Utilizing Manual Therapy Within a Regional Interdependence Model for the Treatment of Cervicothoracic Dysfunction: 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
University of Idaho
by
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May 2017

AUTHORIZATION TO SUBMIT DISSERTATION

This dissertation of Dawn P. Andrews, submitted for the degree of Doctorate of Athletic Training with a Major in Athletic Training and titled "Utilizing Manual Therapy Within a Regional Interdependence Model for the Treatment of Cervicothoracic Dysfunction: 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 capstone product of the Doctor of Athletic Training (DAT) program is a Dissertation of Clinical Practice Improvement (DoCPI), and this extensive document highlights my evolution as an athletic trainer into a scholarly practitioner. Included in my DoCPI is the Plan of Advanced Practice (PoAP) that builds the foundation by which I work toward advanced practice and identifies my current clinical practices, strengths, areas of needed improvement, and professional goals while providing a structure to evaluate my growth as a clinician. The presentation of two multi-site research studies reflects the philosophy of an action researcher utilizing practice-based evidence to address local clinical practice challenges and enhance clinical decision-making. The exploration of the effects of Mulligan Concept® thoracic sustained natural apophyseal glides (SNAGs) for the treatment of secondary impingement syndrome provided a means of investigating the regional interdependence model by indirectly treating shoulder pain via the scapulothoracic region. Further investigation of Mulligan Concept® positional SNAGs provided a foundation for the direct treatment of non-traumatic musculoskeletal injury of the cervicothoracic region without hesitation. The insight I gained through participation in action research allowed me to apply practical solutions to specific problems within my clinical setting, and the following DoCPI provides evidence of how I integrated and applied action research within my clinical setting, highlighting my journey from a novice athletic trainer to advanced practitioner.

ACKNOWLEDGEMENTS

Earning a Doctorate of Athletic Training degree requires a village of individuals guiding and supporting each candidate along the path. I could not have completed this task alone, and I would like to acknowledge the individuals who were instrumental in my completion of this first step toward becoming and advanced practitioner.

Dr. James May, my Major Professor, thank you for challenging and supporting me in my journey as a student and clinician. Patience truly is a virtue, as you demonstrated the past three years. Thank you for your optimism, calmness, and faith in my ability to succeed as a clinician and scholar.

Dr. Alan Nasypany, thank you for not only making students think "outside the box" regarding healing, but for challenging us to become more than we thought we were capable. Your effervescence is contagious and your desire for students to be good people as well as great clinicians made an immeasurable impact on my life.

Dr. Russell Baker, thank you for your wit and patience. Your helpful nature combined with astute scholarly ability is one to be admired. Your mentorship, support, and feedback were greatly appreciated.

Dr. Jeff Seegmiller, thank you for having the vision of the Doctorate in Athletic Training program, and the courage to see it realized.

Eric Dinkins, thank you for sharing your knowledge of Mulligan Concept and supporting this investigation.

Last, but certainly not least, Kari Odland-Wolf. Thank you for your support and friendship. Together, we made one great team. You set the bar with your remarkable intellect and vast scholarly experience, challenging me daily to be a better clinician and scholar.

DEDICATION

I would like to dedicate this document, and all the work that it represents, to my family for instilling in me a sense of independence and desire to learn.

Mom, you demonstrate what unconditional love and support means daily. It is from you I get my explorative nature and fearlessness.

Dad, my inspiration for becoming the person I am today. Your wit and humor is my wit and humor. Your courage inspired me to look for ways to improve the lives of others and never stop improving.

To my brother, Shane, you have been my biggest champion through this process and I hope to live up the vision you have of me as you live up to mine.

To my grandparents, I'm proud to say there is finally a doctor in the family.

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NARRATIVE SUMMARY

Healthcare providers are perpetually challenged to respond to the growing demands of education and clinical practice, and athletic training (AT) is no different. First recognized as a healthcare profession by the American Medical Association (AMA) in 1990, leaders have implemented several waves of AT educational reform, most recently, the mandate by the Commission on Accreditation of Athletic Training Education (CAATE) that by 2022 all accredited professional AT programs must result in the granting of a Master of Science degree in AT (“Revisions” 2015). While AT programs currently offer professional education at the baccalaureate and Master of Science levels, an important need persists for ATs to embark on improving their foundational knowledge through original research (Knight and Ingersoll, 1998). Traditional terminal degrees available to ATs (e.g., Ph.D. and Ed.D.) are most commonly designed to advance knowledge through controlled laboratory research with moderate application to the clinical setting; however, in 2011, faculty the University of Idaho (UI) created a post-professional Doctor of Athletic Training (DAT) degree with an emphasis on facilitating clinical expertise through professional residency creating an individualized area of advanced practice (AP) (Nasypany, Seegmiller, & Baker, 2013). Athletic trainers working towards AP develop a focused area of clinical practice within the scope of AT practice in addition to developing the practice of a clinician and researcher alike (Nasypany et al., 2013).

Developing a terminal degree program with a clinical focus is similar to the model of other professional doctoral programs that utilize a professional practice dissertation (PPD) as a capstone product focused on clinical experiences that assist in preparing students for AP (Willis, Inman, & Valenti, 2010). The UI DAT capstone product is a Dissertation of Clinical Practice Improvement (DoCPI) that serves as a scholarly and reflective document highlighting the evidence of clinical practice improvement as well as describing the unique professional path each student takes as an aspiring AP. Following the guides of PPDs, students create evidence of scholarly practice and contribute to transformations within healthcare and demonstrate knowledge, while managing situations that arise within professional practice (Willis, et al., 2010). The evidence of clinical practice improvement includes scholarly products such as those submitted to professional journals for publication, peer reviewed presentations, or in-depth analysis of personal experiences in patient care and evidence of clinical decision-making improvements. Highlighting academic and clinical progression toward becoming an AP serves as the cornerstone to creating a DoCPI. As such, my DoCPI is evidence of my improved clinical skills and current professional outlook regarding patient-care. I am no longer a novice, but a professional AT committed to improving and evolving my clinical practice as I continue to learn.

To assist students in developing evidence toward clinical practice improvement, the UI DAT is uniquely structured to emphasizing clinical residency, identifying local problems within the clinical setting and developing a priori plans to investigate patient-care improvement. Within my clinical residency, I built a foundation of expertise based on evidence-based practice (EBP) and collection of practice-based evidence (PBE). The practice of utilizing constructs of EBP encourages best practices in patient-care based on current scientific research, helping to guide clinical practice growth beyond foundational knowledge (Hurley, Denegar, & Hertel, 2011; Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). However, current scientific research based in the laboratory setting or in the form of random control trials (RCTs) does not typically apply to the clinical setting, creating a gap between theory and practice. As a result, clinicians develop a heavy reliance on intuition and experience when unable to transfer evidence from RCTs to their patient population (Meyer, 2000). To bridge the research-to-practice gap, EBP is used to create PBE, as evidence created by clinicians through focused study of their clinical practice provides clinicians with evidence of the effectiveness of their interventions (Krzyzanowicz, May, & Nasypany, 2014) and provides the opportunity for implementation of patient-oriented evidence into clinical practice (Hurley et al., 2011; Sauers et al., 2012).

In my clinical setting, I combined EBP and PBE, embracing an applied action research (AR) philosophy with the intention of strengthening my ability to create and apply methods to enhance my patients' healthcare. I completed thorough reviews of literature to determine current best-practices and develop an understanding of the relevance between the scientific research and my clinical setting. I then utilized PBE as a mechanism to assess my patient-care, completed by studying the effects of treatment on an individual or small groups of patients and documented through case series, which allowed me to assess data on a local level and reflect upon the evidence to improve patient-care (Holmqvist, Philips, & Barkham 2015;

Kovacs, 2015). Adoption of an AR philosophy based on my day to day practice of clinicians, which provided me the opportunity to generate outcomes that may be more meaningful to practitioners (Koshy et al., 2011; Meyer, 2000).

Growing through clinical residency with an AR philosophy focus required a deeper understanding of the best available traditional and novel treatment interventions currently employed by clinicians. This improved depth led me to a deeper understanding of regional interdependence (RI) or the implications of dysfunction in a separate region of the body contributing to the patient's chief complaint (Sueki, Cleland, & Wainner, 2013). I began to structure my injury assessments and treatments to address regional pain and/or dysfunction and began collecting more balanced outcome measures that assessed both patient-oriented evidence (POE) as well as disease-oriented evidence (DOE). Incorporating POE as opposed to a singular focus on DOE provided me the opportunity to evaluate data that the patient felt was meaningful to his or her treatment, such as pain and disability. I no longer generalized my data collection based on what I observed, but combined observation with subjective evaluation from patients regarding their care, improving communication and understanding the impact each intervention technique applied. Incorporating a balanced approach to outcome measures and concentrated data collection, I developed evidence of improved clinical competence. I then utilized the evidence I developed to disseminate information in the form of conference presentations and peer reviewed publications.

While I continued to infuse my budding AR philosophy and PBE approach within my clinical practice, I also began to develop a priori designed multi-site research studies to enhance my scholarship and refine my patient care. Multi-site studies incorporate characteristics of collaborative research, which allows enhanced external validity, greater statistical power and rapid recruitment of participants over single-site trials (Weinberger et al., 2001). Further, utilizing multiple-sites for patient recruitment can enable larger sample size of patients across multiple patient populations, which can lead to a more diverse patient population and meaningful results. Completing AR in this manner may also aid clinicians in comparing results and expectations to their own clinical setting outside of laboratory settings or randomized controlled trials (RCTs). As well as increased application, adopting a multi-site approach assisted my scholarly growth by providing greater opportunities for learning, developing competence with clinical practice improvements, and cultivating an openness to continued practice improvement (Ishimaru, Yamada, Matsushita, & Umezu, 2016).

To begin a journey, one must develop a plan, and Chapter 2 of my DoCPI serves as a map for my journey towards AP. My Plan of Advanced Practice (PoAP), includes reflection on my professional development, awareness of my strengths as well as areas that need improvement, and an evaluation of my goals toward AP. The document is a reminder of my background from a secondary school student aide to practicing professional working toward AP. The document is presented as a guide for formulating future professional goals within my chosen areas of focus, and through consistent evaluation of my established goals, I will grow as a professional while recognizing the progress made along my journey towards AP. Further, my PoAP is an ever-evolving document that 1) details my professional and clinical strengths and weaknesses; 2) illustrates my advancement in my chosen areas of focus; 3) provides a description of my clinical, rehabilitation, low back pain, and education philosophies; and 4) provides justification of my areas of AP and the goals I developed and continue to assess.

While my PoAP is presented as a structured plan toward AP utilizing objective and subjective measures, chapters 3 and 4 are scholarly products representing my ability to conduct multi-site research, create PBE and disseminate the evidence to the larger healthcare community via peer reviewed publications. Chapter 3 is a multi-site case series titled "The Utilization of Mulligan Concept Thoracic Sustained Natural Apophyseal Glides by Novice Practitioners on Secondary Impingement Syndrome: A Multi-Site Case Series." The purpose of the case series was to investigate the effects of one Mulligan Concept thoracic sustained natural apophyseal glide (SNAG) treatment session on patients classified with secondary impingement syndrome (SIS), while utilizing a classification-based treatment protocol. Although patients classified with SIS are more commonly treated locally, I developed an a priori research plan to investigate the effects of treating patients classified with SIS with a RI philosophy after treating a patient diagnosed with SIS who also presented with pain during thoracic extension. I utilized the Mulligan Concept thoracic SNAG technique while the patient actively performed seated thoracic extension that resulted in a complete resolution of the symptoms associated with SIS (i.e., the patient's chief complaint). Based on the positive patient outcome, I hypothesized patients who complained of symptoms of SIS may also have dysfunction at the scapulothoracic junction, and I developed an a priori study to determine whether my experience with the initial patient was an isolated patient-specific finding or if more patients complaining of SIS report positive outcomes when treated with the Mulligan Concept thoracic SNAGs. Based on the findings of our multi-site investigation, we found patients classified with SIS reported positive short-term effects following one treatment of Mulligan Concept thoracic SNAGs directed at the scapulothoracic junction.

The investigation of Mulligan Concept thoracic SNAGs directed at the scapulothoracic region was a positive experience, improved my patient care and lead to my next multi-site research examining the RI effects of SNAGs. Chapter 4 is a multi-site case series entitled, "An Exploratory Case Series Examining Mulligan Concept Positional Sustained Natural Apophyseal Glides on Patients Classified with Mechanical Neck Pain." the case series was developed to investigate the effects of Mulligan Concept positional SNAGs directed at the cervicothoracic region on patients in the secondary school and collegiate athletic population with mechanical neck pain (MNP). Currently, MNP is a recalcitrant problem within the athletic population and disagreement persists regarding which treatment is most effective in this patient population. Ten consecutive patients classified with MNP received three treatments (i.e., three separate days) of Mulligan concept positional SNAGs directed at the cervicothoracic region over a one-week period. During the investigation, we observed statistically significant and clinical meaningful changes in pain, patient-reported function, and cervical range of motion. The largest clinical and statistical improvements occurred immediately following the first treatment session and were maintained at completion of care as well as at a two-week follow-up. The results gathered during this case series provided evidence for a novel intervention to treat patients classified with MNP compared to the often-utilized high velocity low amplitude (HVLA) thrust technique. An alternative intervention may prove beneficial as ATs traditionally do not utilize HVLA thrusts due to state practice acts and/or lack of training. Consequently, further research is warranted to examine patient care strategies when treating MNP.

