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Translating Evidence to Practice in Athletic Training

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Key Phrases
Evidence-Based, Literature Review, Knowledge-Translation Resources

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EDITORIAL

Evidence and evidence-based practice (EBP) are buzzwords within the field of athletic training and healthcare. These words may create mixed feelings, as polarizing as politics, for athletic trainers. However, the unifying of these words into the fabric of athletic training has been symbolized with the integration of EBP as a core competency in the 2020 Standards for Accreditation of Professional Athletic Training Programs.[1] The framework for EBP is here to stay and it will be a driving force in the growth and recognition of the athletic training profession.[2] The incorporation of EBP provides clinicians with the tools needed to search the literature, assess the quality, and integrate their clinical expertise in combination with patient values to interpret the appropriate clinical course of action.[3,4] Furthermore, EBP can provide the base for quality improvement initiatives within athletic training to formalize the clinical expertise portion of EBP. Examples of the benefits of EBP are all around us, signaling the need for all athletic trainers to embrace the practice.

The translation of EBP into clinical practice is not an easy one, however. Athletic trainers perceive that they lack the knowledge on how to implement EBP into clinical practice.[5] Even when knowledge of EBP is increased, confidence in implementation methods decrease over time and resulted in the failed adoption of EBP concepts in clinical practice.[5] To enhance the integration of the available literature into the clinical decision-making process there is a need to understand, breakdown, and overcome the barriers to EBP's implementation. Barriers related to time and the availability of EBP resources have been prevalent within the literature.[6] These two barriers are most likely connected as busy clinicians' feelings that they may not have the physical time to commit to the reading, understanding, and interpretation of complex research articles would only be exacerbated by a lack of access to EBP resources that would reduce the investment needed to complete this process.[6] Overall, this may signal the need for more processed and refined literature to reduce the perceived barrier of time and act as an approachable gateway into EBP habits.[7]

Systematic reviews and meta-analyses stand as the pinnacle of evidence and attempt to provide a refined view of the knowledge on a given topic. They do this well by completing many steps of the EBP process for a practicing clinician: search of literature, organization of multiple investigations, critical appraisal, and summary of evidence.[3,4] As such, systematic reviews have the potential to reduce the time needed to engage with the literature in order to develop the knowledge needed to inform clinical decisions. However, systematic reviews and meta-analyses often present barriers to the clinician as they may feel unapproachable due to complex contextualization of findings, statistical approaches, and a lack of actionable policy recommendations.[8] You may be among the many clinicians that have identified a promising review only to realize that there was a lack of clinically relevant and actionable information beyond the conclusion statements. This situation leaves clinicians to press on into a review of other literature for the answers they seek. In turn, the EBP process is lengthened and may leave clinicians frustrated as they fall back on their clinical expertise with the failure of the EBP process.

To enhance the uptake of systematic reviews and meta-analyses, there is a need to reduce the barriers and enhance the clinical applicability of findings by enhancing knowledge-translation resources available to clinicians. Simplistically, these resources can take on the form of summaries that layout the systematic reviews take-home messages in layman's terms while adding value by evaluating the quality of the review, assessing the findings' applicability, and providing recommendations for adoption and translation.[9] The Evidence-to-Practice Review (ETPR) manuscript type for *Clinical Practice in Athletic Training* provides an innovative format for knowledge-translation. ETPRs are short and digestible reviews of timely and relevant systematic reviews and meta-analyses with the focus on clinical applicability. The reviews provide a non-threatening, focused, and concise entryway into the evidence for the practicing clinician. Additionally, ETPRs focus on clinical translation of information as they are is designed to give actionable steps and organized resources for continued exploration, ultimately leading to enhancing knowledge and application into clinical practice.

The goal of research is to provide information that can directly impact clinical practice and inform practices such as quality improvement and practice-based research. Individual research investigations are often nuanced in ways that limit generalizability without the combination of multiple investigations. Meanwhile, systematic reviews often lack the detail needed to allow for easy translation and application of summary findings into clinical practice. Knowledge-translation resources, like the ETRP, provide a bridge between individual investigations and systematic reviews. ETRP can provide summaries of the evidence in combination with specific protocol recommendations and details needed to inform practice-based research and quality improvement initiatives. Initiatives that are imperative as the profession of athletic training aims prove that we have fulfilled our social contract with the public of providing safe, effective, and timely health care for our patients.[2] I encourage all to engage with knowledge-translation resources, such as the ETPR, and to allow these innovative resources to facilitate the EBP process within their clinical practice.

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An Evidence-to-Practice Review on the Efficacy of Instrument Assisted Soft Tissue Mobilization

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ABSTRACT

Instrument assisted soft tissue mobilization (IASTM) is the use of specially designed instruments that provide a mobilizing effect to soft tissue to help with decreasing pain and improving range of motion. Over the years, there has been an increase in the use of IASTM as well as an increase in research for its effects on soft-tissue injuries, range of motion (ROM), and pain management; however, the results have not been supported as a whole. Evidence for the positive outcomes from the use of IASTM, in conjunction with therapeutic exercise or other interventions, has been lacking in many studies. As a result, clinicians question its effectiveness. The purpose of this evidence-to-practice review was to summarize the results of the systematic review and apply it to clinical practice. The authors of the guiding systematic review aimed to investigate the current state of available literature on the topic of IASTM, specifically using studies that compared IASTM pre & post-treatment and compared the IASTM group to other intervention or control groups. Seven total studies were included in the final review, and of those, five focused on IASTM treatment for musculoskeletal pain and two focused on IASTM treatment for joint ROM. Each study varied in methodology, interventions, treatment times, and outcome measures. Therefore, the systematic review was unable to make a direct comparison between all studies and results were deemed inconclusive. In conclusion, using IASTM as a stand-alone treatment is not recommended in any case. However, in the event the treatment is not contraindicated and the clinician is inclined to use the treatment for physiological improvement, then implementation and use of IASTM is not unreasonable and could potentially benefit the patient when used in conjunction with therapeutic exercise or other form of treatment.

Key Phrases
Therapeutic devices, rehabilitation, clinician-rated outcomes

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ORIGINAL REFERENCE AND SUMMARY

Cheatham SW, Lee M, Cain M, Baker R. The efficacy of instrument assisted soft tissue mobilization: a systematic review. Journal of the Canadian Chiropractic Association. 2016;60(3):200-211.

SUMMARY

CLINICAL PROBLEM AND QUESTION

Soft tissue injuries are common among the general and athletic populations and these injuries can lead to acute and chronic loss of function, adhesions, and pain.[2-4] Instrument assisted soft tissue mobilization (IASTM) is the use of specially designed instruments that provide a mobilizing effect to soft tissue to help with decreasing pain and improving range of motion (ROM).[2-4] Over the years, IASTM has become a popular treatment for soft tissue injuries involving myofascial restrictions and in increasing pain thresholds.[5] This therapy has been utilized over a variety of different treatment areas, almost all of which involving a musculoskeletal injury or pathology.[2-4]

During the healing process of an injury or pathology, the human body will respond with an initial inflammatory response, followed by a proliferation phase, and then finally maturation of the new tissue. During these last two phases, IASTM is traditionally utilized as an intervention/modality in order to aid the realignment of tissue, collagen elasticity, and increase perfusion of tissues to promote healing.[2] Studies have been conducted to investigate the effect of IASTM on patient ROM and pain.[2,4,5] Results of these studies lack definitive findings in almost all cases, and in turn, many clinicians have been using IASTM without truly understanding the outcomes of the technique. Therefore, the purpose of this review was to assess the clinical effectiveness and efficacy of IASTM as a treatment protocol.

SUMMARY OF LITERATURE

The authors conducted a systematic search for studies/clinical trials using IASTM through the databases of PubMed, PEDro, Science Direct, the EBSCOhost collection, and hand searching known journals. Studies that were included in the review had to meet the following criteria: 1) peer reviewed, English language publications, 2) controlled clinical trials that compared pre- and post-test measurements for an intervention data extraction and synthesis program using IASTM, 3) investigations that compared an intervention program using IASTM, and 4) investigations that compared two intervention programs using IASTM. The search identified 261 articles, plus two others identified through other sources, for initial review. After duplicates were removed and records were screened, 47 full-text articles were reviewed for inclusion. After review, seven articles were included in the qualitative synthesis.

SUMMARY OF INTERVENTIONS

Of the articles synthesized (**Table 1**), six articles examined the Graston Technique® and one examined the Fascial Abrasion Technique®. Five studies investigated the effects of IASTM on the patients' pain from a musculoskeletal pathology, while two studies examined the effect of IASTM on the ROM in healthy individuals. For the five studies that focused on IASTM treatment for patients with pathology, the interventions in each study differed so it was difficult to determine which resulted in a better outcome. Two studies focused on comparing IASTM with a control group, one to treat patients classified with lateral epicondylitis[6] and the other to treat the upper back.[7] One study compared IASTM with soft-tissue massage to treat patients with carpal tunnel syndrome[8] and one study compared two different intervention programs that included IASTM, strengthening exercises, stretching, and chiropractic manipulative therapy to treat patients with patellofemoral pain syndrome.[9] The final study compared three intervention programs including IASTM, dynamic strengthening, or proprioception exercises to treat patients with chronic ankle instability.[10] All studies that used Graston Technique® had a timeframe for interventions ranging from 2-6 weeks. Only one study followed the recommended Graston Technique® protocol with other studies modifying it or not including all components of intervention in their reported methods.

The two studies that focused on IASTM treatment for joint ROM measured the effects of the treatment on ROM of the shoulder and knee in healthy subjects. The study focusing on the shoulder measured the difference in glenohumeral ROM after a single session of Graston Technique® treatment with an experimental and non-intervention control group.[11] The other study compared the effects of one session of IASTM following the Fascial Abrasion Technique® and one session of foam rolling.[11] The Graston Technique® protocol was not followed in the first study and no specific IASTM protocol was used in second study. From these two studies we can see that IASTM was able to increase ROM over control group, so IASTM could possibly be a tool used for increasing ROM, however, further research is needed to validate this.

SUMMARY OF OUTCOMES

The five studies that focused on IASTM as treatment for musculoskeletal pathologies included a combination of patient-reported and clinical-rated outcome measures (**Table 1**). The most common patient-reported outcome used was the Visual Analog Scale for pain. All studies measured outcomes pre-intervention and immediately post-intervention. Three studies reported a second follow-up, which ranged between 2-3 months post-treatment. The two studies using IASTM as treatment for joint ROM both used joint ROM, measured with a digital inclinometer, as the primary outcome measure. There were no patient-reported outcome measures used in those studies, but they both measured pre-intervention and immediately post-intervention outcomes. The study that followed the Fascial Abrasion Technique® was the only method to conduct a 24-hr post-intervention follow-up assessment.

