either 1) continue treating the motion with repetitions or isometric holds in the same manner, 2) modify the treatment motion (e.g., changing repetitions, isometric hold time or provide assistance to the motion)or 3) move to the next imbalance.[8] In general, the patient continues to progress to the next greatest imbalance score until all six of the motions have been treated or identified imbalances have been resolved.[8] The goal is to create symmetry in the TMR® movements between the left side and right side.[8] Further, resolving at least one upper body, a trunk and one lower body imbalance is recommended for each session in order to maximize the treatment effect and retention of movement quality.[8]

While TMR® technique is a relatively un-researched approach to patient care, evidence exists to supporting the use of the technique.[9,10] Researchers reported significant improvements in range of motion in a patient diagnosed with bilateral tissue extensibility dysfunction in the posterior lower extremity following three TMR® treatments over the course of five days.[9] Similarly, researchers reported improved range of motion deficits in the upper extremity and found increases in shoulder mobility following TMR® treatments in male high school and collegiate aged baseball athletes.[10] However, there are no peer-reviewed articles that illustrates utilizing TMR® to treat patients with PFPS. Therefore the purpose of this a priori designed case series was to assess the clinical outcomes of patients diagnosed with PFPS who were treated with TMR® technique. It was theorized that using the TMR® technique would assist in resolving symptoms associated with PFPS as measured by patient reported outcomes.

Methodology

Participants

Patients were included in the study if they presented with the following: anterior or retropatellar knee pain in the absence of other specific pathology, positive PFPS special orthopedic tests (pain with squatting, pain with kneeling, compression test, vastus medialis coordination test, patellar tilt test) and were free of identified exclusionary knee conditions. Patients were excluded if they had rheumatoid arthritis, total knee arthroplasty, fracture, growth plate injury, post operative knee surgeries, positive clinical tests of ligamentous involvement, clinical exam consistent with non-musculoskeletal etiology, <18 years of age, or > 50 years of age.

Based upon history and clinical examination (pain location and PFPS orthopedic special tests presented in Table 1) five patients [N=5 (3 females, 2 males), age 35.4 ± 8.65 years] met the inclusion criteria to receive the Total Motion Release® (TMR®) technique. There were no contraindications that would preclude the patients from TMR® technique. All patients were evaluated in the same manner to determine eligibility for inclusion. Outcome measures were collected for all patients enrolled in the study. Each patient was treated using TMR® protocol. No other intervention (e.g. stretching, cryotherapy) was applied and no activity modifications were imposed. Each patient gave informed consent to the use of data concerning his/her case for publication per Institutional Review Board approval.

Outcome Measures

Outcome measures were utilized to assess treatment effectiveness. The outcome measures chosen for this case series have, established, minimal clinically important differences (MCID), which clinicians may use to assess meaningful patient reported changes. The NPRS is a method for patients to assess current pain intensity and scored 0 (no pain) to 10 (severe pain).[11] A decrease of 2-points or 30% has been established as an MCID.[11] The DPA scale, designed for the physically active includes questions relating to health-related quality of life, impairment, functional limitations, and disabilities. The DPA scale is completed by the patient and scored from 0 to 64.[12] A MCID of 6 points on the DPA scale has been established for patients with persistent conditions and 9 points for patients with acute conditions.[12] Normal ranges for uninjured, healthy participants has been reported at a range of 0-34.[12] The LEFS is a questionnaire that rates the level of difficulty of lower extremity functional tasks from 0 (extreme difficulty) to 4 points (no difficulty) with a maximum score of 80.[13] A MCID of 9 points has been associated with improvement.[13] The PSFS is a self-reported patient specific measure designed to assess functional change, scored 0 (unable to perform) to 10 (able to perform at same level before injury).[14] In this case series, each patient was asked to perform and score three motions: descending stairs, single leg squat performed with an anterior reach with the unaffected leg and patient's identified meaningful task. A MCID of 3 points is associated with meaningful improvement.[14]