Collectively, the chapters comprising my DoCPI serve as evidence of my ability to conduct scholarly activities necessary to propel myself toward AP. Prior to starting the UI DAT, I developed my clinical practice as an entry-level athletic trainer utilizing only the foundational knowledge I developed as an athletic training student (ATS) in my undergraduate Athletic Training Program (ATP). I completed tasks such as providing medical coverage at practices and games, handing out ice bags on a regular basis, and taping painful joints to restrict motion, all of which I learned during my professional education. However, as a UI DAT student, I became aware of the short-comings to utilizing only foundational knowledge. As such, I worked to scour the literature, infusing EBP into my clinical setting while assessing my patient care through a PBE approach. Through increased knowledge and skills regarding the application of treatment interventions and completion of my DoCPI, I became keenly aware of my improved competence as an athletic trainer providing healthcare. I now identify myself as an AT striving toward AP in a healthcare profession that is in its infancy.

As a young profession, athletic training is currently undergoing educational reform that has primarily focused on improving professional education; however, experienced clinicians must consider improving their clinical practice through developing their clinical skills to include the use of applied clinical research and PBE. Improving and strengthening my foundational knowledge as well as continuing to increase my competence in advanced patient-care strategies has been a rewarding challenge, and as I advance my own clinical practice to include applied clinical research and PBE I find it vital to disseminate my knowledge to a larger audience of healthcare providers. Sharing the knowledge I have gained through scholarship not only contributes to my personal clinical growth and the advancement of the AT profession, but also creates a sense optimism for the future with a renewed level of excitement for improved patient-care.

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CHAPTER 2
PLAN OF ADVANCED PRACTICE

PURPOSE OF PLAN OF ADVANCED PRACTICE

Becoming an advanced practitioner (AP) requires a well-designed plan. Development of this plan includes a personal journey (e.g., individual perceptions and experiences) that commonly includes self-reflection of current practices and analysis of patient outcomes used to create a strategic blueprint for intervention and necessary changes that leads back to self-reflection (Koshy, Koshy, & Waterman, 2011). The developmental process is cyclical and unending, but every journey must begin by setting a course. For clinicians aiming to become APs, the plan of advanced practice (PoAP) serves as the journey's intended map.

My PoAP illustrates a structure to obtain goals as an aspiring AP focused on improving clinical practice care through assessment and treatment of injury. With this focus, I have pursued a model of patient assessment fostering regional interdependence (RI) and care with a focus on manual therapy interventions utilized to provide immediate patient reported changes. The RI model is based on the theory that dysfunction in a separate region of the body may contribute to the chief complaint reported by the patient. Implementing the RI approach allows me to better classify injuries based on dysfunction and incorporate appropriate intervention strategies to improve patient-care outcomes. To improve the outcomes after proper classification, I also utilize various manual therapy techniques for acute and chronic injuries. Ultimately, through improved patient-care, I am working to develop as a professional and clinical scholar who may influence the healthcare community.

REFLECTION OF PRIOR CLINICAL COMPETENCE

Professional Experience and Development

To create my professional path for the future, I must first understand where I began. My path to becoming an athletic trainer (AT) began as a high school athletic training student aide (ATSA). As a secondary school freshman, I attended an "Expanding Your Horizons" conference in Moscow, Idaho, designed to introduce young women to professional women in different career areas. I attended a session on athletic training led by the then-head AT at Moscow High School. Based on questions I asked during the session, she pulled me aside at the end to ask if I were interested in learning more about athletic training. I enthusiastically responded, "Yes!" and she provided me the name of the head AT at the high school I would be attending. She also advised me to attend a Cramer Sports Medicine camp, which I subsequently attended, and where I received my first exposure to athletic training. During the three-day camp, I received instruction on various athletic training topics that helped affirm my desire to join an athletic training program. I contacted the head AT at the high school I would be attending, and we agreed I would start as an ATSA with football two-a-day practices.

As an ATSA, I was exposed to many facets of AT in the secondary school setting, such as managing pre-participation paperwork, prevention and care of injury, and emergency care. For three years, I spent every afternoon in the athletic training clinic absorbing as much information as my mentor could provide. I was tenacious in my pursuit of a career in athletic training and began searching for a college athletic training program (ATP) to best position myself for a career in athletic training.

As I was determining which university to attend, athletic training education was undergoing changes. In the mid-1990s, students interested in pursuing athletic training essentially had two choices: an internship route or an accredited curriculum program to become a certified AT. While at the time, each program type was viewed to have positive and negative attributes, I chose the University of Montana (UM), an accredited curriculum program that seemed to offer me the best opportunities. The debate on athletic training program requirements ultimately ended in 2000 when the National Athletic Trainers Association (NATA) transitioned to approve curriculum programs fully and eliminated internship programs completely in 2004. The UM ATP had established itself as a curriculum program prior to the NATA transition, and I felt the UM ATP offered me the "best of both worlds" as an athletic training student (ATS) due to the requirement of completing academic courses not required in the internship programs as well as completion of a minimum of 1,000 hours experience in the clinical setting compared to the 800 hours required by other accredited programs.

As a senior ATS, I was assigned to men's and women's indoor track and field, a position often delegated to the ATS demonstrating the most independent competence as there was little assistance or input from the preceptor. I traveled with both teams providing medical coverage for three months with minimal communication and mentorship from my preceptor regarding patient care. Although there is debate regarding whether ATS autonomy is ideal (Knight, 2008), I was able to make decisions and manage a major sport program successfully on my own, which for me was rewarding and led to improved confidence in my abilities without the supervision of a preceptor.

Outside of my intercollegiate clinical education, I was also involved with the UM Rodeo team as an unofficial ATS (i.e., provided AT services outside of ATP clinical assignment). Rodeo was a club sport, not recognized as an intercollegiate sport, thus not under the UM athletic training umbrella for official sports medicine services. While Rodeo was not a requirement of my ATP program, it was my passion, and I took it upon myself to develop a professional relationship with Dr. Keith Peterson, DO, to gain extra experience at numerous collegiate and professional rodeos in Montana. Working with rodeo competitors provided me with the opportunity to practice my skills as an ATS while being supervised by Dr. Peterson, a well-respected member of the medical community. The experience also allowed me to find a professional niche outside of intercollegiate athletics with which I continued to stay affiliated for the following 10 years.

My experience working with minimal supervision during indoor track & field and Rodeo with patients holding high expectations for expedited treatment provided a sense of confidence in my ability to provide autonomous patient-care once I entered the workforce as a certified athletic trainer (ATC). In 2000, I began working in Seattle, Washington, for HealthSouth as an Outreach Athletic Trainer, dividing my time between the Ballard Sports Medicine Clinic and West Seattle High School where I provided patient-care. Unfortunately, in the spring of 2003, HealthSouth drastically increased my work-load from providing healthcare for one secondary school to being responsible for three secondary schools simultaneously. The added patient load and travel time often left me feeling as if I were at the wrong place at the wrong time, and I found it difficult to build relationships with new patients and coaches. Both patients and coaches at the new schools viewed me as a temporary substitute, and in truth, they were correct. With responsibility for three secondary schools, I became dissatisfied with my practice and I decided I needed to make a change. I made the choice to leave Seattle when I found a graduate education program in Tyler, Texas, where I could work as an AT while pursuing a Master of Education degree.

The University of Texas at Tyler (UTT) offered a Master of Education (MEd) in Health and Kinesiology, a degree program in which a large population of ATs were enrolled. Two hospital systems (i.e., Azalea Orthopedics and Trinity Mother Frances) offered paid graduate assistant positions to ATs attending UTT while working at local secondary schools, providing sports medicine service. For my fellow graduate assistants, the graduate assistant position was as an assistant AT; however, I was placed as a head AT based on my previous experience. Clinically, I provided medical service to a population of patients in a small community, and academically, I stretched my didactic education in health and kinesiology by attending 18 hours of required foundation courses set by the MEd program as well as 18 hours of elective courses consistent with my career objectives. I focused on academic classes consisting of exercise physiology (e.g., neuromuscular exercise physiology) as well as a focus on education and educational constructs. It was not until much later that I realized although the courses in which I enrolled improved my knowledge regarding principles of physiology and education, I did not transfer that knowledge to a usable form in my clinical setting or clinical skills. Ultimately, I continued to practice as a clinician utilizing the entry-level knowledge earned in my undergraduate ATEP without awareness to the deficiencies in my clinical practice.

After graduation from UTT, I followed my professional ambition of working as an AT in the secondary school setting at Episcopal High School, a private high school in Houston, Texas. I worked as an assistant AT and science teacher at the secondary school, which allowed me to utilize the knowledge I gained during my MEd program as an instructor of Anatomy and Physiology. Having an influence on young people who desired a future in healthcare was exciting, and I realized, for my next professional step, I wanted to influence aspiring ATSs in professional ATPs. Unfortunately, I felt limited in this next step with minimal experience as an AT within the collegiate setting, and I did not possess a terminal degree that would be most helpful to gain employment at the collegiate level. I continued to work at the secondary school level while searching for an academic program to earn a terminal degree that would allow me to focus on improving my foundational knowledge as well as my clinical skills. I ended my search in December 2013, when I was accepted to the University of Idaho (UI) Doctor of Athletic Training (DAT) program.

REFLECTION OF CURRENT KNOWLEDGE

I based my initial decision to pursue a doctoral degree on my desire to teach more effectively and influence the next generation of ATs. However, the uniquely designed UI DAT, with a primary focus of improving clinical practice allowed a greater purpose of becoming a better clinician while simultaneously building my didactic foundation. Prior to the UI DAT program, I made clinical decisions based on personal experience and observation rather than on athletic training knowledge and evidence, which resulted in deriving many of my clinical choices from habit and without purpose. I did not recognize the shortcomings of my clinical practice at the time; however, through curricular coursework, in-depth research analysis of current literature, presentations at conferences, and applied clinical residency experiences, I became more aware of my previous limitations. I now utilize evidence-based practice (EBP) and practice-based evidence (PBE) to provide a framework of informed knowledge that guides my advancing clinical practice.

Incorporating EBP with patient-oriented outcomes aids in my selection of treatment interventions that are more closely directed toward the needs of each individual patient. Utilizing patient-oriented outcomes allows me to analyze my evaluations and selected treatment interventions to develop a stronger understanding of my clinical decision-making. I can now develop logical explanations as to why my patients report the outcomes they do and make refinements to my clinical skills and reasoning when necessary. The clinical reasoning and outcomes I have developed from my increased knowledge and understanding is evidence of my continual progress toward advanced practice.

Reflection on Strengths

Important to the pursuit of advanced practice is the reflection and comprehension of current areas of strength. Elements I identify as successful provide a foundation for my path toward becoming an AP, and illustrate my confidence and competence within my clinical practice. The following list highlights my current areas of strength.

- <u>Professional role model/Communicator:</u> Over the course of my career I have been fortunate to work with ATSAs, ATSs, and ATs, helping each to learn, grow, and become more effective. I have enjoyed the opportunity to act as a mentor, and allow my passion toward the athletic training profession to inspire their decision to pursue athletic training. I am a positive role model for students and current professional ATs alike as I never display an attitude of complacency toward education and clinical growth. I constantly challenge those with whom I am connected to investigate new treatment interventions for implementation into their clinical settings and use opportunities to demonstrate new strategies. Mentoring allows me to empower others on their path toward clinical practice improvement.

- <u>Patient-Centered Care</u>: As a clinician striving toward advanced practice, I consider each patient an opportunity to learn, and I approach the patient as a person who needs individual care. Based on the RI model, I utilize and integrate several evaluation and treatment techniques to administer holistic patient care. Focus placed singularly on the patient's area of pain may cause me to miss the root cause of pain, prolonging the patient's time away from activity. Importantly, I strive to use both disease-oriented and patient-oriented outcome measures to meet the needs of the patient and determine treatment effectiveness.
- <u>Manual Therapy Interventions</u>: To provide patient-centered care, one must establish competence in multiple intervention strategies. As such, I have competence to provide patient-care employing the following intervention strategies: Mulligan Concept®, Positional Release Therapy (PRT), Muscle Energy Technique (MET), Primal Reflex Release Technique (PRRT), Total Motion Release (TMR), Myokinesthetic System, and Energy Medicine. Utilization of the intervention strategies described is intended to be balanced as I begin at the local site of pain (e.g., Mulligan Concept®) and expand to utilizing global intervention techniques (e.g., Energy Medicine) to meet the individual needs of the patient. My primary goal of using a balanced approach toward indirect manual therapy is to clear the source of dysfunction causing pain with the expectation of immediate improvement defined by patient-oriented outcomes.
- <u>Amenable to Change</u>: An inevitability of life is change, so I welcome it as an old friend. I have worked with patients in multiple socio-economic, geographical, and clinical environments over the course of my career, and all my experiences have been an opportunity for growth. As I increase the demands I place upon myself as a person and clinician, I must adapt so that I may continue to pursue clinical practice improvement. I refuse to become stagnant; I reject the reasoning of "this is how we

have always done it"; and I look for opportunities to facilitate change in every environment. Whether I am the one to change or the one who facilitates change in others, I am open to the challenge and unafraid to enter new circumstances.