FINDINGS AND CLINICAL IMPLICATIONS

Each study varied in methodology, interventions, treatment times, and outcome measures (**Table 1**) and therefore, the systematic review was unable to make a direct comparison between all studies and results were deemed inconclusive. Out of the 7 articles included in the systematic review, Graston Technique® was the most common form of IASTM used, only one study did not use Graston Technique®. However, the recommended treatment protocol was only followed by one of the six studies, while others had their own variation, which may have been a contributing factor to the inconsistent results across the studies. The studies examined in the review, along with their methods and outcomes, can be seen in **Table 1**. The differences in the protocols followed by each study also deemed the results insignificant in determining the effectiveness of Graston Technique® because the specified Graston Technique® protocol was not followed. Due to the variability in the study protocols (which includes methodology, interventions, and outcome measures), it was difficult to determine the best treatment protocol. Clinicians conducting future research should consider what technique they are utilizing and differentiate if the technique chosen followed the manufactures' specific treatment protocols, or if just the tools or general treatment method was used.

From this systematic review, evidence does not support the efficacy of IASTM for treating certain musculoskeletal pathologies and is weak in supporting effectiveness of IASTM for increasing lower extremity joint ROM as a standalone treatment. Though IASTM is a form of myofascial therapy, there is a lack of evidence to support its use or validation. As a result of this, there still lies a gap between the current research and clinical practice. However, IASTM may have a degree of clinical utility due to each study individually identified improvements for their outcome measures. Clinicians should be tentative in the use of IASTM since it has not been validated; however it may still be used clinically paired with another treatment to help improve patient-reported outcomes, barring any contraindications. Future research should focus on testing specific IASTM protocols, with uniformity in methodology, interventions, and outcome measures, to validate its use.

CLINICAL BOTTOM LINE

The guiding systematic review suggests that IASTM lacks the efficacy to positively support its use in myofascial treatment. While IASTM was found to not have good efficacy, depending on the patient, it may help improve outcomes of acute joint ROM (**Table 1**).[11] In order to implement IASTM clinically to have the best possible results, it is recommended that the clinician follow the specific IASTM treatment protocols provided by the manufacturer and to ensure the patient does not have any contraindications for the treatment. If a clinician were to implement IASTM into a treatment, it is always important to consider the patient population that is undergoing the treatment as well as the patient presentation. In the case of working with patients that are minors, parent/guardian education and consent should always be considered, especially if the treatment results in adverse effects such as visible bruising, ecchymosis, petechiae, or inflammation. When treating the geriatric patient population, it is important to consider their current health status and the ability of their bodies to withstand and recover from this type of treatment. In order to maintain consistent quality and standard of IASTM treatment, it is recommended that clinicians utilizing IASTM receives training in the application and administration of the treatment, and specialized training should be at the discretion of the clinician or the clinician's employer. To conclude, IASTM has not been shown to have adequate efficacy, and using IASTM as a stand-alone treatment is not recommended. Based upon the results of current literature, IASTM was not an effective intervention for certain musculoskeletal pathologies and further research is necessary to better understand the clinical effect of this intervention.

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Table 1. Summary of Studies[1]

Study	Pathology	Intervention	Outcome Measures	Graston Technique® Used	Graston Technique® Protocol Followed	Results
Blanchette and Normand[6]	Lateral Epicondylitis	• IASTM: Twice a week for 5 weeks • Control: Education, computer ergonomics, stretching exercise, ice, and anti-inflammatory medication	• VAS • Pain rated evaluation • Grip strength	Yes	No	• Post intervention and 3-month follow-up: both groups showed improvement in all outcome measures
Burke et al[8]	Carpal Tunnel Syndrome	• IASTM:2x/week for 4 weeks, 1x/week for 2 weeks • Control: Soft tissue mobilization, 2x/week for 4 weeks, 1x/week for 2weeks	• VAS	Yes	Yes	• Post intervention and 3-month follow-up: Both groups showed improvements in all outcome measures
Gulick[7]	Myofascial Trigger points in upper back	• 2 Phases of IASTM: 5 min, 6 treatments (2x/week for 3 weeks) • Control: no treatment	• Pressure sensitivity with algometer	Yes	No	• Post intervention: both groups showed improvements in outcome measures • No secondary follow-up reported

Laudner et al[11]	Posterior shoulder muscle	• IASTM: 1 treatment, treatment time of 40 seconds • Control: No Treatment	• Glenohumeral horizontal adduction, and internal rotation of motion	Yes	No	• Post intervention: IASTM group showed greater acute improvements in ROM compared to the control group • No secondary follow-up reported
Markovic[12]	Quadriceps and Hamstrings	• IASTM: One treatment, 2 minutes each region • Control: Foam Rolling, one session 2x/I minute	• Passive straight leg raise test • Supine passive knee flexion test	No (Fascial Abrasion Technique® used)	N/A	• Post intervention: both groups showed improvement in joint ROM • 24-hour follow-up: IASTM group -> the most joint ROM
Schaefer and Sandrey[10]	Chronic Ankle Instability	• IASTM: 2x/week, max of 8 min • Control: 4-week balance program (single-limb hops to stabilization, hop to stabilization and reach, unanticipated hop to stabilization, single-limb stance activities)	• VAS • Foot and ankle ability measure • 4-way ankle ROM • Star Excursion Balance Test	Yes	No	• Post-intervention: all groups showed improvement in all outcome measures • No long-term follow-up reported

Brantingham et al[9]	Patellofemoral Pain Syndrome	• Chiropractic manipulative therapy, exercise • Group 1: IASTM to knee joints only • Group 2: IASTM to lumbosacral, hip, knee, ankle, and foot • Both groups received treatment 1-3x/week for 2-6 weeks, total of 6 treatments	• VAS • Anterior knee pain scale • Patient satisfaction scale	Yes	No	• Post-intervention and 2-month follow-up: both groups showed improvement in all outcome measures

VAS = Visual Analog Scale; IASTM = Instrument Assisted Soft Tissue Mobilization

Diagnostic Accuracy of Imaging Techniques for Rotator Cuff Pathology: An Evidence-to-Practice Review

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ABSTRACT

When comparing imaging techniques for rotator cuff pathologies, clinicians tend to consider musculoskeletal ultrasonography (MSK US), magnetic renaissance imaging (MRI), and magnetic renaissance imaging with arthrogram (MRA) as diagnostic imaging techniques. Since the most recent systematic review on imaging conducted in 2003, imaging technology has improved, indicating the need for a meta-analysis to evaluate the accuracy of new diagnostic techniques (MSK US) for evaluating rotator cuff pathologies. The accuracy of MSK US readings between radiologists and non-radiologists was also analyzed. Data were extracted from three different databases and included articles exploring diagnostic imaging and the accuracy of technique at the shoulder joint. All research findings were then rated for any risk of bias using the revised version of the quality assessment of diagnostic accuracy studies (QUADAS-2). Statistically, the authors used hierarchical summary receiver-operating characteristics to compare accuracy of diagnostic imaging techniques across the literature. The results from the guiding manuscript indicated that MSK US, MRI, and MRA were considered highly sensitive diagnostic imaging techniques for full-thickness rotator cuff tears (Sn: US: 0.86-0.94, MRI: 0.85-0.95, MRA: 0.83-0.95). For partial-thickness rotator cuff tears, likelihood ratios indicated an increased accuracy in MRA diagnostic ability (Sn: MRA: 0.83), though MSK US and MRI were still considered highly sensitive for diagnosing partial-thickness rotator cuff tears (Sn: MSK US: 0.68, MRI: 0.67). When comparing radiologists and non-radiologists use of MSK US, there was no significant difference in diagnostic accuracy based on the reading provider. As the diagnosis based on imaging determines the need for surgical intervention, the guiding review indicated that all three diagnostic tools (MSK US, MRI and MRA) were considered highly sensitive for rotator cuff pathologies (average SN of all diagnostic tools: 0.90-0.91). Determining which imaging technique to use should be based on patient-centered factors, such as possibility of the presence of other shoulder pathology, invasiveness of the procedure, and financial implications. Diagnostic MSK US optimizes these factors, in addition to being highly sensitive.

Key Phrases
Diagnostic testing and physical examination: upper extremity; college and university patient population, clinic and hospital patient population

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ORIGINAL REFERENCE

Roy JS, Braen C, Leblond J, et al. Diagnostic accuracy of ultrasonography, MRI, and MR arthrography in the characterization of rotator cuff disorders: a systematic review and meta-analysis. Br J Sports Med. 2015;49(20):1316-1328

SUMMARY

CLINICAL PROBLEM AND QUESTION

Shoulder pathologies affect much of the general population and most commonly are a result of injury to the rotator cuff tendons.[1] The rotator cuff is the group of muscles (supraspinatus, infraspinatus, teres minor and subscapularis) that are primarily responsible for external and internal rotation of the shoulder along with assisting in stabilizing the glenohumeral joint during a majority of all other shoulder movements. and in stabilizing the glenohumeral joint. Conditions of the rotator cuff often constitute rotator cuff tendinopathies, partial thickness rotator cuff tears, and full thickness rotator cuff tears.[2] Without treatment, such as therapeutic rehabilitation or surgical intervention, patients suffering from a rotator cuff pathology may experience lifelong pain and significant functional limitations.[2] Surgical intervention is often indicated and time-sensitive for individuals with full thickness rotator cuff tears, so an accurate diagnosis is critical.[3] The three diagnostic imaging techniques tools to determine the degree of injury and guide treatment are musculoskeletal ultrasonography (MSK US), magnetic resonance imaging (MRI) and magnetic resonance arthrography (MRA). Musculoskeletal ultrasound (often referred to as diagnostic ultrasound) is the use of a sound wave through a transducer to visualize the structures below. The MRI and MRA are both operated by using a high-powered magnet within the machine to formulate an image to be interpreted by a radiologist. The sole difference between MRI and MRA is the joint being evaluated is injected with medical dye before an MRA scan to help define the structures of concern.[1] Since each diagnostic imaging technique's last systematic review (2010-2015) of diagnostic accuracy, new research and advanced technology have emerged including a more widespread use (+347% between 2003-2015) of musculoskeletal ultrasonography non-radiologists (radiology us decreased by 28% from 2003-2015).[4,5] In sports medicine cases, a re-evaluation of the diagnostic imaging techniques is warranted. A new statistical measure, the hierarchical summary receiver-operating characteristic (HSROC), has been validated for diagnostic accuracy and guides the study recommendations for utilization of MSK US, MRI and MRAI. HSROC allows researchers to take into account within and between study variability and better differentiates different thresholds of study results.[6-8] The purpose of the guiding systematic review study was to evaluate the diagnostic accuracy of MSK US, MRI, and MRA for rotator cuff pathologies. The secondary aim was to determine the accuracy of improved technology in diagnosing rotator cuff tears and to assess the use of MSK US when utilized by radiologists as compared to non-radiologists. Understanding the diagnostic accuracy of MSK US, MRI and MRA is important to better guide intervention strategies, especially in regard to making surgical recommendations, in addition to the benefits regarding patient-centered care (i.e. less cost, time, and a less invasive of the procedure).