Procedures

Orthopedic Examination

Patients were examined at baseline, at the completion of weekly treatments (i.e., weeks 2 and 3), discharge (i.e., 4th week), and at 1-month follow-up. All examinations included an orthopedic assessment, history relating to pain location, intensity, and frequency as well as prior musculoskeletal history of injury only at baseline. Each patient underwent an orthopedic examination that included active range of motion and special tests. Goniometric measurements utilizing a goniometer included: knee flexion and extension and hip flexion, extension, abduction, adduction, and internal and external rotation. Knee special tests were performed to rule out other knee pathologies that may be present and exclude a patient from participation, these included: Lachman's Test, Valgus Stress Test, Varus Stress Test, and Appley's Compression/Distraction Test. Patellofemoral Pain Syndrome special tests were performed to determine the presence of PFPS, these included: Pain with Squatting, Pain with Kneeling, Compression Test, Vastus Medialis Coordination Test and Patellar Tilt Test. The modified Star Excursion Balance Test (mSEBT) was performed to measure dynamic balance and function of a single limb. The mSEBT is commonly used as a screening tool to evaluate dynamic balance in the lower extremity, assess deficits and recognize patients who are at risk for a lower extremity injury.[15] The patient performed three maximal reaches with the nonstance limb in the anterior, posteromedial and posterolateral directions while maintaining single-leg stance on the test limb.[15] Three test trials were performed on each leg. The distance (in centimeters) of the most distal portion of the reach foot as it contacts the grid for each of the three directions was recorded for each leg. For each direction the greatest reach distance was used to calculate the composite mSEBT score. The three reach distances (anterior, posteromedial, and posterolateral) were averaged then divided by limb length to result in a single composite mSEBT score per patient. Limb length was measured from the anterior superior iliac spine to the medial malleoli bilaterally. Finally, each patient was asked to identify a meaningful task they were limited in or reported increased symptoms as related to their complaints of PFPS. Each patient was asked to perform the meaningful task and rate pain using the NPRS. The meaningful task/movement was assessed prior to performing the TMR® technique and following TMR® technique each treatment visit.

Outcome Measurement Time Intervals

The NPRS was administered pre- and post-treatment, discharge and 1-month follow-up. The DPA scale, LEFS and mSEBT were administered at initial evaluation, once a week thereafter, discharge and 1-month follow-up. The PSFS was administered at initial evaluation, at the beginning of each treatment, upon completion of intervention, discharge and 1-month follow-up. Following the collection of outcomes measures, TMR® technique was applied to each patient as described in Intervention and available in further detail in Appendix B.

Intervention

After the initial orthopedic examination, a treatment protocol using only TMR® technique was performed by the same primary investigator. The primary investigator had completed TMR® coursework, incorporated TMR® technique into clinical practice over the past two years and is considered a novice practitioner of TMR®. Each patient was instructed to perform the Fab 6 motions (Appendix A) on both the left and right side and identify which side had the greatest asymmetry. Each patient graded their problem side on a scale of 1-100 with 100 representing a high level of asymmetry and 1 representing no asymmetry. The grade is based on patient perceived range and quality of motion, stability of motion and sensation(s) (e.g., pain, tightness). Based on the patient reported FAB 6 score the primary investigator determined two motions (one upper & one lower) each patient would perform as a treatment. In addition, each patient performed the trunk twist and was instructed to perform the motion of the highest asymmetry on the easier side (right vs. left). The patient was asked to perform 2 sets of 8 reps for the sit to stand motion and 2 sets of 10 second isometric holds for all other motions with a 60 second rest between each set. After completing the initial treatment, the patient re-tested the side of asymmetry by performing the identified Fab 6 motion and rated improvement. Each patient re-tested both the upper and lower motion that was identified in TMR® evaluation and subsequently scored. During the initial evaluation each patient identified an impairment measure (meaningful task) experienced as a result of PFPS. The meaningful task was re-assessed at the completion of 2 sets of exercise. Based on the patient reported changes the treatment either remained the same or was modified based on the TMR® rules (Appendix B). The TMR® treatment was applied two times per week for four weeks as a means of addressing movement asymmetries/dysfunction. The TMR® assessment and intervention was performed in the same manner each treatment visit. The patients were not given a home exercise program to complete between visits while participating in physical activity as able.

Results

Numerical Pain Rating Scale

The mean values for NPRS are reported in Table 2. The NPRS at discharge (mean 0.8 ± 0.8 points) was lower than baseline NPRS (mean 2.8 ± 0.8 points) meeting the established MCID in the literature and indicating a meaningful change in current pain perception.[11] Patient #3 reported a NPRS that met the MCID value after 1 week of treatment and at the 3rd week of treatment three patients (Patient #2, #4, #5) reported meaningful changes in the NPRS that met the MCID value. Additionally, all five patients maintained or reported a decrease NPRS from discharge to 1-month follow-up. The NPRS at 1-month follow-up (mean 0.6 ± 0.9 points) was lower than baseline NPRS (mean 2.8 ± 0.8 points) and all five patients reported a MCID value at 1-month follow-up.