Reflection on Areas for Improvement

Reflection and self-assessment is not limited to evaluation of strengths only. Equally important in the pursuit of advanced practice is the reflection and comprehension of areas that warrant improvement. The journey toward becoming an AP is not built upon an endless path of successes, but from identifying small elements that require change to enable growth. While utilizing critical self-reflection, I identified areas that warrant enhancement or awareness as I continue to pursue advanced practice. The following list highlights the current areas in which I need to improve.

- <u>Foundational Knowledge</u>: As I expand my practice to include various new intervention techniques, I have highlighted gaps within my foundational knowledge. As such, I am obligated to develop a better understanding of functional anatomy and the physiology of pain as well as the physiological mechanism of action for each intervention. To assist, I find opportunities to educate fellow ATs as well as the patients with whom I work. I find as my ability to explain concepts improves so does my competence. Informal teaching combined with critically investigating the research and completing specific continuing education courses has been my primary method of engaging in more complex theories while I work to improve my foundational knowledge.
- <u>Continuing to expand knowledge and competence in my practical skills</u>: Although I am comfortable with utilizing a diverse array of intervention strategies, I recognize that as an aspiring AP who is interested in continued evolution, I must continue to expand my knowledge and competence in other interventions over time. Continued expansion upon the interventions I utilize will allow me to reach my goal of providing best-practices as I also research the interventions that may be developed and explained in future literature.

PERSONAL PHILOSOPHIES

Important to a well-crafted PoAP, I must have a firm understanding of my philosophical approach to clinical practice, rehabilitation, and education. Understanding my clinical practice and rehabilitation philosophies provides a platform for my current practice as well as the foundation upon which I built my PoAP and my goals for the future. Developing an educational philosophy provides a foundation for future education of ATs in a post-professional forum related to my current job setting. The following represents my current philosophies as related to clinical practice.

Clinical Practice Philosophy

As a clinician, I strive to provide patient-centered care beyond the injury diagnosis or symptoms by incorporating evaluation and treatment to the whole person. To accomplish this, I utilize patient-oriented outcomes to aid in identifying factors patients determine important to their recovery. Completing a comprehensive evaluation that incorporates data derived from the patient-oriented outcomes with disease-oriented outcomes used traditionally by medical professionals' leads to developing a classification of injury and streamlining the treatment process. I utilize a variety of treatment interventions to address the findings and address each patient's specific needs.

Rehabilitation Philosophy

My rehabilitation philosophy is structured to address the individual needs of patients to identify and treat the source of the dysfunction. Depending on the findings of a comprehensive evaluation, I utilize direct manual therapy interventions such as Positional Release Therapy (PRT) and Mulligan Concept® Mobilization with Movement to address the musculoskeletal system to decrease pain and increase range of motion. Further, I utilize indirect manual therapy interventions such as Total Motion Release (TMR) and Reflexive Neuromuscular Stabilization (RNS) to address motor control dysfunction with the goal of restoring a dynamic center of gravity and proper movement patterns following injury. Using a structured system for determining appropriate manual therapy interventions allows me to treat a variety of injuries in a short timeframe leading to optimal results and reduced time for patients away from activity. My goal for providing manual therapy intervention is to enhance healing to promote optimal movement patterns.

Education Philosophy

My educational philosophy is to create an environment that fosters critical analysis and problem solving. My responsibility as an educator is to provide information for students beyond the traditional classroom setting that consists of both current and accurate information while allowing students to examine the individual characteristics and theories of treatment interventions. As the students apply the information to their individual clinical practices I *strive to mentor how to link clinical decisions to patient outcomes. Further, I encourage a sense of professional responsibility for developing clinical abilities and desire to provide patient-centered care.*

GOALS FOR PROFESSIONAL PRACTICE

As I transition to an Injury Prevention Specialist with a company focused on developing safe work habits for industrial patients, I am confident that my professional experience, clinical practice philosophies, and unique clinical skills will aid in a successful transition. Integrating the RI model and global assessment strategies with multiple manual intervention techniques is an approach that directly impact patients by identifying causes of dysfunction leading to discomfort and providing patient-centered care under the guidelines of the Occupational Health and Safety Administration (OSHA). I work continuously to deepen my understanding of the current treatment interventions I utilize beyond the novice practitioner to develop my clinical skills and improve my efficiency and efficacy for treating dysfunctions that become increasingly agitated when combined with the repetitive motion of moving products in a warehouse.

The industrial "athlete" is an essential part of our daily lives as he/she provides services many overlook such as supplying goods to grocery stores, manufacturing windows for homes, road construction, etc., yet little education and focus is placed on providing quality patient-centered care to these workers. Utilizing my unique manual therapy skills while working with industrial patients allows me the opportunity to develop PBE regarding the use of intervention strategies that can be completed within the guidelines set by OSHA. Further, I can develop scholarship by establishing best practices regarding patient-centered care to inspire ATs within the industrial setting to cultivate their clinical abilities and clinical decision-making skills.

Regardless of my work setting, whether secondary school or industrial, my goal is to be a leader for change within the athletic training profession. I work to foster an environment within my athletic training clinic by demonstrating the value and efficacy of manual therapies that can provide profound changes in dysfunction and discomfort, which is clinically meaningful to athletic trainers. My ongoing analysis of my journey toward advanced practice has led me to identify areas of growth as a clinician and scholar, leading to identification of a number or goals that I plan to engage in and achieve as I continue toward advanced practice.

In a continual effort to provide quality patient-centered care utilizing the RI model for assessment, utilizing multiple manual therapy intervention techniques, and developing scholarship, I can help shape the future of athletic training. My timeline for accomplishing the goals listed below combines definitive and tentative deadlines to reflect the fluid nature of the path to advanced practice, with an understanding that true advanced practice growth requires constant evaluation of the stated goals as well as the goals of an ever-changing healthcare profession.

Table 2.1. Evaluating Dysfunction Utilizing the Regional Interdependence Model: objective and subjective measures

Area of Focus		Method and Status	
Regional Interdependence			
Assessment Technique:	Intent	Completed	To Complete
Myokinesthetic™ System	Scholarly Advanced AT Practitioner	• *MYK Lower Body – Lumbar and Sacral Plexus* – July 2015 (Uriarte, 2010)	• MYK Upper Body (2018) • MYK Certification Class – November 2018 • Develop MYK Action research regarding minimally clinically important difference (MCID) related to number of abnormalities reduced through intervention. (2020) • Continue review of literature related to regional interdependence (current and ongoing)
Selective Functional Movement Assessment	Scholarly Advanced AT Practitioner	• Read *Movement Book* – October 2014 (Cook, 2010)	• Complete SFMA Level 1 Course (2017) • Complete SFMA Level 2 Course (2018) • Complete FMS Level 1 Course (2017) • Complete FMS Level 2 Course (2018) • Continue review of literature related to movement dysfunction (current and ongoing)

Table 2.2. Implementing Manual Therapy Interventions Intended to Treat Neuromuscular Dysfunction: objective and subjective measures

Area of Focus		Method and Status	
Manual Therapy Interventions			
Assessment Technique:	Intent	Completed	To Complete
Mulligan Concept®	Scholarly Advanced AT Practitioner	• MC Spinal and Peripheral Treatment Techniques with Application to Rehabilitation and Athletic Training – July 2014 • MC Upper Quadrant – March 2015 and October 2016 • MC Spinal and Peripheral Treatment Techniques – July 2015 • Complete MC Advanced Course – February 2017 • Certified Mulligan Practitioner – February 2017 • Read *NAGS, SNAGS, MWMS etc*. – Summer 2014 (Mulligan, 2010) • Read *The Mulligan Concept of Manual Therapy* – Summer 2015 (Hing et al., 2015	• Continue review of literature related to MC (current and ongoing) • Continue to incorporate MC into clinical practice (current and ongoing) • Collect outcomes and analyze results (current and ongoing)
Myokinesthetic System™	Scholarly Advanced AT Practitioner	• MYK Lower Body – Lumbar and Sacral Plexus – July 2015	• MYK Upper Body (2019) • Collect outcomes and analyze results (current and ongoing)
Positional Release Therapy	Scholarly Advanced AT Practitioner	• PRT – July 2014 • Read *Positional Release Therapy – Summer* 2014 (D'Ambrogio, & Roth, 1997)	• PRT Lower Quadrant (2017) • Complete PRT – Spine and Pelvis Course (2017) • Implement PRT into clinical practice, record and analyze outcomes • Collect outcomes and analyze results (current and ongoing)
Total Motion Release	Scholarly Advanced AT Practitioner	• TMR Level 1 – March 2014 (Dalonzo-Baker, nd) • TMR Level 2 – March 2014 (Dalonzo-Baker, nd) • TMR Level 3 – May 2014 (Dalonzo-Baker, nd)	• Implement TMR into clinical practice, record and analyze outcomes (current and ongoing) • Develop TMR warm-up program as wellness program
Primal Reflex Release Technique	Scholarly Advanced AT Practitioner	• PRRT Home Study Course (Iams, nd)	• Complete PRRT Home Study Course • Complete PRRT Liquidating Low Back and Leg Pain • Attend PRRT Level 1 Seminar (2019) • Collect outcomes and analyze results (current and ongoing)

Muscle Energy Technique	Scholarly Advanced AT Practitioner	• MET M-1 Home Study Course (Ockler, 2015)	• Implement MET into clinical practice (ongoing) • Collect outcomes and analyze results (current and ongoing)
Energy Medicine	Scholarly Advanced AT Practitioner	• Read *Energy Medicine* – July 2015 (Eden & Feinstein, 2008) • Read *Energies of Love* – September 2016 (Eden & Feinstein, 2014)	• Complete Balance Your Energy and Overcome Past, Present and Future Physical, Emotional, Social, and Mental Blockages (2017) • Exhaust literature on Energy Medicine (current and ongoing) • Implement Energy Medicine into clinical practice (current and ongoing) • Collect outcomes and analyze results (current and ongoing)
Trauma Releasing Exercises	Scholarly Advanced AT Practitioner	• Read *Trauma Releasing Exercises* - September 2015 (Berceli, 2005)	• Exhaust literature on trauma and somatic presentation of pain (current and ongoing) • Implement TRE into clinical practice (ongoing) • Collect outcomes and analyze results (current and ongoing)
Neurodynamics	Scholarly Advanced AT Practitioner	• Read *The Neurodynamic Techniques* – Fall 2015 (Butler, 2005)	• Implement Neurodynamics into clinical practice (current and ongoing) • Collect outcomes and analyze results (current and ongoing)

Table 2.3. Professional Development: objective and subjective measures		
Area of Focus	Method and Status	
Scholarship		
Intent	Completed	To Complete
Scholarly Advanced AT Practitioner	• 2016 NATA Annual Symposia Special Topics Presentation: Abstract, "Two Birds One Stone: Cutting Down Time for Effective and Efficient Treatment of Elbow Pain" – Accepted • 2016 NATA Annual Symposia Free Communications: Abstract, "Utilizing Mulligan Concept Thoracic Sustained Natural Apophyseal Glides (SNAGs) for Treatment of Mechanical Neck Pain in the Athletic Population: A Clinical Case Series – Accepted • 2016 NWATA Free Communications Program: Abstract, "Utilizing Mulligan Concept Thoracic Sustained Natural Apophyseal Glides (SNAGs) for Treatment of Mechanical Neck Pain in the Athletic Population: A Clinical Case Series – Accepted • 2016 Annual Meeting, World Congress on Exercise is Medicine, and World Congress on the Basic Science of Energy Balance of the American College of Sports Medicine: Abstract, "Novel Posture-Based Neuromuscular Treatment for Chronic Pain and Dysfunction of the Lateral Knee – Basketball" - Accepted	• Complete Dissertation • Present 2017 NATA Annual Symposium Learning Lab Presentation, "Snap, Crackle…No Pop: Treating Non-Traumatic Neck Pain in the Athletic Population without Manipulations" • Publish manuscript, "The Effect of Mulligan Concept Thoracic Sustained Natural Apophyseal Glides on Shoulder Impingement: A Case Series" • Publish manuscript, "An Exploratory Case Series Examining the Effects of Mulligan Concept Thoracic Sustained Natural Apophyseal Glides on Mechanical Neck Pain" • Develop a priori investigations using patient outcomes collected utilizing the vast array of interventions mentioned above

JUSTIFICATION FOR PLAN OF ADVANCED PRACTICE

This PoAP was created to guide my journey toward advanced practice, maintaining fluidity as I grow in professional practice through self-reflection and identify new learning opportunities. I specifically developed my PoAP to highlight my areas of focus (i.e., pursuing the RI model of patient assessment combined with utilizing a diverse array of manual therapy interventions to provide immediate changes for patients). I will utilize the data derived from patient outcomes to create scholarship while adding knowledge to the athletic training community. I will continue by documenting new learning opportunities I encounter as well as reflection. Through development of my PoAP, I have provided evidence of my improved clinical skills and attention to patient-care outcomes. Simultaneously, I continue to set goals to discover new opportunities and improvements in my future as an AP.