SUMMARY OF LITERATURE

The guiding systematic review and meta-analysis authors used Medline, EMBASE and CINAHL in their search for articles published before 2014. Articles were included if they 1) included adults participants with shoulder pain, 2) utilized MSK US, MRI, and/or MRA as a diagnostic tool and surgery as a reference standard, and 3) reported on the diagnostic accuracy of the imaging techniques in diagnosing a rotator cuff pathology.[4] The search of the databases revealed 264 studies that met criteria for a full review. Studies were excluded due to incomplete data, small population size, and the use of a different index/diagnostic test. After study exclusion based on two evaluator analyses, 82 studies were included in the meta-analysis. Of these, 47 articles included MSK US studies, 29 articles were included for MRI, and 21 articles were included for MRA. These articles were then analyzed for bias using the Quality Assessment Tool for Diagnostic Accuracy Studies (QUADAS-2) assessing four main components of bias including patient selection bias, the diagnostic test utilized, the reference standard (surgery), and flow and timing in regard to patient retention and speed of intervention.[9] Of the studies included, most had a high risk of bias in 3 of the 4 QUADAS-2 categories.[9] As the reference standard is an invasive procedure (surgery), researchers noted that some bias could not be avoided, particularly in participant selection.

SUMMARY OF OUTCOMES

Data was extracted based on participant characteristics, index test, diagnostic accuracy (sensitivity and specificity) and based on the reference standard. The researchers of the guiding systematic review utilized the HSROC to evaluate the diagnostic accuracy of the three different diagnostic imaging techniques with a specific focus on test settings and technology. The HSROC is a statistical measure used to determine the overall sensitivity and specificity of diagnostic testing.[6] This statistical measure was utilized as it considers between-study and within-study variability and ultimately provides a receiver operating curve, graphing specificity over sensitivity to indicate the tool's accuracy.[9] In addition to analyzing diagnostic accuracy, this measure was also used to compare MRI magnet strength and MSK US transducer frequency levels to guide the best practice use of these tools. Accuracy of radiologist and non-radiologist use of the MSK US was also calculated. Results were deemed clinically important only if variation was beyond the error associated with the accuracy scores. This, along with the analysis of bias through the QUADAS-2 were combined and used to formulate diagnostic tool recommendations.

FINDINGS AND CLINICAL IMPLICATIONS

The guiding systematic review and meta-analysis suggests that there are no significant differences between the accuracy of the three diagnostic imaging techniques based on their specificity and sensitivity found using the HSROC statistics.[8] Diagnostic imaging techniques were assessed for accuracy diagnosing rotator cuff tendinopathy (**Figure 1**), rotator cuff partial-thickness tears (**Figure 2**), and full-thickness rotator cuff tears (**Figure 3**). The HSROC indicated that MSK US had an overall sensitivity of 0.79 (95% confidence interval [CI] = 0.63 - 0.91) and specificity of 0.94 (95% CI = 0.86 - 0.99). For partial-thickness tears, the literature indicated a sensitivity of 0.68 (95% CI = 0.54 - 0.83) and specificity of 0.94 (95% CI = 0.90 - 0.97) while full-thickness rotator cuff tears, sensitivity was 0.91 (95% CI = 0.86 - 0.94) and specificity was 0.93 (95% CI 0.91 - 0.96). For most of these findings, the sensitivity and specificity for MSK US were considered high enough to rule in and/or out suspected rotator cuff pathologies. In addition to assessing the accuracy of the diagnostic test, information was extracted that indicated the qualifications of radiologists or non-radiologist healthcare personnel in reading the MSK US, and their ability to accurately diagnose a rotator cuff pathology using this diagnostic tool. With the reference standard being surgical diagnosis of pathology for all conditions, they found no significant difference (Radiologist - Sn: 0.89, Sp: 0.85; Sonographers & Orthopaedists – Sn: 0.88, Sp: 0.89) in accuracy of the reading provider. While this finding supports the use of MSK US without preference of the individual reading the images, the authors noted that all non-radiologists were specifically trained in the use of diagnostic ultrasound, which could explain the consistencies in imaging interpretations, even when considering alterations in MSK US transducer frequency. Transducer frequency in diagnostic MSK US on average ranges from 5MHz to 20MHz, with the most widely accepted use being set for 7.5MHz. The guiding manuscript indicated that there are no improvements in image quality at transducer frequencies above or below the generally accepted 7.5 MHz.[8]

The findings also indicated that MRI is a highly specific tool. For partial-thickness rotator cuff tears, MRI has a sensitivity of 0.67 (95% CI = 0.50 - 0.82) and a specificity of 0.94 (95% CI 0.88 - 0.99). For full-thickness tears in the rotator cuff, MRI was found to have an overall sensitivity of 0.90 (95% CI = 0.85 - 0.95) and specificity of 0.93 (95% CI = 0.89 - 0.97). There was minimal variation in the sensitivity and specificity numbers between MRI and MSK US. For MRI,

Figure 1. Full-thickness or partial thickness RC tears

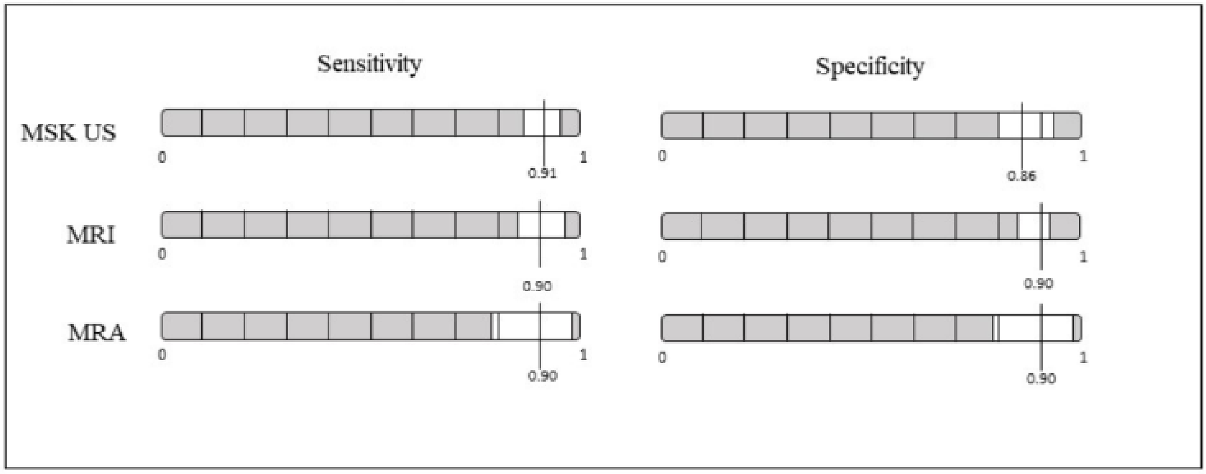


Figure 2 Full-thickness RC tears

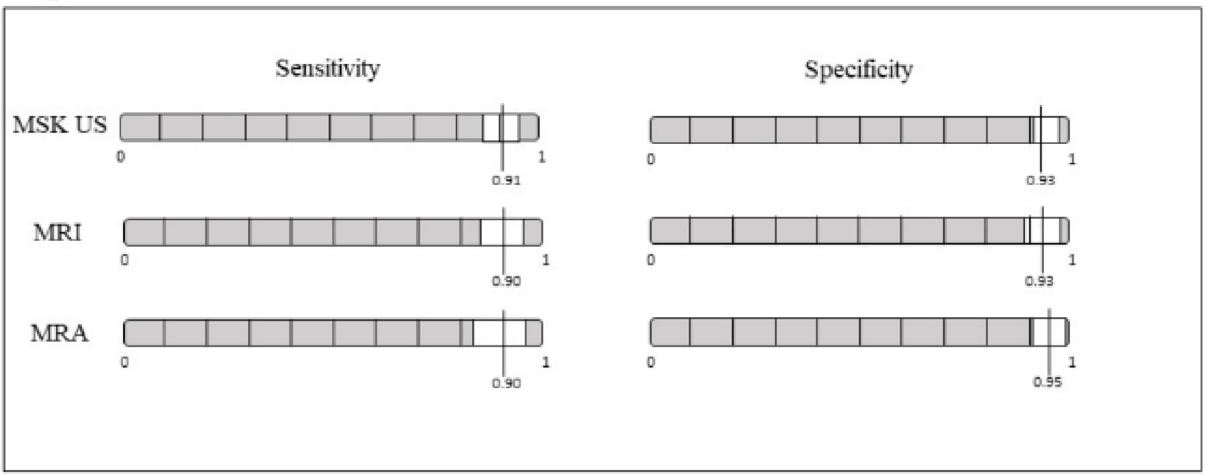
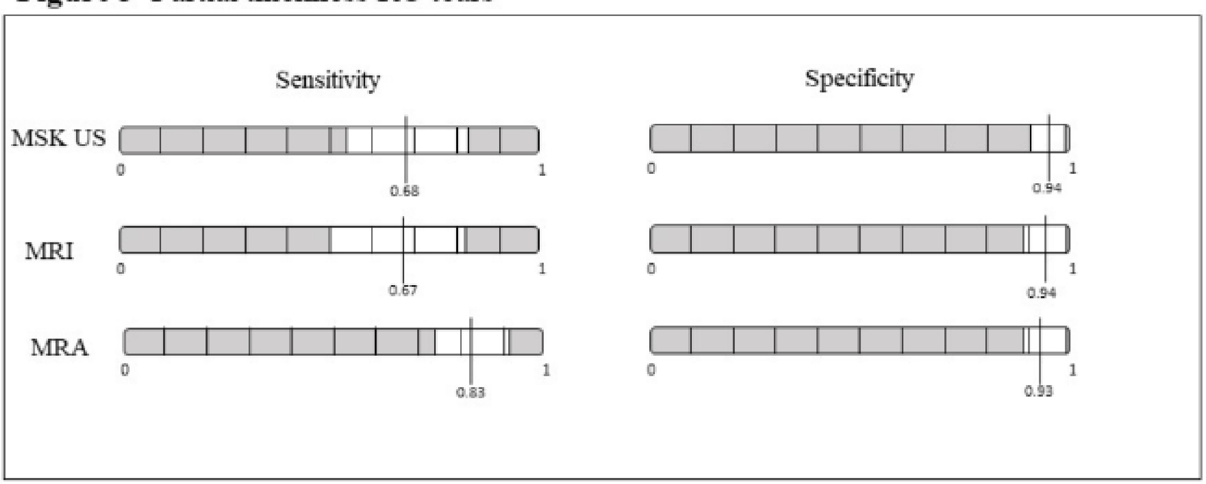