Disability in the Physically Active Scale

The mean values for DPA scale are reported in Table 3. The DPA scale score at discharge (mean 20.0 ± 6.2 points) was lower than baseline DPA scale score (mean 26.0 ± 6.1 points) meeting the established MCID in the literature and indicating a meaningful change in the patient's perception of disability.[12] Two patients (Patient #1 and # 5) reported changes on the DPA scale at week 2 that met the MCID value and were maintained through discharge. Patient #4 reported changes on the DPA scale at week 3 that met the MCID value and was maintained through discharge. The DPA scale score at 1-month follow-up (mean 19.6 ± 5.4) was lower than baseline DPA scale score (mean 26.0 ± 6.1 points) and discharge DPA scale score (20.0 ± 6.2 points). At discharge and 1-month follow-up 100% of patients continued to report a DPA scale score within the reported range for uninjured, healthy patients.[12] Important to note, the initial baseline DPA scale scores of all five patients in this study were within the reported range for healthy, uninjured patients and therefore the scores may not have been reported at a level in which to expect an MCID.

Lower Extremity Functional Scale

The mean values for LEFS are reported in Table 4. The LEFS score at discharge (mean 69.0 ± 10.1 points) was higher than baseline LEFS score (mean 65.0 ± 3.7 points), indicating improvement. Occurring at discharge, one patient (Patient #5) reported a score (increase of 9 points), which met the MCID value. Four patients reported an increase in LEFS scores at discharge (mean 69.0 ± 10.1 points) and 1-month follow-up (mean 72.0 ± 6.3 points).

Patient Specific Functional Scale

The mean values for PSFS are reported in Table 5. The PSFS score at discharge (mean 8.8 ± 1.0 points) increased as compared to baseline PSFS score (mean 5.1 ± 0.7 points) exceeding the established MCID in the literature and indicating a meaningful change in the patients perception of function.[14] After two weeks of treatment, Patient #2 reported a PSFS score that met the MCID value and at week three, Patient #1 reported a PSFS score that exceeded the MCID value. At discharge four patients reported an 8 or higher, with 10 representing the highest score possible. At the 1-month follow-up, all five patients reported a score of 8 or higher. The PSFS score at 1-month follow-up (mean

8.7 ± 0.5 points) improved as compared to baseline PSFS score (mean 5.1 ± 0.7 points) meeting the MCID value.

Modified Star Excursion Balance Test

The individual composite mSEBT scores (affected and unaffected sides) are reported in Table 6. Daily activities impacted individual patient scores over the course of four weeks, however an overall trend of improvement in composite mSEBT scores (affected and unaffected sides) at discharge compared to baseline was observed. Four patients demonstrated improvement in both the affected and unaffected side composite mSEBT scores at discharge as compared to baseline. At 1-month follow-up all five patients demonstrated improvement in unaffected side composite mSEBT scores as compared to baseline.

The changes in mSEBT asymmetry (side-to-side differences in kinematics during task performance) are also presented in Table 6. Four patients demonstrated improvement in side–to-side asymmetry at discharge as compared to baseline as well as 1-month-follow-up as compared to baseline.

Discussion

This case series, exploratory in nature, was performed to investigate the treatment effect of the TMR® technique on patients diagnosed with PFPS. The patients in this case series reported positive changes in collected patient-oriented outcome measures at completion of weekly treatment sessions, discharge and 1-month follow-up, highlighting positive effects of the TMR® technique. The TMR® technique was effective at addressing patients dysfunction as indicated by reduction in pain and improvement in function at discharge in a total of eight treatments over the course of four weeks as measured by improvements in measures of function (DPA scale, LEFS, PSFS and mSEBT).