Developing my PoAP allowed me to strengthen my clinical abilities, enhance my patient-centered care, and grasp a better understanding of my clinical and academic philosophies. As a result, this PoAP has positively affected me, my colleagues, and most importantly, my patients. My PoAP provides evidence that I am a more skillful clinician who is better able to provide treatment interventions based on classifications gained through a comprehensive and structured evaluation process, and I will continue to measure future clinical improvement through utilization of patient-oriented outcomes.

I understand as I improve as a clinician I will become a better mentor to ATs of all ages and experience levels by sharing my gained knowledge and skills. Comprehensive investigation of patient outcomes and discernment of effective treatment based on best evidence (EBP or PBE) will allow me to present a patient-centered approach to clinical practice, and my ability to contribute to current literature through producing original research will create limitless opportunities for dissemination of future knowledge. Ultimately, the realization of this PoAP shall permit me to pass on a sense of urgency and desire within the athletic training community to provide quality patient-care based on best evidence and reflection into their personal clinical practice.

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CHAPTER 3
THE UTILIZATION OF MULLIGAN CONCEPT THORACIC SUSTAINED NATURAL APOPHYSEAL GLIDES BY NOVICE PRACTITIONERS ON SECONDARY IMPINGEMENT SYNDROME: A MULTI-SITE CASE SERIES

Submitted to *International Journal of Sports and Physical Therapy*

ABSTRACT

Background and Purpose: Secondary impingement syndrome (SIS) is a common complaint in the sporting population particularly among athletes engaging in overhead throwing activities. While symptoms may be present at the shoulder with patients complaining of SIS, spinal alignment or dysfunction can influence scapular positioning and overall shoulder girdle function. As an adjunct therapy to traditional interventions for SIS, thoracic high-velocity low-amplitude (HVLA) thrusts have been utilized and correlated with patient reported decreases in pain. Mulligan Concept (MC) thoracic sustained natural apophyseal glides (SNAGs) are an emerging treatment intervention utilized to treat patients with shoulder pain and dysfunction as the evidence supporting an interdependent relationship between the thoracic spine and the shoulder is growing. The purpose of this case series was to investigate the effects of one MC thoracic SNAG treatment session on patients classified with SIS, while utilizing a classification-based treatment protocol. **Case Descriptions:** Seven patients classified with SIS were treated utilizing a Mulligan Concept thoracic SNAG. The Numeric Pain Rating Scale (NPRS), and the Shoulder Pain and Disability Index (SPADI) were collected to identify patient-reported pain and dysfunction. **Outcomes:** Following one MC thoracic SNAG treatment (3 sets of 10 repetitions), minimal clinically important differences (MCIDs) were reported. An increase in cervical flexion, shoulder internal and external rotation was detected immediately post-treatment. At 48-h follow-up, the NPRS change scores for resisted external rotation (RER) and active abduction were clinically important. **Discussion:** Based on the results of this case series, thoracic SNAGs may influence short-term pain levels and shoulder mobility in patients with SIS and support the concept of regional interdependence (RI) between the thoracic spine and glenohumeral joint. Continued

exploration into the proposed benefits of the MC thoracic SNAG treatment as an adjunct therapy when treating patients complaining of SIS is warranted.

Key Words: Impingement Syndrome, Regional Interdependence, Treatment Intervention

Level of Evidence: 4 (Case Series)

BACKGROUND AND PURPOSE

Secondary impingement syndrome (SIS) is the most common diagnosis for patients complaining of pain and dysfunction in the shoulder, and accounts for up to 44%-65% of all shoulder related medical visits.[1-6] Commonly, the physical presentation of patients classified with SIS includes a slouched posture or kyphosis,[2] which increases thoracic spine flexion resulting in decreased elevation of the glenohumeral joint.[7,8] Further, adding the demands of sporting activities at the shoulder (e.g., range of motion, force, acceleration, repetitive movement, and instability patterns), a kyphotic posture predisposes athletes who participate in overhead sports such as swimming, tennis, baseball, football, volleyball, or javelin prone to developing symptoms of SIS.[7,9-12]

Clinicians and researchers alike continue to utilize the regional interdependence (RI) model to treat patients classified with SIS as the available evidence is limited regarding which traditional treatment method (i.e., rest, non-steroidal anti-inflammatory drugs [NSAIDs], corticosteroid injections, therapeutic exercise, passive modalities, and manipulation) is recommended.[8,13] Regional interdependence is defined as, “seemingly unrelated dysfunction in a separate region of the body that may contribute to the patient’s chief complaint”.[14] A correlation between decreased mobility in the cervico-thoracic spine and shoulder pain has been established, supporting the RI model in which dysfunction of the thoracic spine influences shoulder function.[15-16] Utilizing the RI model and treating the thoracic spine in practice creates an expanded approach when treating SIS beyond the traditional local techniques.[1,17,18]

Investigating the treatment of SIS through a RI model, Boyles et al[2] assessed the short-term effects of HVLA thrusts. Patients (N=56) were recruited and evaluated based on modified inclusion criteria from Bang and Deyle.[1]Subjects were between 18 and 50 years of age, reported a 2 or greater pain rating on a 10-point Numeric Pain Rating Scale (NPRS) with either orthopedic special test in Category 1 *and* reported a 2 or greater on NPRS in either

Category 2 *or* any resisted test in Category 3 (Table 3.1). Boyles et al[2] demonstrated positive short-term effects with statistically significant results at 48-hour follow-up for shoulder pain and disability index (SPADI) and NPRS values for Neer Impingement Test, Hawkins Test, resisted empty can, resisted internal rotation, resisted external rotation, and active abduction utilizing HVLA thrusts in the management of SIS.

The Mulligan Concept, a mobilization technique at the spine referenced as sustained natural apophyseal glides (SNAG), is an alternative to thoracic HVLA thrusts.[19-21] Developed by Brian Mulligan, a thoracic SNAG combines elements of active physiological movement with an accessory glide directed along the facet joint plane, which facilitates pain-free movement throughout osteokinematic range of motion.[20] Unlike posterior to anterior manipulative procedures such as HVLA thrusts, the advantage of a thoracic SNAG is the facilitation of the correct physiological motion while in weight-bearing.[22] The benefit of the thoracic SNAG treatment to the clinician is the ability to directly affect the painfully restricted movement, even in the acute stage, by using a movement that would normally increase the patient's symptoms but are now pain-free.[15,22] The Mulligan Concept primary guidelines and concept stress the treatment should be **p**ain free, **i**mmediate and **lo**ng-**l**asting, referenced as the PILL concept.[20] A clinician may incorporate a sub-therapeutic SNAG into their initial assessment and if the response matches the PILL concept, the SNAG is clinically indicated at the therapeutic level. To date, no studies examining the effect of thoracic SNAGs on shoulder pain and disability in patients with SIS have been conducted, as researchers focused primarily on the painful arm movement rather than the RI theory that mobility of the thoracic spine may affect glenohumeral joint movement. Accordingly, the purpose of this case series was to investigate the effects of one Mulligan Concept thoracic SNAG treatment session on patients classified with SIS, while utilizing a classification-based treatment protocol.

DESCRIPTION OF CASES: PARTICIPANT HISTORY AND SYSTEMS REVIEW

Seven patients (6 males, 1 female) ranging in age from 15-22 years (mean= 19 ± 2.83) presented to the clinic with complaints of SIS. Patients represented three "in-season" sports (water polo, baseball, basketball) and one "off-season" sport (volleyball) (Table 3.2). All patients were evaluated in the same manner to determine eligibility for inclusion. Outcome measures and range of motion (ROM) were collected for all patients enrolled in the study.

The Mulligan Concept thoracic SNAG treatment protocol was identical for all patients. All patients denied an acute musculoskeletal injury to the shoulder within the previous 30 days or receiving prior treatment for the current presentation of shoulder pain. Each participant provided informed consent to the use their patient case and data for publication. Participant confidentiality was protected according to the United States' Health Insurance Portability and Accountability Act (HIPPA).

Clinical Impression #1

Secondary Impingement Syndrome (SIS) is commonly addressed using treatments focused on reducing soft tissue (e.g., tendon, bursae) inflammation and increasing neuromuscular dynamics (e.g., strengthening, proprioception). As the patients had not reported any previous treatment for the current presentation of shoulder pain and denied any acute musculoskeletal injury within the last 30 days, the cause of the patient's chief complaint was hypothesized to be a result of repetitive overhead activity. Further evaluation needed to be performed to determine whether the subjects could be classified with SIS versus a scapulothoracic restriction based on traditional evaluation techniques.

Examination

Examination included patient reported history relating to duration, mode of onset, distribution of symptoms, nature of symptoms, aggravating/relieving factors, and any prior shoulder treatments. Physical examination included shoulder ROM, cervical ROM, Spurling's test, cervical distraction test, and special tests for the shoulder. For the purpose of this study, investigators defined SIS as having pain, weakness, decreased activity of the rotator cuff muscles, crepitus, stiffness which may result in loss of activity and sleep disturbances, and pain associated with arm elevation above the height of the shoulder while being internally rotated.[1,7,12,13,23]

Inclusion in the study occurred if participants met the classification-based inclusion criteria established by Boyles et al[2] (Table 3.1). Participants were excluded from the study if they: 1. Reported a positive result on a cervical distraction or Spurling's test, 2. Reported primary complaint of neck or thoracic pain, 3. Received previous treatment of shoulder mobilization or thoracic manipulation since onset of current shoulder pain, 4. Received a cortisone injection into the shoulder joint within the last 30 days, 5. Demonstrated a neurologic deficit, and 6. Demonstrated an unwillingness to participate in the study or inability to attend a 48-h follow-up.

Investigators administered three outcomes measures during the study. First, the investigators administered the NPRS prior to the shoulder evaluation, immediately post-treatment, and at the 48-h follow-up. The patient self-reported pain utilizing the NPRS during the following orthopedic special tests: Neer impingement test, Hawkins impingement test, active shoulder abduction, resisted external rotation (RER), resisted internal rotation (RIR), and resisted empty can (REC). The investigators also administered the SPADI prior to the shoulder evaluation, immediately post-treatment, and at the 48-h follow-up. Finally, the investigators administered the GROC at the 48-h follow-up to determine the degree of perceived change in status regarding their condition.

Clinical Impression #2

Based on the ROM measurements, results of special tests, and patient-reported history, investigators developed the working clinical diagnosis of SIS as a result of scapulothoracic restriction. As the patients' complaints were consistent with the examination results and traditional treatments had yet to be administered, investigators focused treatment on the scapulothoracic region in an attempt to use a RI treatment approach. It was theorized that utilizing Mulligan Concept thoracic SNAGs to address the shoulder pain and decreased mobility could assist in resolving any underlying positional fault that may have been contributing to their decreased mobility at the shoulder resulting in a clinical presentation of SIS.

INTERVENTION

Outcome Measures

To evaluate the effect of treatment for SIS, it is necessary to assess relevant outcome measures, such as pain and functional disability. Clinical relevance refers to the benefits derived from that treatment, its impact upon the patient, and its implications for clinical management of the patient. Assessment of clinical relevance is completed through the detection of minimal clinically important differences (MCIDs) while interpreting patient-reported outcomes measures. A determination of the detectible change outside of error is represented by a minimal detectable change (MDC) for ROM.

The NPRS is an 11-point pain rating scale ranging from 0 (no pain) to 10 (worst imaginable pain) used to assess pain intensity.[24] A two-point or 30% change on the NPRS has been identified as the MCID.[16,25] Numeric pain rating scales have been shown to yield reliable and valid data and shown to be the most responsive (effect size 0.86).[26-31] Normative data values of the NPRS have not been reported in the current literature. Intraclass correlation coefficient (ICC) for test re-test (0.68) represents a moderate correlation for utilizing the NPRS in a broad patient population with various musculoskeletal conditions.[32]

Pain and disability associated with the patient's shoulder injury were measured using the SPADI. The SPADI is a 100-point, 13-item self-administered questionnaire which is divided into two subscales: a five-item pain subscale and an eight-item disability subscale. A 10-point change on the SPADI has been identified as the MCID.[33-34] Normative data values of the SPADI for SIS have not been reported in the current literature. Intraclass correlation coefficient (ICC) for test re-test is 0.65 represents a moderate reliability of measuring shoulder pain and disability between applications of the outcome measure.[33-34]

On the GROC, patients rate their change with respect to a particular condition over a specified time period.[35-36] The GROC is a retrospective, patient-report, 15-point rating scale used to report the degree of perceived change in status.[35-36] The scale ranges from -7 ("a very great deal worse") to 0 ("about the same") to +7 ("a very great deal better"). In previous studies researchers concluded GROC scores of +4 and +5 indicate moderate changes in patient-perceived status and that scores of +6 and +7 indicate large changes in patient status.[36] Investigators of this study determined a score of +4 or greater indicated a successful treatment.