Figure 3 Partial thickness RC tears



RC – Rotator Cuff

though not statistically significant, data did reveal an advantage in image quality when using a 3.0T MRI when compared to a 1.5T machine. Finally, the sensitivity and specificity did not significantly vary between the results for full-thickness tears and partial-thickness rotator cuff tears for MRA. The literature did indicate that likelihood ratios supported the use of MRA in diagnosing partial-thickness tears when compared to MSK US and MRI.[8]

The limitation in this analysis was that the accuracy of MSK US as a diagnostic tool may be inflated. When the QUADAS-2 assessment was used, researchers believed there was bias that led to an increased likelihood of rotator cuff pathologies. This further resulted in an increased likelihood of findings through imaging. This review is also limited by the incomplete patient profiles reported resulting in incomplete data reporting. When exploring HSROC curves assessing diagnostic imaging techniques tools for their accuracy, it is evident that there is no significant difference between MSK US, MRI, and MRA. Each graph's curve was similar and had statistically significant numbers to help substantiate the accuracy of each tool. The only reason that MRI or MRA would be indicated over MSK US would be if there is an additional structure injured that may be contributing to the signs and symptoms the patient is presenting with. Additionally, insurance and instrument availability of diagnostic imagery may play a role in diagnostic image used though not considered by this review.

CLINICAL BOTTOM LINE

Patients who participate in sport and physical activity experience various pathologies including rotator cuff injuries. The sports medicine team is tasked with accurately advising their patients in the proper management of these shoulder injuries. For rotator cuff pathologies, it is imperative that full-thickness rotator cuff tears are diagnosed quickly and accurately as research indicates surgical intervention yields the best outcome for patients and athlete to return to play.[3] MSK US, MRI and MRA are the most commonly used diagnostic imaging tools for diagnosing rotator cuff pathology. The guiding manuscript indicates that there is no statistical difference between the ability of MSK US, MRI and MRA to diagnose rotator cuff pathology in individuals presenting with a possible rotator cuff pathology when performed and read by trained individuals.[8] There is some evidence indicating that MRA has a slightly increased ability to detect partial-thickness rotator cuff tears, though this finding is not considered to be statistically significant.[8] MRI and MRA are not cost or time effective due to their need for additional insurance authorization and appointments since imaging machines need to be reserved ahead of time. MSK US is recommended as an immediate screening tool, prior to ordering further imaging.

In the athletic population, there is an abundance of overuse shoulder pathology, especially in overhead sports such as baseball, softball, tennis and throwing events in track and field.[10] Rotator cuff pathology can be managed through intensive therapeutic rehabilitation and modification of activities, though concern for worse injury is often present. Musculoskeletal ultrasound provides a cost effective, timely and reliable means of preliminarily evaluating a patient to assess the degree of injury and determine if surgery is warranted. Currently, MSK US can be performed by physician's trained in its uses and in the identification of musculoskeletal pathology or by an athletic trainer who has been trained and has the approval from their supervising physician. Further research is warranted to examine the cost benefit of an MSK US machine when portability and integration with various technological interfaces are considered. As the athletic training profession advances, all athletic trainers should be encouraged to take advantage of MSK training options. The use of MSK US in the athletic training facility can decrease the need for referral to an orthopedic physician as identification of a tendinopathy vs. a tear in the shoulder and other joint pathologies would be possible, ultimately decreasing cost and time for the patient. For the athletic trainer, MSK US machines are on average MSK US is recommended when rotator cuff pathology is suspected, but considerations should be made specific to the individual. Orthopedic evaluation should precede the use of MSK US as other pathologies may be present and not found upon evaluation with this diagnostic imaging technique.

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The Value of Patient-Provider Interactions in Orthopedic Settings: An Evidence-to-Practice Review

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ABSTRACT

Clinical outcomes are influenced by specific physical therapy interventions and several nonspecific factors associated with the healthcare professional, patient, and setting. The relationship built between patients and providers is based on treatment outcomes is referred to as the patient-provider interaction, which is a nonspecific factor. The purpose of this review was to investigate patients' and clinicians' perceptions of factors that influence patient-provider interactions. Eleven different databases were accessed as potential research sources. Thirteen qualitative studies were selected that examined the perceptions of non-specific factors which impact the patient-clinician relationship as well as the perceptions that healthcare providers and patients in musculoskeletal settings. Out of these 13 articles, four common themes were found to influence the patient-provider interaction across all the literature selected for this review: clinician interpersonal and communication skills, clinician practical skills, individualized patient-centered care, organizational and environmental factors. Articles for this study were only considered for review if they were published in English. This was stated as a limitation of the study, as well as the fact that this review only identified factors that are perceived to be related to patient-provider interactions. The review highlighted that patients and clinicians believe communication, interpersonal and practical skills, individualized care, and appropriate time and flexibility for patient care influence patient-provider interaction in musculoskeletal settings. These factors can serve as facilitators as well as barriers, depending on the level of intensity that they are implemented in the overall patient-provider interaction. Athletic trainers, as healthcare professionals, need to be responsible for implementing patient-centered care concepts to encourage a healthy patient-provider interaction.

Key Phrases
Organizational and personal outcomes & patient education

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ORIGINAL REFERENCE AND SUMMARY

O'Keeffe M, Cullinane P, Hurley J, Leahy I, Bunzli S, O'Sullivan P, O'Sullivan K. What influences patient-therapist interactions in musculoskeletal physical therapy? Qualitative systematic review and meta-synthesis. Phys Ther. 2016;96(5):609–622.

SUMMARY

CLINICAL PROBLEM AND QUESTION

Sports medicine providers assist a wide range of patients with various degrees of musculoskeletal pain, guiding them through both the physical and psychological aspects of recovery and rehabilitation and often forming strong bonds along the way. Healthcare providers who practice from a clinician-driven mindset will focus on identifying the diagnosis and prescribing interventions and rehabilitation for treatment.[1] A clinician-driven mindset can often cause the provider to neglect important patient-centered care principles during the patient-provider interaction. The patient-provider interaction is defined as the sense of collaboration, warmth, and support between the patient and the clinician.[2] Previous research has focused on the impacts that patient-provider relationships have on treatment outcomes. The common theme identified in multiple studies has been a strong bond between the healthcare provider and patient results in improved patient outcomes and recovery.[3] Positive patient interactions in therapeutic rehabilitation settings have been linked to reduced pain and disability, as well as higher treatment satisfaction.[4] However, there is little known about what specific components ultimately help form and facilitate that crucial relationship between the patient and healthcare provider. The primary clinical question of this systematic review was to explore what factors hindered or assisted the relationship formed between sports medicine providers and their patients through the therapeutic rehabilitation process. The research team of this systematic review focused on the term "nonspecific factors", defined as factors associated with provider, patient, and setting, to differentiate from more clinically related factors such as prescribed interventions.

SUMMARY OF LITERATURE

Previous literature selected for the guiding systematic review[2] had to meet specific guidelines based on the clinical question. Studies were included if they examined the opinions and viewpoints of patients or physical therapists in regard to the factors that proved to enable or serve as an obstacle to a positive interaction between patients and their provider.[2] Exclusion criteria was defined as primarily quantitative studies, literature that was not reported in English, studies looking at settings that did not fit musculoskeletal physical therapy or conditions, or measured only the strength of the relationship between healthcare provider and patient rather than the factors that established it in the first place.[2] Through quality assessment and screening, 13 articles were approved to be included in the systematic review and meta-synthesis with a total of 253 patients and 78 providers being interviewed. The guiding systematic review[2] was the first to look at provider and patient perceptions of patient-centered care simultaneously. Eight articles investigated clinician's interpersonal and communication skills, ten articles evaluated clinician practical skills, seven articles examined individualized patient-centered care, and six articles investigated organizational and environmental factors.[2]

SUMMARY OF OUTCOMES

The authors from the guiding systematic review[2] examined the providers' and patients' perceptions of factors that influence patient-provider interactions in musculoskeletal settings. The authors examined the thirteen qualitative studies using the Critical Appraisal Skills Programme (CASP) Qualitative Research Assessment Tool. The patient-provider interaction is also referred to as the relationship between patients and healthcare providers on treatment outcomes. The relationship is usually built from a sense of collaboration, warmth, and support between individuals and includes agreement on goals and interventions and overall attitudes among each other.[2] This is essentially the basis of patient-centered care: ensuring that high quality, holistic care is being provided that includes the values and goals of the patient.