Patellofemoral pain syndrome has consistently been found to be one of the most common knee injuries reported by patients.[1-4,6] Current and previous research has focused on multiple approaches to the treatment of PFPS and although these treatment choices have been critically reviewed, no one recommendation has been recognized as a “gold standard”. Current treatment of PFPS has focused on a variety of proximal, distal and local factors thought to contribute to the development of PFPS and as a result numerous conservative treatments including taping, orthoses and strengthening of hip and quadriceps musculature are commonly prescribed.[2] Current evidence suggests the use of patellar taping and orthoses may be beneficial for short-term pain relief but as a stand-alone treatment would not be considered adequate and importantly the long-term effects remain inconsistent at best.[16,17]

Recently, factors proximal to the patellofemoral joint such as weakness of muscles surrounding the hip and abnormal trunk movement has been found to play a role in the development of PFPS and subsequently the focus of treatment.[16,18] Baldon et al.[18] compared the effects of global emphasis treatment focused on strengthening of hip-musculature and functional stabilization training (FST) to a primarily local treatment focused on quadriceps strengthening (ST). Patients from both groups performed the training protocol 3 times per week for 8 weeks. The outcomes of pain as measured by the visual analogue scale (0-10 cm) and function as measured by the LEFS (0-80) were reported at baseline, discharge and 3-month follow-up. The FST group performed a total of 15 exercises that lasted 90 to 120 minutes in duration per session and the ST group performed 8 exercises for duration of 75 to 90 minutes per session. At the conclusion of 8 weeks of treatment the FST group reported greater improvement in mean pain scores at discharge (1.4 ± 1.4) and 3-month follow-up (0.9 ± 1.5) as compared to the ST mean pain scores at discharge (3.1 ± 3.2) and 3-month follow-up (2.5 ± 2.7). Similarly, patients treated with TMR in this case series, also reported improvements in mean pain scores as measured by NPRS at discharge (0.8 ± 0.8) and 1-month follow-up (0.6 ± 0.9). Patients in this case series also reported improvement in function as measured by mean scores on the LEFS at discharge (69.0 ± 10.1) and 1-month follow-up (72.0 ± 6.3) as compared to baseline (65.0 ± 3.7). In the Baldon et al.[18] study the FST group reported a similar improvement in mean scores on the LEFS at discharge (74.3 ± 4.6) and 3-month follow-up (74.9 ± 3.9) as compared to baseline (55.4 ± 12.8). The ST group mean scores at discharge (70.6 ± 8.0) and 3-month follow-up (70.4 ± 8.4) also improved as compared to baseline (57.6 ± 7.2). While both groups (FST and ST) experienced improvements in reported outcome measures, the FST group, which utilized exercises emphasizing a global approach to the treatment of PFPS, exhibited greater treatment success at discharge and follow-up. The TMR® intervention used in this current case series also emphasized a global focus and patients reported improvements in additional patient-oriented outcome measures (DPA scale, PSFS, mSEBT) following a relatively short treatment session (approximately 5 minutes/treatment session) as compared to the 90-minute treatment session used by Baldon et al.[18] The shorter treatment time associated with TMR® technique may be beneficial, both for clinicians as well as patients. Researchers[1,2,4,18] that have investigated the effects of a strengthening program for the treatment of PFPS reported improvements in outcome measures between 2, 6, 8 and 9 week intervals, while the patients in this current case series who received treatment to the good side only, reported improvements in patient-oriented outcome measures at the completion of each week of treatment, discharge and additionally, maintained or continued to improve at 1-month follow-up.

Total Motion Release® is a novel treatment option and the underlying theory of TMR® may not be well understood. One possible theory that may explain the actions of how TMR® works is the concept of cross education which describes the strength gains in opposite, untrained limb following unilateral resistance training.[19,20] It has been hypothesized that cross education occurs in one of two ways: 1) unilateral resistance training may activate neural circuits that modify the efficacy of motor pathways that project to the opposite limb or 2) unilateral resistance training induces adaptations in motor areas within the central nervous system that are primarily involved in the control of movements of the trained limb.[19,20] The TMR ® technique applied in this case series was performed on the good side of the body, which may increase brain activation patterns, specifically stimulating adaptations in the neural circuits that project to the muscles of the opposite or untrained limb by way of a new motor engram that is subsequently used bilaterally.[20] A second theory that may explain how TMR® works to improve muscle imbalances is the fascial system, what some consider the biomechanical regulatory system.[21] Fascia, a whole-body, uninterrupted three-dimensional viscoelastic web of support, is thought to transmit mechanical forces generated by muscles.[21] Fascia functions like adjustable tensegrity around the skeletal system, meaning it acts as a continually inward tension system distributing stress and strain evenly within the human body.[21] Because TMR® utilizes the patients perceived good side to perform motion, the fascial system acts as a balanced regulatory system, which further allows the fascia to perform a modulating role in force generation and mechanosensory fine-tuning, thereby improving neuromuscular coordination. Finally, neural coupling which relates to the concept of brain-based modulation and coordination of sensation and movement in the body may also support the theory of TMR® technique.[22] Researchers have demonstrated that motion of the upper extremity promotes neuromuscular activation of the lower extremity and vice versa as a result of spinal connections in the locomotor neural networks which provides support to the theory that upper body limb motion and trunk rotation used during a TMR® treatment may have an effect on lower extremity motion.[22] The methods described above, while not mutually exclusive, may be used to explain how unilateral training, as seen in the TMR® technique can produce bilateral improvements.