Investigators commonly utilize shoulder ROM measurements to demonstrate change in flexion, extension, abduction and rotation motions, represented by a 8° change in flexion, 4° change in abduction, 8° change in internal rotation (IR) and a 9° change in external rotation (ER) ROM as the MDC.[37] Normative data values for flexion (180^{o}) extension (60^{o}), internal rotation (70^{o}), external rotation (90^{o}) and abduction (180^{o}) have been established in the literature for asymptomatic shoulders, however normative data regarding shoulder ROM for

SIS have not been reported. The ICC for test re-test is moderate for flexion (0.58), and high for abduction (0.95), ER (0.88) and IR (0.93).[37]

Treatment Procedure

The clinician palpated the upper thoracic spine to identify spinous process tenderness and identified the level of hypomobility by asking the patient to extend their back actively to elicit pain (Table 3.3). The level of spinous process tenderness coupled with the location of hypomobility was determined by the investigator asking the patient performing trunk extension (lumbar, thoracic and neck) and reporting pain and/or movement restriction. After identifying the painful or restricted level the clinician placed one arm around the patient's chest above the established treatment level, while placing the ulnar border of the mobilizing (treatment) hand over the thoracic spinous process of the determined level and performed a single central SNAG using a cephalad glide applied parallel to the facet joint plane (i.e. toward the patient's eyes) (Figure 3.1).[38] The patient actively performed one repetition of trunk extension returning to the starting point while the clinician continued to apply the glide. The patient then reported any pain experienced during the repetition. Patient report of complete pain cessation indicated the treatment level and the process was repeated for a set of 10 repetitions as the clinician maintained the pain-free glide. Upon completion of the first set of repetitions, the patient rested for one minute. The clinician then re-applied the thoracic SNAG at the previously identified level and the process was repeated for a total treatment of 3 sets of 10 repetitions. Total treatment time was less than 5 minutes. Immediately following the thoracic SNAG treatment, patients were re-evaluated for pain levels during orthopedic special tests and ROM to examine the effects of one treatment of thoracic SNAGs. After completing treatment all patients resumed normal sport activity. Patients returned to the clinic 48-hours after initial treatment for follow-up outcomes collection of pain levels for orthopedic special tests, SPADI self-report, and ROM measurements. Patients received no further treatment during the follow-up session, concluded by release from the study.

One patient (N=1) was excluded from the study after failing to return for the 48-hour post-treatment follow-up due to illness unrelated to treatment.

OUTCOMES

Numerical Pain Rating Scale

To assess the effectiveness of the Mulligan Concept thoracic SNAG treatment to address pain from initial exam to immediately post-treatment, total mean change was calculated on the average NPRS scores reported during initial and immediate follow-up exam. Table 3.4 contains the differences detected between initial exam NPRS and immediate follow-up examination for dependent variables. To assess the effectiveness of the Mulligan Concept thoracic SNAG treatment to address pain from initial exam to 48-hour follow-up, total mean change was calculated on the NPRS scores reported during initial and 48-hour follow-up exam (Table 3.4). At 48-h post-thoracic SNAG treatment intervention the mean percent change of all dependent variable except Neer Impingement test reached an MCID (Table 3.5).

Range of Motion

To assess the effects of the Mulligan Concept thoracic SNAG treatment to address ROM from initial exam to the immediate post-treatment, mean change was calculated on the average ROM values reported during initial and post-treatment exam. A MDC was found between initial exam shoulder internal rotation (IR) average ROM values (IR mean = 48.8^{o}) and immediate post-treatment exam shoulder IR average ROM values (IR mean = 58.2^{o}). The mean change (9.4±7.1) indicates that the treatment effect was enough to produce a MDC (8^{o} increase) for IR shoulder ROM. A difference was also detected between initial external rotation (ER) average ROM values (ER mean = 104.5^{o}) and immediate post-treatment exam shoulder ER values (ER = 108.4^{o}).

To assess the effects of the Mulligan Concept thoracic SNAG treatment to address ROM from initial exam to the 48-h follow-up, mean change was calculated on the average ROM values reported during initial and 48-h follow-up exam. Although there was improvement between initial IR (IR mean = 48.9^{o}) and 48-h follow-up IR (IR mean = 56.0^{o}) and between initial flexion (flexion mean = 146.^{o}) and 48-h follow-up flexion (flexion mean = 152.2^{o}) and between initial abduction (ABD) (ABD mean = 150.2^{o}) and 48-h follow-up ABD (ABD mean = 153.4^{o}), MDC was not achieved (Table 3.6).

Shoulder Pain and Disability Index

To assess the effects of the Mulligan Concept thoracic SNAG treatment to address disability from initial exam to 48-hour follow-up, total mean change was calculated on the mean SPADI scores reported during initial and 48-hour follow-up exam. Investigators discovered a mean change of score difference (+6.8-point change) between initial exam average scores (mean = 23.1±6.6 points) and follow-up exam average SPADI scores (mean = 16.3±10.2 points) which resulted in a percent change score of 29.4% (Table 3.4).

Global Rating of Change

To assess the overall degree of perceived change in status, patients were asked to rate their change in pain and disability associated with SIS from initial exam to 48-hour follow-up. Patients reported a mean minimal change in overall perception of their SIS reported symptoms at the 48-hour follow-up exam (mean = 2.0±2.0 points).

DISCUSSION

In this multi-site case study two novice practitioners of Mulligan Concept utilized thoracic SNAGs to, at least in the short-term, affect pain and disability at the glenohumeral joint in patients initially classified with SIS. Positive patient-reported changes in pain (NPRS) and ROM were observed immediately post-treatment and at the 48-h follow-up. Patient reports for the SPADI improved at the 48-h follow-up, however not to the level of meeting the MCID (Table 3.4).

Utilizing thoracic SNAGs on patients classified with SIS is based upon RI,[2,39] in which seemingly unrelated impairments in a remote anatomical region can contribute to or be associated with the patient's primary complaint. Patients with SIS often develop compensatory motor patterns in the shoulder and thoracic spine (regional) to protect damaged tissue.[39] Dysfunction of the thoracic spine may influence shoulder function, therefore treatment focused on the thoracic spine should result in changes in shoulder pain and function. Previously, investigators of several studies utilized a RI treatment approach[1,17,39] to demonstrate the effectiveness of including scapulothoracic manual therapy interventions for patients classified with SIS. Investigators observed increases in shoulder internal and external rotation using a thoracic spine treatment intervention during this case series, and the positive mean change of pain (NPRS) and disability (i.e., SPADI, ROM) scores during this case series supports the RI model.

Investigators developed this current case study based on a report by Boyles et al. (2009), however we treated fewer patients, which prohibited statistical assessment beyond descriptive analysis. Investigators produced a total mean change in NPRS scores from initial to 48-hours post-treatment for provocation tests and ROM, greater than the the mean changes reported by Boyles et al.[2] Investigators demonstrated greater changes in NPRS scores for resisted empty can, RIR, RER, and active abduction, and the baseline SPADI measurements of 34.7(17.4) and 48-h measurements as 27.9(21.4) for a mean change of 6.8(5.1) equaled the mean change reported by Boyles et al.[2] (2009) (Table 3.4).

Boyles et al[2] failed to report ROM values, therefore no comparison between this study and Boyles et al[2] could be achieved (Table 3.6), however several explanations for an immediate change of ROM are proposed. First, the application of thoracic SNAGs may improve thoracic mobility leading to improved shoulder range of motion. Otoshi et al[40] suggests that a reduction in thoracic kyphosis can lead to an improvement in shoulder ROM, and manual therapy that includes thoracic spine treatment interventions provide decreases in self-reported pain measures and disability in patients with SIS. Norlander et al[41-43] also reported on the relationship between reduced cervicothoracic mobility and the presence of neck-shoulder pain. Second, an increase in shoulder ROM may be a result of decreased neuromuscular inhibition. Cleland et al[44] demonstrated an increase in lower trapezius muscle strength immediately following thoracic manipulation. Lastly, a hypothesized hypoalgesic effect may contribute to the reduction of shoulder pain leading to an increase in shoulder range of motion. Vicenzino et al[45] and Fernandez-Carnero et al[46] both demonstrated hypoalgesic effects following cervical manipulative therapy in patients with lateral epicondylalgia. The reported ROM measurements although immediate, only constituted a temporary change in observed findings which may be explained by the body returning to its previous functional state as the source of dysfunction had not been directly addressed.

Other research conducted regarding ROM and the shoulder include various research studies conducted to determine the effect of several stretching protocols aiming to improve glenohumeral internal rotation deficit (GIRD), a precursor to SIS. For example, one investigation utilizing a sleeper stretch demonstrated an average12.4° increase in subjects over a 4-week static stretching program.[47] Similarly, use of sleeper stretches produced an increase of 3.1° in IR after one treatment session.[48] In a collegiate baseball population, a 4-week stretching-plus-mobilization protocol demonstrated an increase of 19 ° in IR in subjects.[49] Linter et al[50] reported IR increases however, those increases were only achieved after a 3-year IR stretching program. Shoulder ROM improvements associated with stretching protocols are found with static stretching, but the findings also suggest the improvements required repetitive application of the stretching protocols targeted to specific musculoskeletal tissue over extended time frames. Continued investigation of a larger participant population is needed to determine if the observed total mean changes for shoulder IR and ER ROM in this study from a single Mulligan Concept thoracic SNAG treatment challenge the efficacy of static stretching protocols.

Patients in previous shoulder investigations reported baseline SPADI scores at much higher levels than reported in this study. Mean scores ranged from 43% to 75% compared to the mean (23.07%) reported in this investigation.[51-52] We included all scores in the data analysis due to consistency of reports by patients as well as the limited number of patients available to investigate the effect of thoracic SNAGs on this patient population. The total percentage change of scores (29.4%) nearly reached clinical meaning of 30% change. The utilization of SPADI is indicated to detect pain and dysfunction in patients, however the current patient population began at low levels of pain and dysfunction measured by the SPADI, which may lead to the failure to reach statistical significance utilizing the outcome measure. In previous intervention[53] patients also reported symptoms at longer reporting periods (> 3 months) than the patients in this investigation. Patients in this investigation reported pain and dysfunction within 30 days of onset of symptoms of pain and dysfunction providing a basis for lower reported SPADI scores. We hypothesized the shortened time frame prevented patients from reporting increased levels of pain and dysfunction on the SPADI. Based on the improvements in pain for provocation tests, the application of thoracic SNAGs appears to optimize conditions for treating patients classified with SIS, especially with early intervention.

Limitations and Future Research

Limitations of this study include a lack of a control group or randomization of patients, and short-term follow-up. Also, this study included a small sample size and relatively specific patient population. Additionally, the decision to treat the patient at a single thoracic level differs from Boyles et al[2] who treated three different levels of the spine with HVLA. It is possible the single location was not the optimal treatment level and may illustrate the need to treat SIS using a multi-level intervention versus a single level treatment approach. Likewise, a treatment intervention utilizing thoracic SNAGs in conjunction with a glenohumeral MWM may produce greater results for patients who do not respond favorably to the thoracic SNAGs alone. The evaluation of thoracic SNAGs in isolation from local interventions such as manual therapy directed at the glenohumeral joint may explain the lack of clinical significance during this case series. Pain associated with SIS may be a result of a local response to injury which may necessitate a local treatment intervention as suggested by Lewis[4] and Teys[54] who reported that for patients with shoulder pain, posteriorly directed pressure applied to the region of the humeral head led to an immediate increase in shoulder elevation range of motion and associated decrease in pain when compared with a sham and a control technique.

Despite these limitations, the results of this case series demonstrate positive outcomes in pain and disability across all patients in this study. Future studies should include additional multi-site study of this thoracic SNAG technique to treat SIS. Also, cohort studies comparing Mulligan Concept thoracic SNAGs versus thoracic SNAGs combined with a glenohumeral MWM would be beneficial in determining the effectiveness of the thoracic SNAG technique. Additional research is also necessary to determine the effectiveness of a single treatment versus the cumulative effects of multiple thoracic SNAG treatments on multiple spinal segments when warranted.