FINDINGS AND CLINICAL IMPLICATIONS

From the 13 studies that were included, four themes were reported to influence patient-clinician interactions (**Figure 1**). The first theme encompassed clinician interpersonal skills, such as active listening, empathy, friendliness, encouragement, confidence, and nonverbal communication.[2] Physical therapist practical skills comprised the second theme, which focused on clinician practical skills, which included proficiency, training and ability to explain healthcare concepts to the patient. Theme three was individualized patient-centered care, which was assessed by taking the patient's opinion into consideration and individualizing the treatment. Lastly, organizational, and environmental factors,

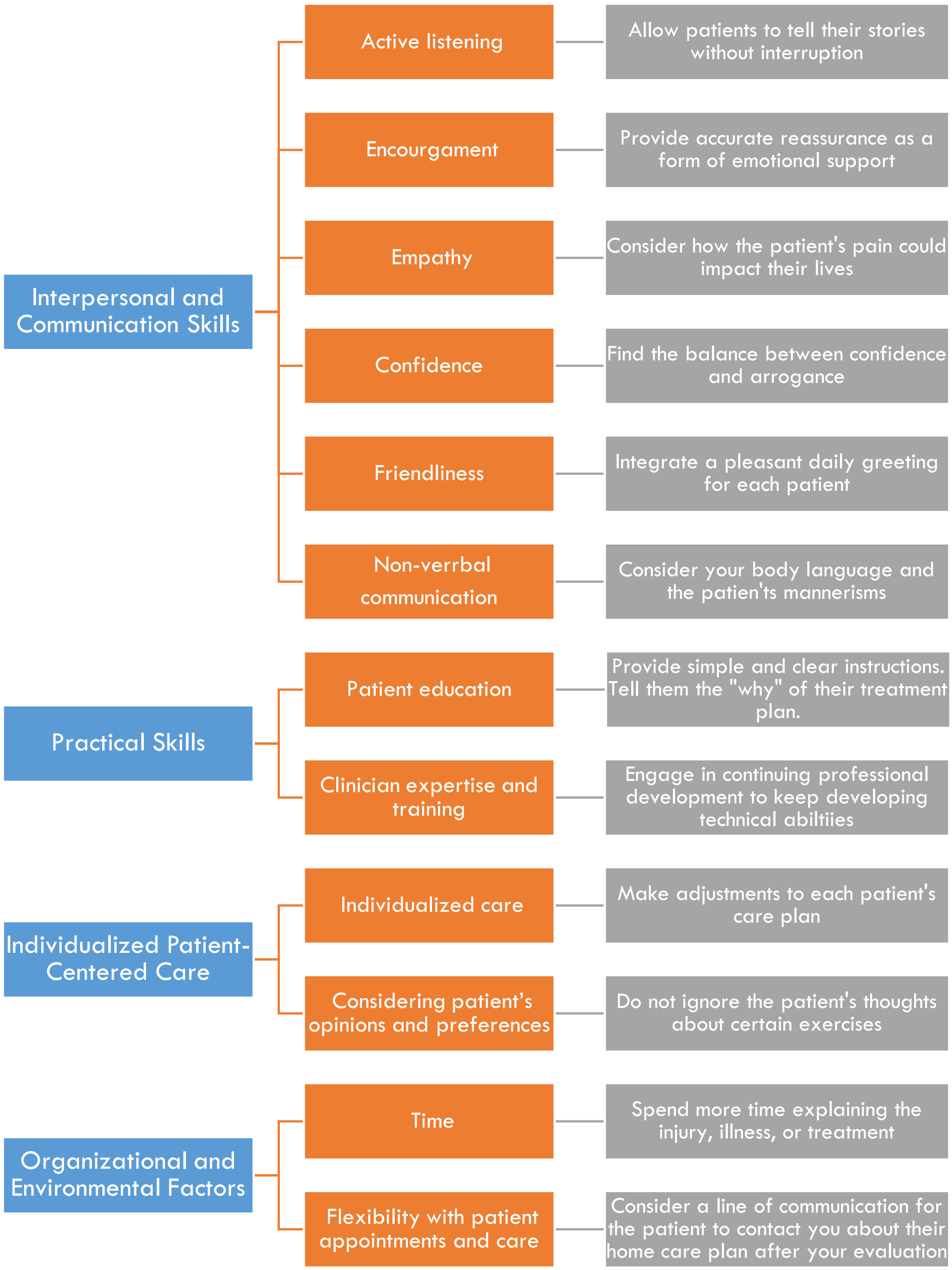

Figure 1. Main Influences of Patient-Provider Interactions in Musculoskeletal Physical Therapy. The first and second column are the main themes and traits from the study. The third column includes clinical bottom lines and suggestions to improving patient-provider interactions.

including the time and provider's flexibility with care and appointments constituted the fourth theme. The four themes found in this study can be incorporated regularly into everyday athletic training clinical practice to enhance patient-provider relationships.

Theme 1 - Clinician Interpersonal and Communication Skills

There were several interpersonal and communication factors from both the patient and clinician that determined the quality of interactions, such as verbal and nonverbal communicative ability, empathy, and trust. Active listening was the most common aspect stated by both patient and clinician.[2] Active listening is giving one's undivided attention to the speaker while using appropriate non-verbal communication to assure the patient that they are being understood.[2] Clinicians who actively listen will reassure the patient that they are valued, which will strengthen the patient-clinician bond.[5] The findings also showed a discrepancy between clinician and patient about encouragement for the patient during their appointment. Patients that did not receive enough encouragement may feel less motivated to give their best effort during rehabilitation and improvement goals may not be met on time.[6] From the thirteen articles included in the guiding review, there were zero reported statements regarding encouragement from the clinician's stance. Athletic trainers should practice active listening with non-verbal communication, along with sincere empathy and encouragement for the patient to optimize patient satisfaction.

Theme 2 – Clinician Practical Skills

The next theme focused on the practical skills of the clinician. Healthcare professionals and patients share the belief that healthcare expertise was crucial to the development of a strong patient-clinician relationship.[2,6] Clinician expertise encourages patients to develop trust and reliance with the clinician, strengthening the patient-provider interaction.[2] Clinicians stated that continuing education and skill development were important to the maintenance of the patient-clinician relationship. Patients highly valued a provider who could easily explain the patient's problem, how the provider could help them, and why the provider was prescribing specific exercises in their rehabilitation.[2,7] The concept of patient education can relate directly back to athletic training, where the athletic trainer is on the front lines of sharing and disseminating information to the patient on their diagnosis and rehabilitation plan while avoiding medical jargon. Athletic trainers should address health literacy and assist patients in their capacity to process and understand their health conditions. Patient education with clear explanations can help the patient feel more comfortable with their rehabilitation protocol and clinician's decision making.[2] Athletic trainers share this priority for developing and maintaining clinical competency and have expressed a professional desire for more research to be done in focus group sessions for the Prioritized Research Agenda for the Athletic Training Profession organized by the Strategic Alliance Research Agenda Task Force.[8]

Theme 3 - Individualized Patient-Centered Care

Patient-centered care is the practice of being "respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions."[9] Patients highlighted the importance of individualized patient care and taking into consideration patients' opinions and preferences in regards to the patient-provider relationship[2], stating that they found it annoying when their clinician ignored their preferences and felt that it diminished the overall interaction.[5] Patients appreciated when their clinician made an effort to adjust or adapt their rehabilitation in relation to their inability to complete a task, which positively affected the patient-provider relationship.[2] This can easily relate to the profession of athletic training. Athletic trainers are providers with the unique opportunity to work with patients from initial injury to final discharge. Throughout this process, the athletic trainer should tailor the patient's rehabilitation to their functional goals and personal preferences to facilitate patient engagement and commitment.

Theme 4 - Organizational and Environmental Factors

A healthcare professional's lack of organization regarding the amount of time given to patients and appointment flexibility created a general dissatisfaction for patients.[2] Athletic trainers may be limited in their amount of time for patient care. In this guiding review, both patients and providers stated that allowing patients appropriate time to explain their problem and discuss their treatment was essential to maintaining a positive patient-provider interaction.[2] It may be beneficial for the provider to be proactive and plan out each patient's rehabilitation and main points of discussion prior to seeing them, as well as being flexible. However, only one healthcare provider in the guiding review stated that flexibility with patient appointments and care was important, compared to five patient statements. Patients expressed appreciation towards clinicians who accommodated patient care and appointment scheduling based on their needs.[2] Athletic trainers work with a variety of patient populations who also have busy schedules that have to be worked around to fit in rehabilitation appointments. To reduce the feeling of being rushed and increase the patient's satisfaction, athletic trainers should outline the allotted time available for the patient's session at the beginning of the appointment.[10] By implementing patient-centered care techniques into appointment scheduling, athletic trainers can maximize the use of their time and convey that the patient's time is just as valued.

CLINICAL BOTTOM LINE

The guiding review concluded that healthcare professionals and patients believe that communication and interpersonal skills, practical skills, individualized care, and organizational and environmental factors have influences on the relationship developed during the rehabilitation for musculoskeletal injuries. Furthermore, there is a difference between clinicians and patients about the value of patient education. Patients rated their own education of their rehabilitation as highly important to the facilitation of the patient-provider interaction, however clinicians rated it low in value. Patients primarily felt importance in active listening, patient education, individualized rehabilitation, and encouragement from their clinician. Clinicians that take the time to actively listen and provide individualized care are much more likely to develop stronger interactions and relationships that may promote rehabilitation outcomes.[2,5-7] Scheduling out a block of time during the day for one patient to come in while preventing interruptions from other individuals can show the patient that the clinician has their undivided attention for communication and rehabilitation.[5,6,11]

Patients value their feelings and beliefs regarding their care planning. Similarly, athletic trainers' value their own time and effort that they put into treatment and rehabilitation with their patients. Patients in the guiding review reported strong values in education from the clinician. Athletic trainers with a sufficient understanding of the injury and patient's goals can enhance the patient-clinician interaction through patient-centered care tactics. Gaining patient insight can be accomplished by asking what questions or worries the patient may be having about their rehabilitation process. Athletic trainers should also work on creating a habit in providing clear explanations of their responsibilities and duties with the patient when creating goals and decision making with certain interventions. The guiding review also observed that patients reported that encouragement from their clinician was important, even though the clinician did not see any value in this factor. Encouraging patients through their rehabilitation exercises demonstrates a deeper level of care and emotional support, which aligns specifically with patient-centered care principles. The evidence from this review supports clinician interpersonal and practical skills, individualized care, and organization factors as influences that can cultivate the patient-clinician relationship.

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Myofascial Compression Interventions: Comparison of Roller Massage, Instrument Assisted Soft-Tissue Mobilization, and Floss Band on Passive Knee Motion Among Inexperienced Individuals

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ABSTRACT

Myofascial compression interventions have become popular in rehabilitation and fitness. To date, no studies have directly compared foam rolling, instrument assisted soft-tissue mobilization, and floss band among unexperienced individuals. The primary purpose of this investigation was to compare the immediate post intervention effects of foam rolling, instrument assisted soft-tissue mobilization, and floss band on passive knee joint range of motion (ROM) among inexperienced individuals using a standard treatment time. The secondary purpose was to determine the interchangeability of the interventions and to provide preliminary research for long-term comparison studies. This pretest-posttest randomized controlled trial was conducted in a university laboratory. Thirty participants (M=15, W=15) were randomly assigned to three groups: (1) foam rolling, (2) instrument assisted soft-tissue mobilization, and (3) floss band. The intervention time for each group was 2-minutes. The outcome was passive knee joint ROM. Between group analysis revealed a statistically significant post-intervention difference between the three interventions for passive knee flexion ROM ($p < .001$). Within group comparison for ROM revealed a 2 degree ($p < .001$) post-intervention increase for foam rolling, a 3.5-degree ($p < .001$) increase for the instrument assisted soft-tissue mobilization, and a 4-degree ($p < .001$) increase for the floss band. The three interventions produced similar immediate post intervention effects on passive knee joint ROM among inexperienced individuals. Clinically, these interventions may be interchangeable by producing similar effects on knee ROM. Clinicians may want to consider these finding prior to administering these interventions with their patients.