In this case series the use of TMR® technique resulted in improvements on patient-reported outcome measures. Important to note, the patients in this case series had lower initial pain scores (2.8±.8 on NPRS) and higher initial functional outcome measures (65.0±3.7 on LEFS and 5.1±.7 on PSFS) at baseline compared to available literature.[2,17,23] In addition, all five patients reported a baseline DPA scale score within the normative range (0-34) for uninjured, healthy patients (26.0±6.1). While there are individual exceptions, a global focus on individual patient results indicates a consistent trend of improvement over time as well as specific pre and post TMR® treatment measures (NPRS, DPA scale, LEFS, PSFS and mSEBT). At discharge, TMR® treatment improved scores on the NPRS, DPA scale, LEFS, PSFS and mSEBT. The trend in NPRS and PSFS improvement was clinically meaningful indicating that TMR® treatment may led to a reduction in pain. The technique also appeared to have long-lasting results for a majority of the patients without any continued intervention. In the future, it is suggested that researchers utilize stricter inclusion criteria in order to prevent the occurrence of ceiling and floor effects and more accurately assess patient progress.

Of clinical importance, all five patients reported negative PFPS special orthopedic tests (pain with squatting, pain with kneeling, compression test, vastus medialis coordination test, patellar tilt test) at discharge that were previously reported as positive at baseline exam. In addition, 100% of patient's reported a meaningful task score that met or exceeded the MCID value on the PSFS and overall reported a higher PSFS score at discharge as compared to previous patellofemoral research that utilized the PSFS.[23] At the 1-month follow up, 80% of the patients remained pain-free or continued to improve and none reported a return of their symptoms. It appears clinicians may utilize the PFPS special tests included in this case series as well as a patient-reported functional scale such as the PSFS to monitor patient progress and guide clinical decisions and effectiveness.

Several limitations were identified in the study. This was a priori designed case series rather than randomized trial and the number of patients (n=5) was insufficient for a control or comparison group. It is unclear if the observed results would apply to a larger or different population of participants. In addition, the primary investigator was not blinded to the treatment or outcomes, which may bias the results. Finally, the primary investigator of the study was a novice at applying TMR® and therefore did not have years of clinical practice using TMR® to develop expertise. The TMR® technique was standardized for this study and while many of the steps would remain the same it is important to note that in clinical practice the primary investigator may treat differently as TMR® technique has multiple levels and positions for treatment. Additional research is necessary to determine the effectiveness of TMR® technique as treatment for other musculoskeletal conditions and in combination with other therapies.

Conclusion

The present case series is the first to consider the use of the TMR® technique for the treatment of patients diagnosed with PFPS. In this case series, the use of TMR® technique was associated with reported improvements in patient-oriented evidence such as pain perception (NPRS), disability (DPA scale), and function (LEFS, PSFS and mSEBT). The patients did not require additional treatment following discharge, and improvements were maintained at 1-month follow-up. Based on these results, clinicians may consider the use of TMR® to treat patients with a chief complaint of PFPS but additional research is warranted and needed to further understand the effects of the TMR® technique on PFPS as well as other injuries.