CONCLUSION

The present case series is the first to investigate the use of thoracic SNAGs for the treatment of SIS. In this case series, the use of thoracic SNAGs produced both immediate and short-term positive changes on patient reported outcome measures including the NPRS, SPADI and ROM after 1 treatment. Mulligan Concept thoracic SNAGs are an emerging treatment intervention utilized to treat patients with shoulder pain and dysfunction as the evidence supporting an interdependent relationship between the thoracic spine and the shoulder is growing. Based on initial results, healthcare professionals may expect improved patient outcomes when treating patients classified with SIS utilizing thoracic SNAGs. However, additional studies with larger sample sizes are needed to establish the clinical value of utilizing a single treatment session thoracic SNAGs to treat patients complaining of SIS.

Table 3.1. Inclusion Criteria (Boyles et al., 2009)	
Category 1	
≥ 2 NPRS	Neer's Impingement Sign
	Hawkins Impingement Sign
Category 2	
≥ 2 NPRS	Active Shoulder Abduction
Category 3	
≥ 2 NPRS	Resisted Internal Rotation
	Resisted External Rotation
	Empty Can
NPRS = Numeric Pain Rating Scale	

Table 3.2. Patient Demographics	
Gender	
Male	n=5
Female	n=1
Sport	
Water Polo	n = 2
Baseball	n=2
Basketball	n=1
Volleyball	n=1
Age	
Range	15-22 years
Mean	19 years
SD±	2.82 years

Table 3.3. Physical Examination Clinical Findings			
Symptom Presentation	Duration	7-21 days	
	Mode of Onset	Insidious	
	Aggravating Factors	Repetitive Overhead Activity Laying on Involved Shoulder	
	Relieving Factors	Rest ROM below 90^{o} NSAIDs	
	Nature of Symptoms	Intermittent w/ ADLs – dull ache Constant w/Activity – sharp pain	
	Prior Treatments to Shoulder	Pulsed Ultrasound Rotator Cuff Strengthening Ice Stretching	
Mean Cervical ROM Measurements	Flexion	$40.55^{o} \pm 15.6^{o}$	
	Extension	$71.87^{o} \pm 15.3^{o}$	
Mean Shoulder ROM Measurements	Flexion	$146.13^{o} \pm 20.8^{o}$	
	Extension	$62.57^{o} \pm 13.0^{o}$	
	Internal Rotation	$48.88^{o} \pm 20.8^{o}$	
	External Rotation	$104.55^{o} \pm 9.2^{o}$	
Orthopedic Special Tests	Neer's Impingement Sign	Positive	Negative
		n = 5	n = 1
	Hawkins Impingement Sign	Positive	Negative
		n = 2	n = 4
	Empty Can Test	Positive	Negative
		n = 3	n = 3
Thoracic SNAG Treatment Level	Patient #1	T7	
	Patient #2	T7	
	Patient #3	T7	
	Patient #4	T6	
	Patient #5	T5	
	Patient #6	T6	

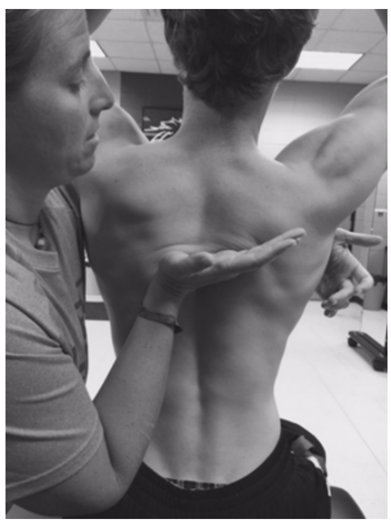
Table 3.4. Clinical Evaluation of Subject Outcome Measures: Initial, Post and 48-Hour Follow-Up Post-Thoracic SNAG Treatment			
Outcome Measure	Initial	Post-Treatment	48-hour FU
NPRS			
Neer	4.2+2.6	3.2+2.5	3.8+1.6
Hawkins	1.7+1.8	1.7+2.3	1.0+1.5*
EC, resisted	2.3+2.3	2.0+2.5	1.2+1.2*
IR, resisted	1.8+1.6	.67+.82*	1.0+1.5*
ER, resisted	5.7+1.6	4.1+1.7	2.2+1.7*
Active ABD	3.7+2.6	2.8+3.2	1.5+1.5*
SPADI	23.1+6.6		16.3+10.2
GROC			2.0+2.0
*= met MCID at 30% change; SPADI = Shoulder Pain and Disability Index FU = follow-up, EC = empty can, IR = internal rotation, ER = external rotation, ABD = abduction.			

Table 3.5. Percentage of Change for NPRS of Dependent Variables					
Outcome Measure	Initial	Post	%Change Post	48-hour FU	%Change 48-h
NPRS					
Neer	4.17	3.17	24.0%	3.83	8.0%
Hawkins	1.67	1.67	0.0%	1	40.0%*
EC, Resisted	2.33	2	14.3%	1.17	50.0%*
IR, Resisted	1.83	0.67	64.6%*	1	45.5%*
ER, Resisted	5.67	4.08	27.9%	2.17	61.8%*
Active ABD	3.67	2.83	30.3%*	1.5	59.1%*
*= met MCID at 30% change; FU = follow-up; EC = empty can; IR = internal rotation; ER = external rotation; ABD = abduction					

Table 3.6. Clinical Evaluation of Subject Range of Motion: Initial, Post and 48-Hour Follow-Up Post-Thoracic SNAG Treatment

	Initial	Post-Treatment	48-hour FU
Cervical			
Flexion	40.6±15.6	56.0±7.9*	52.9±16.8
Extension	71.9±15.3	70.4±10.9	73.8±12.6
Shoulder			
Flexion	146.1±20.8	144.5±18.1	152.1±19.5
Extension	62.6±13.1	62.5±9.7	63.8±13.1
Internal Rotation	48.9±20.8	58.3±10.8*	56.0±12.9
External Rotation	104.6±9.3	108.4±12.0*	95.1±17.4
Abduction	150.2±15.5	130.7±28.3	153.4±17.7
* = met MDC			

Figure 3.1. Hand Placement for Thoracic SNAG



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CHAPTER 4
AN EXPLORATORY CASE SERIES EXAMINING MULLIGAN CONCEPT POSITIONAL SUSTAINED NATURAL APOPHYSEAL GLIDES ON PATIENTS CLASSIFIED WITH MECHANICAL NECK PAIN

Submitted to *Musculoskeletal Science and Practice*

ABSTRACT

Background and Purpose: Mechanical neck pain (MNP) is common in the athletic population. While symptoms may present at the cervical spine for patients complaining of MNP, thoracic spinal alignment or dysfunction may influence cervical positioning and overall cervical function. Traditionally, clinician utilize cervical high-velocity low-amplitude (HVLA) thrust manipulations to treat MNP, albeit with a small level of inherent risk. Mulligan Concept positional sustained natural apophyseal glides (SNAGs) directed at the cervicothoracic region are emerging to treat patients with cervical pain and dysfunction, as evidence supporting an interdependent relationship between the thoracic and cervical spine grows. The purpose of this a priori case series was to evaluate outcome measures of patients classified with MNP treated with the Mulligan Concept positional SNAGs utilizing the thoracic Cleland et al. HVLA MNP CPRs. **Case Descriptions:** Ten consecutive patients classified with MNP were treated utilizing Mulligan Concept positional SNAGs. The Numeric Rating Scale (NRS), Patient-Specific Functional Scale (PSFS), Neck Disability Index (NDI), Disablement in the Physically Active (DPAS), and Fear-Avoidance Based Questionnaire-Physical Activity (FABQPA) were collected for inclusion criteria and to identify patient-reported pain and dysfunction. **Outcomes:** Positive patient-reported changes in pain, function, and cervical range of motion were observed immediately post-treatment and between treatments. **Discussion:** Based on the results of this case series, investigators conclude positional SNAGs directed at the cervicothoracic region may address a variety of patient reported symptoms for MNP, and the number of treatment sessions needed for symptom resolution may be closer to a single session rather than multiple treatments.

Key Words: Mechanical neck pain, Cervicothoracic junction, Mobilization with Movement

INTRODUCTION

Mechanical neck pain (MNP) is a musculoskeletal disorder commonly affecting the weekend warrior and high-level athlete alike. Patient-athletes report spinal pain and dysfunction at an equal or greater rate than the general population, estimated as up to 15% of all sports-related injuries.[1] Surveillance efforts in the athletic population traditionally focused on traumatic cervical spine injuries[2,3] rather than pathology categorized as MNP. Mechanical neck pain is defined as: nonspecific pain in the area of the cervicothoracic junction without an identifiable pathoanatomical cause and most frequently requires that the pain be exacerbated by motion.[4-7] The subset of the athletic population hampered by MNP has been approximated at 36% of all neck pain,[8] and poses unique treatment challenges to the sports medicine clinician, as limited evidence supporting effective interventions is available.[9] Although cervical spine manipulation, also referred to as high-velocity low-amplitude (HVLA) thrust is commonly employed to treat patients with MNP, disagreement persists over the efficacy of the application.[10]

Compared to the cervical and lumbar regions, the thoracic spine is largely neglected in the research literature. Thoracic spine dysfunction is often overlooked due to complicated anatomy, biomechanics, function, proximity to vital organs, and articulation with ribs which can result in false diagnoses and insufficient treatment.[11] Manual therapy intervention strategies such as HVLA thrusts are frequently based on theoretical models of mechanical dysfunction and elucidating symptoms which do not present at the thoracic spine.[12] As such, researchers and clinicians alike theorize that disturbances in joint mobility in the thoracic spine may be an underlying contributor to musculoskeletal disorders in the cervical spine providing the rationale to include HVLA thrust manipulation and/or non-thrust mobilization to the thoracic spine to treat patients with MNP.[13]

Childs et al.[4,14] and Cleland et al.[15] investigated the utilization of thoracic HVLA thrusts on patients presenting with MNP to determine combinations of variables obtained from self-report measures, patient history, and clinical examinations that may lead to patients receiving long-term benefits from thoracic manual therapy. A set of CPRs resulted from the investigations, which have yet to be validated, allowing further investigation of alternative manual therapy interventions for treating MNP including the Mulligan Concept (MC) Mobilization with Movement (MWM).

The MC MWM treatment approach which combines passive accessory glides (i.e., mobilizations) with active movement is indicated to increase joint range of motion (ROM), decrease pain, and enhance muscle function when treating musculoskeletal pain and/or dysfunction.[16-22] The rapid pain-relieving mechanical effect is primarily based on the presence of articular positional faults and realignment through MWMs to correct said faults.[22,23] Similarly, the MC sustained natural apophyseal glide (SNAG) technique has been reported to create sympathoexcitatory effects[24] and increases in ROM[25] when treating musculoskeletal dysfunction at the spine. As the neurophysiological effects of SNAGs such as immediate hypoalgesia and an increase in pressure-pain thresholds have been highlighted in the research[26,27] the use of thoracic SNAGs is recommended as a suitable manual therapy technique to treat patients classified with MNP.[19,23]

At this time, no attempts have been made to examine the effect of positional SNAGs directed at the cervicothoracic region on pain and disability in patients classified with MNP. Additionally, limited comparisons have been investigated between SNAGs and HVLA treatment interventions to treat MNP.[19,23] The purpose of this a priori case series was to evaluate disease- and patient-oriented outcome measures of patients classified with MNP treated with the MC positional SNAGs while utilizing the thoracic Cleland et al.[15] HVLA MNP CPRs.

MATERIALS AND METHODS

Between April 2016 and September 2016 10 consecutive patients who presented to the athletic training clinic with complaints of MNP were evaluated in the same manner to determine eligibility for inclusion in this multi-site case series. Each participant provided written informed consent to use their patient case and data for publication. Participant confidentiality was protected according to the United States' Health Insurance Portability and Accountability Act (HIPPA).

Subjects

Inclusion of patients occurred if patients met 2 or more of the classification-based inclusion criteria established by Cleland et al.[15]; absence of upper-extremity symptoms distal to shoulder, onset of symptoms < 30 days, looking up does not aggravate symptoms, FABQPA score < 12, diminished upper thoracic spine kyphosis, and cervical extension ROM < 30^{o} plus specified scores on the NDI, NRS, and PSFS. Patients (7 males, 3 females) aged 14-20 years representing a variety of sports, reporting neck pain of a non-traumatic musculoskeletal nature within the previous 30 days who did not seek treatment for the current presentation were eligible for inclusion

Patients were excluded from the study if they presented with: medical “red flags” indicating non-musculoskeletal etiology (e.g., suspected fracture), positive Spurling’s or Cervical Distraction Test, history of whiplash within 6 weeks of examination, diagnosis of cervical spinal stenosis, or evidence of CNS involvement (e.g., decreased neurological response distal to shoulder).