Key Phrases
Massage, muscle soreness, pain, release

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INTRODUCTION

Myofascial compression is a popular intervention used by allied health professionals.[1] There are several types of myofascial compression interventions such as foam rolling (FR), instrument assisted soft-tissue massage (IASTM), and floss band (FB). These interventions can be found in various clinical and fitness settings. The research on these types of interventions has increased over the past decade.

The research on FR has documented positive outcomes with reduced post exercise decrements in muscle performance,[2-6] increased post treatment pressure pain thresholds (PPT),[4,7-9] and decreased post exercise muscle soreness in healthy individuals.[2,3,10-12] Several recent studies have also documented positive post intervention effects of FR for different sports,[11,13-15] occupations,[16] and chronic pain conditions.[17] The IASTM research suggests that the intervention is an effective treatment for tendoinopathies,[18,19] arthrofibrosis,[20,21] cerebral palsy,[22,23] musculoskeletal pathologies,[18,24-26] post mastectomy,[27] post total joint arthroplasty,[28,29] and athletic performance measures.[18,24-26] The FB research is still emerging and the available studies have documented post intervention improvements in jump and sprint performance,[30,31] reduced effects of edema in post-surgical patients,[32] and improved pain and function in individuals suffering from Achilles tendinopathy.[33]

One of the most common outcome measures professionals use for all three interventions is joint range of motion (ROM).[34] Researchers have found that FR may improve joint ROM at the shoulder,[35,36] lumbopelvis,[37,38] hip joint,[39-45] knee joint, [9,45-47] and ankle.[48,49] IASTM has also been shown to improve joint ROM at the shoulder,[27,28,50,51,52] hip and knee joint,[51,53,54,55] ankle,[56] and spine.[57] The FB research has documented improved post intervention ankle joint ROM in healthy individuals.[30,31] To date, no studies have directly compared the effects of all three interventions on joint ROM among individuals with no prior experience. Only one study has compared the effects of FR and IASTM on passive hip and knee joint ROM in collegiate soccer players.[51] The study author did not document if the athletes had prior experience with myofascial compression interventions. The primary purpose of this investigation was to directly compare the immediate post intervention effects of foam rolling, instrument assisted soft-tissue mobilization, and floss band on passive knee joint ROM among inexperienced individuals using a standard treatment time. The secondary purpose was to determine the interchangeability of the interventions and to provide preliminary research for long-term comparison studies. The researchers hypothesize that all three interventions will produce similar post treatment effects on passive knee joint ROM after a standard treatment time.

METHODS

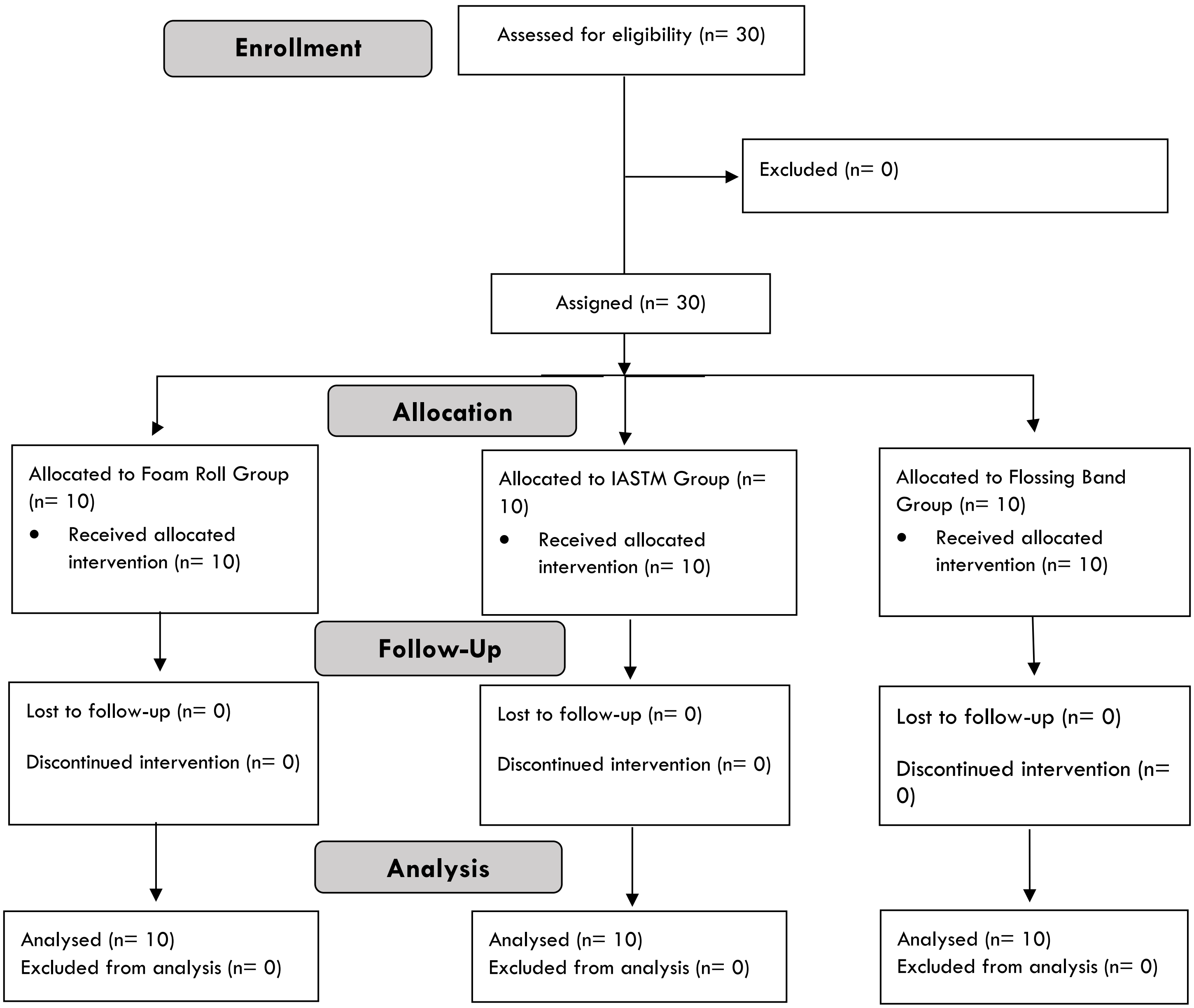
Participants

Thirty healthy, active adults (M=15, W=15) were recruited via convenience sampling and enrolled in the study. Participants were randomly assigned into one of three groups: foam roller (FR) (N=10), instrument assisted soft-tissue mobilization (IASTM) (N=10), and flossing bands (FB) (N=10) (**Figure 1**). A random number generator was used to allocate participants to each group. Participants reported no prior experience using any of the myofascial interventions in this study. Participant exclusion criteria included the following: musculoskeletal, systemic, neurosensory, or metabolic conditions that would affect joint ROM of the lower extremity or the inability to avoid medications that may affect testing.[18,58,59] Participant demographic information is described in **Table 2**. This pre-test, post-test clinical study was approved by the Institutional Review Board at Florida International University.

Outcome Measure and Instrument

The outcome measure used for this investigation was passive knee joint ROM. The Clinometer Smartphone Application™ (Plaincode, Stephanskirchen Deutschland) was used to measure each participant. The Clinometer app has been shown to be valid and reliable for measuring lower extremity ROM.[60-64] For testing, the participant was placed in the prone lying position on a table. The investigator grasped the left ankle and passively moved the left knee. The knee was flexed to the point where the joint could no longer be passively moved without providing overpressure or to the point of initial discomfort. This position was held and a measurement was taken. The investigator monitored for any compensatory movement throughout the lumbopelvis and lower extremities. The investigator took the average of 3 measurements for each participant. Left passive knee joint ROM measurements have been used in prior myofascial compression studies.[65-67]

Figure 1: Data Collection Diagram



Interventions

The FR group used a commercial foam roll and related instructional video were used in this investigation (TriggerPoint, a division of Implus, LLC, 2001 TW Alexander Drive Durham, NC 27709, USA). The video demonstrated the use of the foam roll on the left quadriceps muscle group. The GRID® surface foam roll used in this investigation was commercially manufactured with a hard-hollow core (14 cm diameter) with a moderately firm outer ethylene-vinyl acetate (EVA) foam (**Figure 2**). Participants were issued the foam roll and followed the video with no feedback from the observing investigator. The instructor in the video provided a brief introduction and then discussed the foam rolling technique. The instructor divided the left quadriceps into zone one: top of patella to middle of the quadriceps and zone two: middle quadriceps to anterior inferior iliac spine. The model in the video was instructed to get in the plank position, position the roller above the left patella and roll back and forth in zone one 4x at a cadence of 1inch per second. The model was then instructed to stop at the top of zone one followed by 4 active knee bends to 90 degrees. This sequence was repeated for zone two. The intervention portion lasted a total of 2 minutes. This video has been used in prior foam roll research.[68]

For the IASTM group, the investigator administered an instrument intervention using the Smart Tools® crossbar tool (423 grams) (Smart Tools, 20636 Castlemaine Circle, OH 4419, USA) (**Figure 2**) to the left quadriceps muscle. The investigator was a trained researcher certified in several IASTM paradigms. Participants lied supine on a table with hip and knee straight. A water-based gel was used to decrease friction between the skin and instrument. The investigator delivered a superior and inferior longitudinal stroke with the crossbar perpendicular to the soft tissues while maintaining a 45° instrument edge angle. The investigator first began by placing the edge of the instrument just above the patella. The investigator then delivered a superior stroke up towards the anterior inferior iliac spine (AIIS). Just before reaching the AIIS, the investigator reversed the cross bar and delivered an inferior stroke back to the starting position while maintaining the edge angle. The investigator used a 2 second cadence to complete the sequence using only the weight of the tool. The total intervention lasted 2 minutes.

For the FB group, a 5.08 cm (2-inch) Rockfloss® floss band (RockTape®, a division of Implus, LLC, 2001 TW Alexander Drive Durham, NC 27709, USA) was used along with a related instructional video. The video demonstrated the use of the floss band to the left quadriceps muscle. Participants were issued the floss band and followed the video with no feedback from the observing investigator. The video narrator provided a brief introduction and then demonstrated the technique using a model. The model wrapped the floss band around the left quadriceps muscle (distal to proximal) using a 50% overlapping pattern with an elongation stretch of 50% band length (**Figure 2**).[69] The wrap covered the quadriceps muscles above the patella to below AIIS. The model then demonstrated an active movement sequence consisting of standing hip flexion (30 seconds), seated knee extension and flexion (30 seconds), and bodyweight squats (1minute). The intervention portion lasted a total of 2 minutes. Participants followed the video and wrapped their own leg.