Table 1- Patient History

	Side	PFPS Special Orthopedic Tests	Length of Pain	Previous Tx
Patient #1	R	Squat	2 months	Cryo, NSAIDs, Rehab
Patient #2	R	Squat, Kneel	2 Years	NSAIDs, Rehab
Patient #3	R	Squat, Kneel	1 year	None
Patient #4	L	Squat, VMO Coordination, Patellar Tilt	2 years	Cryo, NSAIDs
Patient #5	L	Squat, Kneel	2 years	Massage

Table 2- Numerical Pain Rating Scale Scores at Baseline, Discharge and at 1-Month Follow-up

Patient	Baseline	Week 1	Week 2	Week 3	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	4	3	3	0*	0	4♦	0^	4♦
2	3	4	3	1*	0	3♦	1^	2♦
3	2	0*	1	1	1	1	0^	2♦
4	3	4	3	2*	2	1♦	2^	1♦
5	2	2	3	2*	1	1	0^	2♦
Mean ± STD	**2.8 ± 0.8**	**2.6 ± 1.7**	**2.6 ± 0.9**	**1.5 ± 0.6**	**0.8 ± 0.8**	**2.0 ± 1.4**	**0.6 ± 0.9**	**2.2 ± 1.1**

* MCID as compared to previous time point
^ MCID at Follow up as compared to Baseline
♦MCID for Total Change at Discharge and Follow up as compared to Baseline
Discharge- completion of 4th week

Table 3- Disability in the Physically Active Scale at Baseline, Discharge and at 1-Month Follow-Up

Patient	Baseline	Week 1	Week 2	Week 3	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	32	31	25*	20	16	16♦	22^	10♦
2	20	20	16	16	16	4	16	4
3	21	22	21	24	22	1	16	5
4	33	34	37	30*	30	3	28	5
5	24	23	16*	16	16	8♦	16^	8♦
Mean ± STD	**26.0 ± 6.1**	**26.0 ± 6.1**	**23.0 ± 8.7**	**21.2 ± 5.9**	**20.0 ± 6.2**	**6.0 ± 6.4**	**19.6 ± 5.4**	**6.4 ± 2.5**

* MCID as compared to previous time point
^ MCID at Follow up as compared to Baseline
♦MCID for Total Change at Discharge and Follow up as compared to Baseline
Discharge-completion of 4th week

Table 4- Lower Extremity Functional Scale at Baseline, Discharge and at 1-Month Follow-Up

Patient	Baseline	Week 1	Week 2	Week 3	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	71	70	71	68	72	**1**	72	**1**
2	66	65	69	76	79	**13♦**	79^	**13♦**
3	64	63	69	66	66	**8**	72	**2**
4	62	62	47	53	53	**0**	62	**9♦**
5	62	64	65	66	75*	**13♦**	75^	**13♦**
Mean ± STD	**65.0 ± 3.7**	**64.8 ± 3.1**	**64.2 ± 9.9**	**65.8 ± 8.3**	**69.0 ± 10.1**	**7.0 ± 6.3**	**72.0 ± 6.3**	**4.0 ± 9.3**

* MCID as compared to previous time point
^ MCID at Follow up as compared to Baseline
♦MCID for Total Change at Discharge and Follow up as compared to Baseline
Discharge- completion of 4th week

Table 5- Patient Specific Functional Scale Average Scores at Baseline, Discharge and at 1-Month Follow-Up

Patient	Baseline	Week 1	Week 2	Week 3	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	4.3	4.3	3.7	7*	9.7	4.7•	9^	5.4•
2	4.7	5.7	8.7*	9.3	10.0	4.3•	9^	5.3•
3	6.0	7.0	8.3	8.3	7.7	2.3	8.3	1.7
4	4.6	5.3	6.3	6.3	8.0	3.4•	8^	3.4•
5	5.7	6.0	6.0	7.7	8.7	3.3•	9^	3•
Mean ± STD	**5.1 ± 0.7**	**5.7 ± 1.0**	**6.6 ± 2.0**	**7.7 ± 1.2**	**8.8 ± 1.0**	**3.6 ± 0.9**	**8.7 ± 0.5**	**3.8 ± 1.6**

* MCID as compared to previous time point
^ MCID at Follow up as compared to Baseline
•MCID for Total Change at Discharge and Follow up as compared to Baseline
Discharge- completion of 4th week

Table 6- Modified Star Excursion Balance Test

Composite Score-Affected Side

Patient	Baseline	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	87.4	92.0	4.6	88.9	1.5
2	90.1	93.5	3.4	93.5	3.4
3	113.0	100.7	-12.3	101.4	-11.6
4	86.7	87.8	1.1	84.9	-1.8
5	78.5	79.6	1.1	80.0	1.5
Mean ± STD	**91.0 ± 13.0**	**90.7 ± 7.8**	**-0.4 ± 6.8**	**89.7 ± 8.2**	**-1.4 ± 6.0**