Outcome Measures

Investigators began the examination by administering the Numeric Rating Scale (NRS),[28-33] Neck Disability Index (NDI),[34,35] Patient-Specific Functional Scale (PSFS),[36] Fear-Avoidance Beliefs Questionnaire-Physically Active (FABQPA)[37-39] outcomes measures as well as collecting patient-reported history relating to duration, mode of onset, nature of symptoms, and aggravating/relieving factors. To evaluate the effect of treatment for MNP, clinicians utilized patient-reported outcome measures to assess perceived levels of pain (NRS) and functional disability (PSFS) as well as disease-oriented outcomes (i.e., active cervical ROM)[40,41] to measure cervical function and global efficacy of treatment.[42-44] Investigators utilized minimal clinically important differences (MCIDs) and minimal detectable change (MDC) to interpret patient-reported outcomes measures including benefits derived from treatment, impact upon the patient, and implications for clinical management of the condition. Outcome measurements were collected at the initial-evaluation, post-3rd treatment, and two-week follow-up visits.

Study Design

After consent was obtained and inclusion was established, each patient assessment to determine the vertebral level of treatment began by the clinician first assessing spinous process tenderness at C2-T4 vertebral levels, followed by the patient performing cervical flexion, extension, and rotation while the clinician palpated for vertebral hypomobility. The matched level of spinous process tenderness and hypomobile segment was deemed the initial treatment level. The clinician completed a single sub-therapeutic dose of the positional SNAG at the established treatment level (assessed hypomobile segments) and corresponding side of the most painful cervical ROM self-selected by the patient. The clinician started by placing thumb on the higher ipsilateral side (ROM restriction) segments and opposite thumb on the lower contralateral side of the spinous process providing a translational direction of the glide (Figure 4.1) while the patient actively performed previously reported restricted ROM. In the event the patient did not report a pain-free, immediate, and long-lasting (PILL) effect to the sub-therapeutic treatment the clinician adjusted (e.g., re-directed angle and/or intensity) the positional SNAG to earn the necessary PILL effect. Inability to elicit a pain-free response at the originally assessed level caused the clinician to move to the next vertebral level directly adjacent to the originally assessed segment and provide another single sub-therapeutic positional SNAG. A maximum of three consecutive vertebral levels was assessed, and the treatment level was determined as the level in which the sub-therapeutic dosage of the positional SNAG combined with the patient-reported PILL effect. Outcome measurements were collected at initial-evaluation, post-3rd treatment, and two-week follow-up visits.

The treating athletic trainers have an average of 12 years of clinical experience, and both completed 3 Mulligan Concept Upper Extremity courses including practical training in the use of cervical and thoracic positional SNAGs. To ensure inter-rater consistency all examination, outcome assessments, and treatment techniques were standardized (i.e. body position, goniometric landmarks, hand placement), video recorded, and shared between clinicians and reviewed by third party clinician (20 years of clinical experience). Also, video recordings were reviewed by a Mulligan Concept Teachers Association (MCTA) certified practitioner to establish intervention face validity and consistency between the investigating clinicians. The same procedures where utilized with each patient encounter.

Treatment Intervention

Treatment began at the vertebral level determined during the patient evaluation and sub-therapeutic positional SNAG assessment. The investigator provided verbal instructions for the patient to move into the previously restricted motion and provide over-pressure at the end-ROM while the investigator maintained the transverse glide for a set of 10 repetitions

(Figure 4.2). After the patient clearly understood treatment parameters and the importance of a pain-free treatment, each patient was treated therapeutically. Upon completion of the first set of 10 repetitions, the patient rested for one minute. The clinician re-applied the positional SNAG at the previously identified level for a total treatment of 3 sets of 10 repetitions with one-minute rest between sets. Total treatment time was less than 5 minutes.

Each patient was treated three times with at least 24 to 72 hours separating each treatment. During each treatment session, both pre- and post-treatment outcome measures for NRS, and PSFS were collected while CROM was recorded before each treatment session only. All patients returned after 24 hours and two weeks following the third treatment to assess both short-term and long-term effects on pain and function.

Data Analysis

All data was analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). One-way repeated measures analysis of variance (RM-ANOVA) tests were conducted to evaluate the effect of MC SNAGs on the NRS, PSFS, and CROM across time. Mean differences from the initial-visit scores and 95% confidence intervals (CIs) were calculated for the NRS, PSFS, and CROM for post-3rd treatment and two-week follow-up. Significant changes were further analyzed with Bonferroni post hoc testing. Prior to data analysis, normality of distribution was assessed with the alpha level set at $p < .05$. Effect size differences were computed with Partial Eta squared (η_p^2). A small effect size is $\eta_p^2 = 0.02$; medium effect size is $\eta_p^2 = 0.13$; large effect size is $\eta_p^2 = 0.26$.[28]

RESULTS

Numeric Rating Scale (NRS)

Application of MC SNAGs resulted in statistically significant improvements in pain (NRS) over time [Wilks' Lambda=.075, $F(3, 7)=28.97$, $p<.001$, $\eta_p^2=.925$, power=1.00] (Table 4.2). Mauchly's test of sphericity indicated the assumption of sphericity had been violated ($\chi^2(5)=18.11$, $p=.003$); therefore, a Greenhouse-Geisser correction was applied [$F(2.054, 18.48) = 42.31$, $p=.000$, $\eta_p^2=.825$, power=1.00]. The mean changes in NRS scores from initial-visit to post-1st treatment (M=4.40, 95% CI[2.14 – 6.65], p=.001), from initial-visit to post-3rd treatment (M=5.30, 95% CI[3.48 – 7.11], p=.001), and from initial-visit to two-week follow-up (*M*=5.07, 95% CI[3.12 – 7.02], *p*=.001) were significant. Further analysis revealed 8/10 patients achieved significant clinical and statistical improvement in pain (4-point reduction) exceeding the minimal clinically important difference (MCID)[29] post-1st treatment. An additional 0.90-point improvement was achieved post-3rd treatment, and all patients (10/10) maintained their clinical gains at the two-week follow-up examination. Overall effect size for pain was 0.91 (Table 4.1, 4.2).

Patient-Specific Functional Scale (PSFS)

Application of MC SNAGs also produced statistically significant improvements in function (PSFS) over time (Wilks' Lambda=.075, $F(3, 7)=28.89$, $p=.001$, $\eta_p^2=.925$, power = .1.00) (Table 4.3). The mean changes in PSFS scores from initial-visit to post-1st treatment (*M*=2.35, 95% CI[4.28 - .414], *p*=.05), from initial-visit to post-3rd treatment (*M*=4.60, 95% CI[6.26 - 2.94], *p*=.001), and from initial-visit to two-week follow-up (*M*=4.80, 95% CI[6.35 - 3.25], *p*=.001) were significant. The mean change in PSFS scores from initial exam to two-week follow-up exam exceeded the MDC value on the PSFS.[30] Of greater clinical relevance for the MDC values, 6/10 of patients reported a PSFS score exceeding the MDC value (3.5-point improvement) after the 1st treatment. After the 3rd treatment, 9/10 of patients reported a score of 9 or higher, with 10 representing the highest score possible. At the two-week follow-up, 10/10 of patients reported a score of 10. Overall effect size for function was 0.91 (Table 4.1, 4.3).

Cervical ROM

Extension (EXT)

The MC SNAG treatment produced statistically significant changes in overall cervical extension over time (Wilks' Lambda=.157, $F(3, 7)=12.51$, $p=.003$, $\eta_p^2=.646$, power=.989) (Table 4.4). Mauchly's test of sphericity indicated the assumption of sphericity had been violated $\chi^2(5)=20.82$, $p=.001$; therefore, a Greenhouse-Geisser correction was applied [F(1.463, 13.16) = 16.39, $p=.001$, $\eta_p^2=.646$, power=.989]. The mean changes in overall cervical extension scores from initial-visit to post-1st treatment (*M*=13.44, 95% CI[33.31 - 6.43], *p*=.05) was not significant. However, mean changes from initial-visit to post-3rd treatment (*M*=27.05, 95% CI [46.86 - 7.23], *p*=.01), and from initial-visit to two-week follow-up (*M*=28.68, 95% CI[50.47 - 6.88], *p*=.01) were significant (Table 4.4).

Flexion (FLEX)

Overall cervical flexion also improved over time as statistically significant changes were reported (Wilks' Lambda=.213, *F*(3, 7)=8.63, *p*=.01, η_p^2=.787, power=.905) (Table 4.4). Mauchly's test of sphericity indicated the assumption of sphericity had been violated (χ^2(5)=16.87, *p*=.005); therefore, a Greenhouse-Geisser correction was applied [F(1.340, 12.05) = 7.71, *p*=.012, η_p^2=.462, power=.794]. The mean changes in overall cervical flexion scores from initial-visit to post-1st treatment (*M*=12.60, 95% CI[30.50 - 5.30], *p*=.05), from initial-visit to post-3rd treatment (*M*=23.12, 95% CI[44.14 - 2.09], *p*=.05), and from initial-visit to two-week follow-up (*M*=16.07, 95% CI[41.89 - 8.49], *p*=.05) were significant (Table 4.4). In addition, patients (N=4) who reported cervical flexion restriction experienced significantly greater increases in cervical flexion changes over time (Wilks' Lambda=.047, *F*(3, 1)=6.759, *p*=.001, η_p^2=.899, power=1.00) as compared to overall cervical flexion (Table 4.5). Additionally, the mean changes in patient-reported cervical flexion restriction scores from initial-visit to post-1st treatment (M=29.20, 95% CI[73.74 – 15.34], *p*=.05), from initial-visit to post-3rd treatment (M=40.45, 95% CI[86.67 – 5.74], *p*=.05), and from initial-visit to two-week follow-up (M=37.20, 95% CI[80.33 – 5.93], *p*=.05) were significant.

Right rotation (RR)

In addition, statistically significant changes in overall cervical right rotation were produced utilizing MC SNAGs (Wilks' Lambda=.152, *F*(3, 7)=13.04, *p*=.01, η_p^2=.848, power=.982) (Table 4.4). Mauchly's test of sphericity indicated the assumption of sphericity had been violated (χ^2(5)=11.99, *p*=.036); therefore, a Greenhouse-Geisser correction was applied [F(1.648, 14.83)=21.51, *p*=.000, η_p^2=.705, power=.999].The mean changes in overall cervical right rotation scores from initial-visit to post-1st treatment (*M*=12.50, 95% CI[26.26 - 1.26], *p*=.05), from initial-visit to post-3rd treatment (*M*=19.82, 95% CI[30.91 - 8.72], *p*=.001), and from initial-visit to two-week follow-up (*M*=22.15, 95% CI[35.69 - 8.60], *p*=.001) were significant (Table 4.4).

Left rotation (LR)

The MC SNAG treatment also produced statistically significant changes in overall cervical left rotation (Wilks' Lambda=.122, $F(3, 7)=16.74$, $p=.001$, $\eta_p^2=.878$, power=.996) (Table 4.4). The mean changes in overall cervical left rotation scores from initial-visit to post-1st treatment ($M=8.65$, 95% CI[19.20 - 1.90], $p=.05$), from initial-visit to post-3rd treatment ($M=17.22$, 95% CI[30.21 - 4.22], $p=.01$), and from initial-visit to two-week follow-up ($M=26.55$, 95% CI[39.72 - 13.38], $p=.001$) were significant (Table 4.4). Patients (N=5) who reported cervical left rotation restriction experienced significantly greater increases in cervical left rotation changes over time (Wilks' Lambda=.010, $F(4, 1)=24.17$, $p=.001$, $\eta_p^2=.990$, power=.992) as compared to overall cervical left rotation. Mauchly's test of sphericity indicated the assumption of sphericity had been violated ($\chi^2(9)=13.09$, $p=.248$; therefore, a Greenhouse-Geisser correction was applied [F(1.796, 7.183)=8.920, $p=.001$, $\eta_p^2=.690$, power=.864] (Table 4.6). Additionally, the mean changes in patient-reported cervical left rotation restriction scores from initial-visit to post-1st treatment (M=8.70, 95% CI[32.63 – 15.23], $p=.05$), from initial-visit to post-3rd treatment (M=18.30, 95% CI[60.60 – 23.88], $p=.05$), and from initial-visit to two-week follow-up (M=28.50, 95% CI[65.20 – 8.20], $p=.05$) were not significant. Medium to large effect sizes were reported for overall AROM (CEXT = 0.64, CRROT = 0.70, CLROT = 0.87), while a medium effect size was reported for overall AROM (CFLEX = 0.46) which demonstrates that 46 to 87% of the variance in AROM measurements could be explained by MC SNAG treatment (Table 4.7).

Clinical prediction rule (CPR)

Secondary to investigating the effects of positional SNAGs on MNP, we examined whether the 6 predictor variables identified by Cleland et al. (2007) correspond to current patient-reported symptoms and outcomes. The results of this case series illustrate that the Cleland et al.[15] CPR did not need to be fully satisfied to achieve a positive outcome. Cleland recommends for a successful treatment utilizing HVLA thrusts to occur a minimum of 4 predictive variables (93% posttest probability of success) should be present, however the subjects in this case series reported a mean of 3 predictor variables and reported treatment success.