Figure 2: Different myofascial compression devices: Grid foam roller, IASTM tool, and floss band

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Pilot Study

Pilot training was conducted over two-sessions to practice the testing procedures and establish intrarater and interrater reliability among three investigators for passive knee joint ROM. Fifteen participants were independently recruited and enrolled for this portion of the investigation. The Intraclass Correlation Coefficient was used to calculate intrarater (ICC model 3, k) and interrater reliability (ICC model 2, k).[63,70] The results revealed good intrarater (ICC= 0.99; 95% CI 0.88-1.0) and interrater (ICC= 0.94; 95% CI 0.67-0.99) reliability among all investigators. These coefficients are in accordance with the minimum threshold of $\geq$ .90 for ICC values postulated to be acceptable for clinical decision making.[71]

Procedures

Prior to testing, eligible participants reviewed and completed study related materials including the written IRB consent form and demographic questionnaire. All participants underwent one session of testing that included pre intervention measures, followed by the intervention, and then immediate post intervention measures. All participants were tested between the hours of 10 A.M. and 2 P.M. and were instructed to not participate in any strenuous activity 5 hours prior to testing. Participants were also instructed to refrain from taking any medications (e.g. opioids, muscle relaxants) that would interfere with testing. All participants were blinded to the testing results and other individuals in the study.

For each group, one investigator was assigned to take three pre intervention and three immediate post intervention measures and was blinded from the intervention. A second investigator was present to explain the intervention procedures (FR and FB) to each participant and answer any questions. For the IASTM group, the second investigator administered the intervention. These testing methods have been used in prior myofascial research.[72]

Statistical Analysis

The statistical analysis was performed by the program SPSS version 25.0 (IBM SPSS, Armonk, NY, USA). The descriptive statistics for participants were calculated for age, height, body mass, and body mass index (BMI). The ANOVA statistic was used for continuous descriptive data and the Kruskal Wallis statistic for ordinal descriptive data. The ANCOVA statistic was used to measure between group differences. The independent variable was the group, dependent variable was post test scores, and pretest scores was the covariate.[73] Post hoc within group differences were measured with the paired *t*-test. The average of three joint ROM measurements was used for all pre-test and post-test calculations. The effect size was also measured ($d = M_1 - M_2 / \sigma_{pooled}$). The effect size values were interpreted as: >0.70 was considered strong, 0.41 to 0.70 was moderate, and < 0.40 was weak.[74] All statistical assumptions were met for the ANOVA, ANCOVA and paired *t*-test statistics. Statistical significance was considered p< .05 using a two-tailed test.

RESULTS

Thirty participants were enrolled and completed the study (mean age= 25.43 $\pm$ 2.46 years; height= 170.00 $\pm$ 9.17 cm; body mass= 73.82 $\pm$ 9.65 kg; body mass index (BMI)= 26.65 $\pm$ 3.83 kg/m^2) (**Table 1**). Descriptive analysis revealed no statistically significant difference between groups for age (p=0.10), height (p=0.70), body mass (p=0.55), or BMI (p=0.14). All enrolled participants completed the study with no adverse events or attrition.

The between group analysis for passive knee joint ROM revealed a statistically significant post intervention difference between the three groups [F (1,39) =612.32, p=<0.001, partial $\eta 2$=0.944]. The post hoc within group analysis

Table 1. Participant demographics (N=30)

Characteristics	Age (years)	Height (cm)	Mass (kg)	BMI (kg/m²)
Foam Roll Group (N=10)	26.13 ± 2.56 (range 23-30)	169.50 ± 8.72 (range 155-183)	72.73 ± 9.35 (range 59-89)	24.67 ± 2.84 (range 21-28)
IASTM Group (N=10)	24.80 ± 2.04 (range 23-28)	168.15 ± 9.49 (range 150-180)	77.59 ± 9.49 (range 57-99)	27.34 ± 4.45 (range 21-36)
Floss Band Group (N=10)	24.40 ± 2.13 (range 22-31)	172.39 ± 10.37 (range 158-188)	72.26 ± 10.57 (range 57-108)	27.90 ± 4.83 (range 21-38)

Data reported as mean± SD; range (min-max); m=meters; BMI= body mass index; kg/m^2= kilograms-meter squared

Table 2. Pre and post-intervention results (N=30)

	Pretest	Posttest	Change	P-Value	Effect Size
Foam Roll Group					
Knee Flexion ROM (degrees)	115.60 ± 8.66	117.93 ± 9.06	2.33 ± 0.40	<.001	.26
IASTM Group					
Knee Flexion ROM (degrees)	121.97 ± 13.81	125.48 ± 13.00	3.51 ± 0.81	.004	.26
Floss Band Group					
Knee Flexion ROM (degrees)	110.73 ± 8.48	114.73 ± 8.43	4.00 ± 0.03	<.001	.47

Data reported as mean ± SD, kPa= kilopascals; statistical significance considered p<.05; Effect size: $d = M_1 - M_2 / \sigma_{pooled}$

revealed an approximate post intervention knee flexion increase of 2 degrees (p <.001, ES=.26) for FR, 3.5 degrees (p=.004, ES= .26) for IASTM, and 4 degree (p<.001, ES=.47) for FB (**Table 2**).

DISCUSSION

The primary purpose of this investigation was to directly compare the immediate post intervention effects of FR, IASTM, and FB on passive knee joint ROM among inexperienced individuals. To date, no studies have compared these interventions among this population. The results suggest that these interventions produced a statistical significant post intervention effect. However, there was less than a 2° post treatment difference between interventions which may not be clinically meaningful in some settings. It is important to note that the passive joint ROM in this study was taken with a digital device which may be more accurate than standard goniometry.[60] These findings are similar to prior research documenting increased post intervention knee ROM values that ranged from 2-7° for the these interventions.[45-47,51,55]

The secondary purpose was to determine the interchangeability of the three interventions using a standard treatment time of 2-minutes which has been a common intervention time used in prior myofascial research.[68,69] There was a ROM difference of 1-2° between all three interventions which suggests they may produce similar post treatment responses when using the same treatment time and body region (quadriceps muscle). These findings support their interchangeability. For example, a professional may administers a skilled 2-minute IASTM technique to the quadriceps then prescribe a 2-minute self FR or FB intervention as a home exercise to maintain the effects of the IASTM treatment. The results of this study are consistent with findings from the Markovic study which compared the efficacy of a 2-minute FR and IASTM intervention on soccer players.[51] The authors documented improved post intervention passive knee and hip joint ROM from both interventions ($p < 0.05$). Thus, these myofascial compression interventions produced similar post treatment effects.

There are two main scientific theories being postulated by researchers regarding the post treatment effects of these myofascial compression interventions. These interventions may provide a greater deformation of the local myofascial tissues which creates a mechanical and neurophysiological effect. For the mechanical effect, the pressure of the device or wrap may change the viscoelastic properties of the myofascia by mechanisms such as thixotropy (reduced viscosity), reducing myofascial restriction, fluid changes, and cellular responses.[48,75] Clinically, these changes may be observed as a greater lengthening or "stretch tolerance" of the muscle and surrounding tissues as measured by changes in joint ROM. For the neurophysiological effect, the mechanical pressure from the device or wrap may have produced a local and global neurophysiological effect that influences tissue relaxation in the target and surrounding tissues through central nervous system afferent input from the Golgi tendon reflex and mechanoreceptors (e.g. Golgi tendon organ).[7,48,75-78] Perhaps, the active joint movements in the FR and FB interventions enhance the effects of the devices as well as the assisted IASTM intervention. Prior research suggests that active myofascial interventions may enhance the neurophysiological effect producing greater benefits.[68,79] Future studies are needed to validate these theories.

Limitations

There are four limitations with this study. First, this study tested healthy non-experienced participants with no pathology. This limits the generalizability to this population. Second, the three different myofascial compression interventions studied were from specific manufacturers. Other similar interventions from different manufacturers may have produced different results. Third, the immediate post intervention effects were investigated. The long-term effects of the intervention cannot be determined. Fourth, the interventions in this study used a specific technique (e.g. left quadriceps) for a predetermined 2 minute intervention time which has been used in prior myofascial research.[68,69] Other treatment techniques and intervention times may have produced different results.

CONCLUSION

This was the first study to directly measure the immediate post treatment effects of three different myofascial compression interventions on passive knee joint ROM among individuals with no prior experience using a standard treatment time. The results suggest that all three interventions may produce similar immediate post treatment effects which supports their interchangeability. Future studies are needed to further validate these results over a long post intervention time period. The goal of this study was to be exploratory and establish the methodology for long-term investigations. Clinicians may want to consider these results when choosing and administering myofascial compression interventions with their patients.

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The Effects of the MyoKinesthetic System on Medial Tibial Stress Syndrome in the Physically Active: A Case Study

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ABSTRACT

Medial tibial stress syndrome (MTSS) is a common pathology in physically active people and one of many overuse leg injuries present in weight bearing athletes, with the highest prevalence in runners. Researchers have extensively explored treatment for MTSS, but a long-lasting and effective treatment option has not been established. This case report aimed to explore the effects of The MyoKinesthetic System™ (MYK), a form of manual therapy, on two athletes diagnosed with MTSS. Patient one is a 19-year-old male rugby player with a previous history of MTSS, who reported leg pain while running which progressed to constant pain. Patient two is a 24-year-old female collegiate soccer patient who reported increasing leg pain while running, with no previous history of MTSS. After being diagnosed with MTSS, both patients' posture was evaluated using the MYK postural analysis to identify and treat the primary nerve root dysfunction (i.e., S1). Each patient received a total of six MYK treatment sessions over a two-week period. Treatment included manual stimulation via tactile feedback of each muscle innervated by the primary dysfunctional nerve root. Treatments were performed bilaterally with alternating patterns of 4-10 passive and active movements. Implementation of manual therapy resulted in long-term, full resolution of symptoms without modifying or restricting athletic participation. Both patients reported a decrease in pain and an increase in function across six treatment sessions without curtailing activity. Manual therapy techniques such as MYK may be a suitable treatment option for physically active patients with MTSS. The outcomes of this case report suggest that MYK may help improve and ultimately resolve MTSS pain and dysfunction in patients involved in weight bearing physical activity. Future studies should continue to examine the effectiveness of these techniques via randomized clinical trials.