Composite Score-Unaffected Side

Patient	Baseline	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	83.5	90.8	7.3	88.5	5.0
2	86.1	94.6	8.5	93.2	7.1
3	106.5	105.1	-1.4	106.2	-0.3
4	75.4	89.5	14.1	88.8	13.4
5	79.3	81.9	2.6	82.6	3.3
Mean ± STD	**86.2 ± 12.1**	**92.4 ± 8.5**	**6.2 ± 5.9**	**91.9 ± 8.9**	**5.7 ± 5.0**

Asymmetry Composite Scores

Patient	Baseline	Discharge	Total Change Baseline to Discharge	Follow Up	Total Change Baseline to 1-month Follow-up
1	3.9	1.2	2.7	0.4	3.5
2	4.0	1.1	2.9	0.3	3.7
3	6.5	4.4	2.1	4.8	1.7
4	11.3	1.7	9.6	3.9	7.4
5	0.8	2.3	-1.5	2.6	-1.8
Mean ± STD	**5.3 ± 3.9**	**2.1 ± 1.4**	**3.2 ± 4.0**	**2.4 ± 2.0**	**2.9 ± 3.3**

Discharge- completion of week 4

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Appendix A

The Brand New Patient
The FAB 6

- Picture shared with approval from TMR® creator Dr. Tom Dalonzo Baker

Appendix B

1. Rule 1- If TMR® score(s) improved (score decreased by 15 or more-a decrease in score represented improvement) and major limitation improved- do same exercise again the exact same way. A maximum of four rounds of exercise was performed (2x8 or 2x10 sec static holds for 4 times).
2. Rule 2 - if TMR® score(s) had little to no change (score stayed the same, decreased by 14 or less or score increased) or major limitation was getting worse - 1st time- do exercise again. The PI may choose to make the exercise or major limitation movement easier for the patient. Changing repetitions, static hold time, adjusting height for Sit to Stand, or modifying the major limitation movement may accomplish this. If TMR® score(s) had little to no change a 2nd time in a row-tweak it. The tweak involved the patient performing the specific TMR® exercise in both internal rotation and external rotation position, both right and left side. The patient graded each direction (internal and external) 1-100, both right and left side. Grading by the patient resulted in 4 separate grades (R side IR/ER and L side IR/ER). The PI documented and monitored the scoring as to remain consistent with the TMR® rules defined in the study. The patient was asked to determine which of the 4 motions was the best of the best (BOB) and which of the 4 motions was the worst of the worst (WOW). The BOB was used to determine the side and rotation motion used for treatment.
    a. Patient was asked to perform the chosen TMR® motion for 2 sets (8 reps for Sit to Stand and 10 sec holds for all other motions) in the BOB identified motion.
        i. Following TMR® rules if score(s) improved (score decreased by 15 or more) and major limitation improved- do exercise exact same way (BOB)
            1. If TMR® score(s) had little to no change (score stayed the same, decreased by 14 or less or score increased) or major limitation got worse, 1st time perform the BOB exercise again. If TMR® score (s) had little to no change a 2nd time in a row perform TMR® motion for 2 sets in WOW identified motion.

3. Rule 3- If TMR® score(s) continued to increase (gets worse) despite using the internal/external described tweak, a new symptom occurs, pain changes location, or something else happens.
    a. 1^{st} time: perform exercise again as the body may be in transition or patient may not be correctly performing motion
    b. If TMR® score(s) increases a 2^{nd} time in a row then exercise to the opposite side- this may occur if the scores between right side and left side were close (i.e.: R side 50/ L side 60 for Sit to Stand motion)
    c. If TMR® score(s) increases a 3^{rd} time in a row move to next exercise- if patient performed upper body exercise 1^{st} then move to lower body or trunk exercise
4. Rule 4- If patient initially scored <15 for any of the TMR® motions the patient was asked to perform the scored motion in the internal/external tweak position and re-score.
5. Determining when to move to next identified asymmetry motion was based upon
    a. Patient reports TMR® score(s) to 15 or less on 1^{st} TMR® motion of highest imbalance or
    b. Patient has utilized Rule #2 (used internal or external rotation on asymmetry motion) on the exercise with no score improvement and/or
    c. Patient has utilized Rule #3 with no score improvement