DISCUSSION

Patients included in the study

In this exploratory multi-site case series two novice practitioners of MC utilized positional SNAGs at the cervicothoracic region to treat patients complaining of pain and disability at the cervical spine initially classified with MNP. All participants in this case series reported both clinically and statistically significant improvement across outcome measures of pain, function, and CROM.

Changes in NRS

The evidence provided in this case series significantly outperformed evidence previously reported[45-51] on the effects of treating MNP utilizing thoracic HVLA manipulations after the 1st treatment. Those previous investigations reported effect sizes ranging from .17 to .54 (small to moderate) for pain scores on the NRS whereas a .91 effect size (large) was achieved during this case series investigation. Direct comparison of pain scores in the previous studies is difficult due to the time intervals in which post-1st treatment results were reported. The time intervals ranged from 24-hour, 48-hour, and 1-week time intervals[45-51] whereas pain scores during this case series were collected immediately post-1st treatment session.

Changes in PSFS

Important to daily activity and sport specific activities, all participants reported clinically and statistically significant improvements with function (PSFS) at both post-1st treatment and at two-week follow-up. Investigators of previous studies did not report measures of function making comparison difficult; however, a .92 (large) effect size and improvement in patient reported function in this case series exceeded the established MDC[30] for the PSFS immediately post-1st treatment, at post-3rd treatment, and the improvement was maintained at 2-week follow-up.

Changes in cervical ROM

After the first treatment, ROM improvements met previously established MDCs of 7.0^{o} for extension, 9.6^{o} for flexion, 7.6^{o} for right rotation, and 6.7^{o} for left rotation.[52,53] El-

Sodany et al.[50] reported a "significant difference" in range of motion in flexion, extension and rotation after 6 weeks of treatment, and Izquierdo-Perez et al.[51] applied a total of 4 cervical SNAG treatment sessions over 2 weeks, reporting increases in flexion by 8.3°, extension by 13.3°, and rotation (combined) by 12.6° after the initial treatment. In this case series, overall CROM measurement increases (12.6° for flexion, 13.4° for extension, and 10.5° for combined rotation) as well as effect size were equal to the results reported by Izquierdo-Perez et al.[51] within the first treatment session. However, our overall CROM measurement increases (23.1° for flexion, 27° for extension, and 18.5° for combined rotation) as well as effect size outgained those of Izquierdo-Perez et al.[51] post-3rd treatment (11.5° for flexion, 20° for extension, and 11.6° for combined rotation) (Table 4.7).

Isolation of the patients' reported direction of CROM restriction for cervical flexion revealed a trend toward a greater increase in ROM and effect size over time whereas cervical left rotation demonstrated only minimal clinical gains. Hypothesized reasons for the reported large clinical gains for those with restricted cervical flexion include: 1) the mobilization with movement towards the restricted area utilizing positional SNAGs technique, 2) possible increase in one direction of motion leading to a carry-over effect to the other CROM through restoration of normal biomechanics within the cervicothoracic region, 3) and a "ceiling effect" to the increased ROM within the overall cervical flexion ROM group, as those patients who did not demonstrate significant losses in the overall cervical flexion ROM group under-valued clinical improvement demonstrated in cervical flexion restriction group.

Clinical prediction rule

A potential predictor for the success of the SNAG intervention in MNP may be the duration of symptoms. Flynn et al.[13] identified duration of current episode as the strongest predictor for identifying patients with low back pain who are likely to experience a rapid and dramatic response to lumbar HVLA thrusts, and Cleland et al.[54] also demonstrated that a shorter duration of symptoms was predictive for identifying patients with cervical neck pain who would respond to thoracic HVLA thrusts. During this case series, intervention for the majority (n = 7) of MNP occurred within 24 hours of symptom onset, and in some cases (n = 3) immediately after sustaining non-traumatic cervical trauma. The clinical and statistical improvement reported after the first treatment session may indicate that intervention within 24 hours of onset of symptoms utilizing the positional SNAG technique directed at the cervicothoracic region may result in greater reduction of symptoms, as SNAGs reduce soft tissue inflammation, induce relaxation and improve function before restricted movements, tissue irritability, and compensatory patterns set in.[55] This may be especially meaningful for clinicians who provide acute assessment and care on patients by providing immediate changes that are long lasting in patient outcomes opposed to the previously reported timeline of 4-6 weeks of treatment intervention if access to treatment is delayed.[45-50]

Limitations of present study

The primary limitation of this study is the lack of two comparison groups receiving HVLA manipulations and a control group along with those receiving positional SNAGs to treat MNP. The majority of current information and data regarding SNAGs are in the form of randomized control studies utilizing unilateral cervical SNAGS, and no research has been completed to determine the effects of positional SNAGs on patients complaining of MNP. Further examination in the form of controlled trials is necessary to determine whether different SNAG application procedures (e.g., increased or decreased load and treatment length) produces similar patient outcomes.[51,56] Potential bias of practitioners and patients is also a limitation of this study. In situations of MC positional SNAGs, it is difficult if not impossible to prevent bias associated with blinding, as each clinician knows which treatment they are providing. One example of subjective measurement bias is named the "hello-goodbye" or "Hawthorne" effect, in which the patient initially exaggerates symptoms to justify their request for treatment. Subsequently, the person minimizes any problems that remain, either to please the clinician or out of cognitive dissonance in which patients modify or improve an aspect of their behavior in response to their awareness of being observed.[57-59]

In this study, a CPR proposed by Cleland et al.[15] was utilized as a guide to identify patients complaining of MNP who may benefit from positional SNAGs directed at the cervicothoracic region. While this study utilized the Cleland et al. (2007) CPR, two limitations must be discussed: 1) The CPR was originally intended as a means of predicting variables to identify patients with neck pain likely to benefit from HVLA manipulation not SNAGs; and 2) The CPR has not been validated in subsequent studies.[60] Numerous clinical guidelines are present in the literature regarding spinal pain, yet a lack of consensus exists regarding their effectiveness due to wide variability of spinal therapy interventions. Further research is needed to identify a valid CPR for the treatment of MNP using the positional SNAG technique.[61-63] Utilizing the Cleland et al.[15] CPR may also have limited the population size, however utilizing a multi-center approach improves the likelihood of finding subjects matching the inclusion criteria.[64] While the sample size in our case series was small, we feel it was sufficient to produce statistically significant and clinically meaningful outcomes keeping in mind a larger sample size is preferable to narrow CIs and be more representative of the population. In addition, we chose to be conservative with our statistical analyses and used a Bonferroni correction. Despite this approach, our results demonstrated significant differences within-subjects on outcome measures at all follow-up points.

We conducted this case series to serve as a preliminary step in the investigation of the effects of positional SNAGs in patients classified with MNP in the athletic population. The statistically significant and clinically meaningful changes occurred over a short time frame among patients who received positional SNAGs which bolsters the argument that these changes are likely relevant for patients with MNP, providing impetus for future research in this area.

CONCLUSION

While further research is necessary, the positive results reported in this case series provide support for MC positional SNAGs as an alternative treatment option for patients presenting with MNP, regardless of a patient's status on the CPR. Our results support and reinforce the fact that positional SNAGs have positive effects on MNP. Those who received positional SNAGs exhibited substantial reductions in pain after 1 treatment and meaningful improvements in function after 3 treatments that were both statistically and clinically significant.

Table 4.1. Numeric Rating Scale (NRS) and Patient Specific Functional Scale (PSFS) Data from Initial Evaluation to 2 Week Follow-up

	Numeric Pain Rating Scale (NRS)				Patient Specific Functional Scale (PSFS)			
Patient	**Initial Evaluation**	**Post 1st Treatment**	**Post 3rd Treatment**	**2 Week Follow-up**	**Initial Evaluation**	**Post 1st Treatment**	**Post 3rd Treatment**	**2 Week Follow-up**
1	8	0*	0	0	2	5†	10‡	10
2	4	0*	1	1.3	7	7.7	10‡	10
3	4	3	0**	0	4	10†	10‡	10
4	6	0*	0	0	5.5	7.8†	10‡	10
5	6	4*	0	0	5.5	6.5	10‡	10
6	7	3*	0	0	5	6	8‡	10
7	6	0*	0	0	5	8.5†	10‡	10
8	6	0*	0	0.16	6	6	10‡	10
9	4	0*	0	0	5	9†	10‡	10
10	3	0*	0	0.16	7	9†	10‡	10
Mean	5.4	1	0	.16	5.2	7.5	9.8	10

* - MCID Achieved after first treatment; MDIC = 2-point change for NRS
** - MCID Achieved by Post 3rd Treatment
† - MDC Achieved after first treatment; MDC = 2-point change for PSFS Average Activity Score
‡ - MDC Achieved by Post 3rd Treatment

Table 4.2. Statistical and Clinical Significance for Pain from Baseline to 2-Week Follow-up

	Initial Evaluation	**Post 1st Treatment**	**Post 3rd Treatment**	**2-Week Follow-up**	**Total Mean Change**	**MDIC**	***p*-value**	**Partial Eta Squared**
NRS	5.40	1.00	.100	.330	5.07	2	<.001*	0.91

NRS = Numeric Pain Rating Scale; MDIC = Minimal Clinically Important Difference

Table 4.3. Statistical and Clinical Significance for Function from Baseline to 2-Week Follow-up

	Initial Evaluation	**Post 1st Treatment**	**Post 3rd Treatment**	**2-Week Follow-up**	**Total Mean Change**	**MDC**	***p*-value**	**Partial Eta Squared**
PSFS	5.20	7.55	9.80	10.00	4.80	2	<.001*	0.92

PSFS = Patient Specific Functional Scale; MDC = Minimal Detectable Change

Table 4.4. Cervical Range of Motion Mean Values and Within-Subjects Effects of Positional SNAGs								
	Initial Evaluation	**Post 1st Treatment**	**Post 3rd Treatment**	**2-Week Follow-up**	**Total Mean Change**	**MDC**	***p*-value**	**Partial Eta Squared**
CROM-EXT	58.0°	71.4°	85.0°	86.71°	28.6°	7.0°	.003**	0.64
CROM-FLEX	50.0°	62.2°	73.1°	66.74°	16.7°	9.6°	.009**	0.46
CROM-ROT L	58.4°	67.1°	75.6°	85.00°	26.5°	6.7°	.001**	0.87
CROM-ROT R	67.3°	79.8°	87.1°	89.45°	22.1°	7.6°	.002**	0.70
MDC = Minimal Detectable Change								

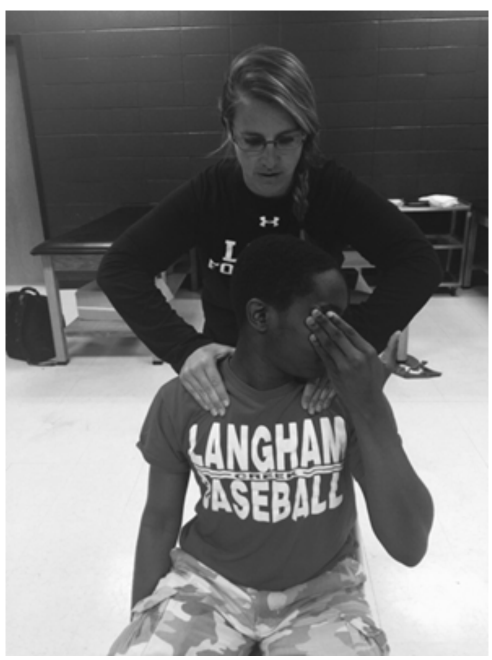
Table 4.5. Cervical Range of Motion Mean Values for Cervical Flexion Restriction Only								
	Initial Evaluation	**Post 1st Treatment**	**Post 3rd Treatment**	**2-Week Follow-up**	**Total Mean Change**	**MDC**	***p*-value**	**Partial Eta Squared**
CROM-FLEX	32.0°	61.2°	72.4°	69.2°	37.2°	9.6°	.001**	0.89
MDC = Minimal Detectable Change								

Table 4.6. Cervical Range of Motion Mean Values for Cervical Left Rotation Restriction Only								
	Initial Evaluation	**Post 1st Treatment**	**Post 3rd Treatment**	**2-Week Follow-up**	**Total Mean Change**	**MDC**	***p*-value**	**Partial Eta Squared**
CROM-ROT L	57.3°	66.0°	75.6°	85.8°	28.5°	9.6°	.01**	0.69
MDC = Minimal Detectable Change								

Table 4.7. Cervical Range of Motion Mean Change Values and Effect Size				
	Post 3rd Treatment Mean Change	**Partial Eta Squared**	**Izqueirdo-Perez et al. (2014)**	**Partial Eta Squared**
CROM-EXT	27°	.64	20°	.31
CROM-FLEX	23.1°	.46	11.5°	.31
COMBINED CERVICAL RIGHT/LEFT ROTATION	18.5°	.78	11.6°	.25

Figure 4.1. Hand Placement direction of glide for (Left Side) Positional SNAG

Figure 4.2. Positional SNAG with Patient Applied Over-Pressure



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