Key Phrases
Manual techniques, patient-reported outcomes, injury risk reduction

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INTRODUCTION

Medial tibial stress syndrome (MTSS), also known as "shin splints", is a lower extremity pathology reported during repetitive weight bearing activities such as running [1-2] and other ballistic sports such as basketball, tennis and track and field.[3] Signs and symptoms include dull, aching or diffuse pain in the distal 2/3 of the posteromedial tibia.[4] Pain is usually absent during moments of inactivity, but will increase during physical activity, and palpation of the posteromedial tibia can elicit pain.[5] Conflicting etiologies and numerous predisposing factors make it difficult to identify a singular root cause.[3] Differences in pronation, plantar flexion, hip internal and external rotation, when compared bilaterally, are examples of intrinsic risk factors contributing to the development of MTSS.[3,6] Imbalances in any of the aforementioned risk factors can alter mechanics along the lower extremity kinetic chain.[3] With these subtle variations in posture, a patient may develop pain and experience decreased function.

Current conservative interventions (e.g., rest, ice, massage, stretching, strengthening) used to treat MTSS address the patient's local area of pain, but none focus on reducing intrinsic risk factors, specifically those that affect posture. A suggested approach to treatment is to view the body as a whole, emphasizing the need for a global assessment, as opposed to focusing on the local area of pain.[7-8] The MyoKinesthetic System™ (MYK) is a global manual therapy treatment model developed by Dr. Michael Uriarte. The treatment paradigm is designed to assess and balance the nervous system by treating the muscles innervated by specific nerve pathways.[9] The purpose of MYK is to evaluate postural imbalances and treat neuromuscular dysfunction as a method to restore allostasis, or homeostasis within reasonable fluctuation.[9-10] Once postural imbalances are identified, the clinician can provide a patient specific treatment to improve postural dysfunctions, while decreasing pain and restoring function. Limited evidence exists on MYK, however, previous published works include a comprehensive overview of MYK, its positive effects on low back pain,[11] disc herniations,[12] chronic knee osteoarthritis,[13] and MTSS.[14]

Identification and implementation of a treatment that not only addresses the physical manifestation of pain, but addresses potential contributing causes is needed. The purpose of this case report is to present two instances of competitive athletes diagnosed with MTSS, who were treated successfully with MYK. This study was approved by the Institutional Review Board of University of Idaho following the Helsinki Declaration. All participants signed an informed consent prior to their inclusion.

PATIENT INFORMATION

Patient One

A nineteen-year-old male club rugby athlete complaining of bilateral shin pain reported to a musculoskeletal pain clinic. Previous history included MTSS seven years ago with no other lower extremity injuries or complaints. The prior bout of MTSS was of slow onset, aggravated only with repetitive activity (e.g., mile runs). Pain subsided when the patient refrained from physical activity and felt no need to seek any other form of treatment. Signs and symptoms of the new complaint included bilateral dull and diffused pain over the distal ⅔ posteromedial aspect of the tibia during physical activity and upon palpation. The patient had been experiencing pain for over a month, which progressed slowly from pain with running, to pain during and after activity, and finally to constant pain. Upon questioning, the patient reported a gradual increase in physical activity, which included running on turf and concrete. The patient's pain was measured by utilizing the Numeric Pain Rating Scale (NPRS). At initial evaluation, the patient reported his worst pain was 7/10 bilaterally while running, best pain 0/10 while seated, and current pain 1/10 while walking. Function was measured by the Lower Extremity Functional Scale (LEFS) and disablement was assessed using the Disablement in the Physically Active (DPA) Scale. Initial scores were 47/80 and 41/64, on the LEFS and DPA scales, respectively.

Patient Two

A twenty-four year old female collegiate soccer athlete complaining of bilateral shin pain reported to her athletic trainer. The patient was otherwise healthy without current or past injuries to the lower extremity. The patient did not report a specific mechanism of injury; she stated running produced constant pain for the past four weeks with gradual worsening. The patient attempted to treat her symptoms with ice and stretching, reporting minimal to no improvement. The patient was initially evaluated mid-competition season with signs and symptoms that included aching and diffused pain along the distal ⅔ posteromedial border of both tibia during weight bearing physical activities (i.e., running), and pain with palpation. The patient's pain was measured with the NPRS. At intake, her worst pain was 10/10 bilaterally while running, best pain was 0/10 at rest, and current pain 3/10 while walking. Function was measured by the LEFS and disablement was assessed using the DPA scale. Initial scores were 59/80 and 36/64, on the LEFS and DPA scales, respectively.

INTERVENTION

Each patient was evaluated and treated at their respective clinics by a single clinician for the duration of their care. In both cases, an orthopedic examination was completed to determine

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diagnosis per established guidelines,[4] as outlined in **Table 1**, and to rule out the presence of a stress fracture. Physical impairments may result from postural compensations and/or dysfunctions within the nervous system, therefore, the MYK postural analysis was used on each patient to assess and identify a primary nerve root dysfunction.[9-10] The clinicians performed a static postural assessment by observing the patient's upper extremities, torso, and lower extremities in standing, seated, and prone positions. The clinicians used the posture assessment chart (**Table 2**) to connect postural imbalances to specific nerve root pathways innervating specific groups of muscles. The nerve pathway containing the greatest number of imbalances was identified as the primary dysfunctional nerve root at the time of assessment. Treatment was performed on the primary dysfunctional nerve root as determined through the postural assessment.[9-10]

Table 1. Signs and symptoms used for MTSS Diagnosis (Yates & White, 2004)

Pain History	Pain with activity lasting hours or days after activity. No history of paraesthesia.
Location	Pain along the posteromedial border of the tibia that was spread out over an area of 5 cm.
Palpation	Diffuse tenderness over the distal 2/3 posteromedial border of tibia.

At intake, both cases' postural assessments indicated the S1 nerve root as the primary dysfunction due to it having the highest number of associated imbalanced postures. The administration of one treatment took approximately ten minutes. Treatment included manual stimulation of each muscle innervated by the S1 nerve root, applied bilaterally with alternating patterns of 4-10 passive movement repetitions immediately followed by 4-10 active repetitions. In theory, the passive motions (**Figure 1**) are performed to clear muscle memory, followed by active movements (**Figure 2**) to re-establish proper neuromuscular firing patterns.[9] Stimulation was applied during the passive and active muscle lengthening motions by using light or deep compressions, glides, or cross-friction. The combination of simultaneous movement and tactile feedback stimulates several ascending sensory tracts and improves communication between the CNS and the muscles innervated by the corresponding nerve root.

During each visit, both patients received a treatment session that consisted of two S1 treatment bouts. After each treatment bout, the patients walked for two minutes to allow the CNS to interpret and adjust to the feedback received during treatment. A second S1 treatment was administered immediately following the two-minute walk. The session ended with a second two-minute walk. This treatment protocol was used at subsequent visits. Discharge criteria was met after patients received a total of twelve MYK S1 treatments completed in six sessions over two weeks. Patients continued their sporting activities while undergoing MYK treatments and through the 15-day follow-up. During this time, both patients refrained from additional therapy.

OUTCOME MEASURES

The MYK posture analysis chart (**Table 2**) was utilized to assess and log each patient's posture. Additionally, patient reported outcomes measures collected that included the NPRS, the LEFS, the DPA scale, and the Global Rating of Change (GRoC) scales. When a minimal amount of change needed to indicate importance to the clinician and patient, also known as the minimal clinical important difference (MCID) achieved, it was noted in **Table 3**. The NPRS is an 11-point scale, by which a score of zero indicates no pain and ten represents the worst pain imaginable, as perceived by the patient. A change in two points on the NPR scale indicates an MCID.[15] The LEFS is a 20-item questionnaire used to assess a person's ability to perform activities of daily living. Each item is scored by the patient; a score of 4 indicates no difficulty with the listed task while a

Table 2. The MyoKinesthetic ™ System Postural Assessment Chart (Uriarte, 2010)

POSTURE CHART

HEAD	
Flexed	______ (C1-T1)
Extended	______ (C1-C3)
Rotated	______ (C1-T1)
Laterally Flexed	______ (C1-T1)

SCAPULA	
Elevated	______ (C3-C4)
Depressed	______ (C3-C5)
Protracted (AB)	______ (C3-C5)
Retracted (AD)	______ (C5-C8)
Upward Rotated	______ (C3-C8)
Downward Rotated	______ (C3-C7)

SHOULDER	
Flexed	______ (C5-C8)
Extended	______ (C5-C8)
Depressed (AB)	______ (C5-C8)
Elevated (ADD)	______ (C5-C6)
Medially Rotated	______ (C5-C6)
Laterally Rotated	______ (C5-C8)

ELBOW	
Flexed	______ (C7-C8)
Extended	______ (C5-C7)

FOREARM	
Supinated	______ (C6-T1)
Pronated	______ (C5-C6)

WRIST	
Flexed	______ (C6-C8)
Extended	______ (C5-T1)
Radial Deviated	______ (C7-C8)
Ulnar Deviated	______ (C6-C7)

THUMB	
Flexed	______ (C7-T1)
Extended	______ (C6-T1)
Abducted	______ (C8-T1)
Adducted	______ (C6-T1)

FINGER	
Flexed	______ (C6-T1)
Extended	______ (C7-T1)
Abducted	______ (C8-T1)
Adducted	______ (C8-T1)

LUMBAR SPINE	
Flexed	______ (L1-L5)
Extended	______ (L1-L2)
Rotated	______ (L1-L5)
Laterally Flexed	______ (L1-L2)

HIP	
Flexed/Ant Rot	______ (L5-S1)
Extended/Post Rot	______ (L1-L5)
Abducted	______ (L2-L3)
Adducted	______ (L4-L5)
Laterally Rotated	______ (L2-S1)
Medially Rotated	______ (L5-S1)

KNEE	
Flexed	______ (L3-L4)
Extended	______ (S1)
Externally Rotated	______ (L2-L3, S1)
Internally Rotated	______ (S1)

ANKLE	
Plantar Flexed	______ (L4)
Dorsiflexed	______ (S1-S2)
Everted	______ (L4)
Pronated	______ (L4)
Inverted	______ (L5-S1)
Supinated	______ (L5-S1)

BIG TOE	
Flexed	______ (L5)
Extended	______ (S1-S2)
Abducted/Varus	______ (S1-S2)
Adducted/Valgus	______ (L5-S1)

TOES	
Flexed	______ (L5)
Extended	______ (S1-S2)

"Reprinted from Myokinesthetic System: Lower Body, Lumbar, and Sacral Plexus, 4th edition, Micharl Uriarte), Posture Chart, pg. 146, 1998, with permission from Elsevier ."

Figure 1: Start and End Positions for Passive Dorsiflexion

Figure 2: Start and End Positions for Active Dorsiflexion

score of 0 identifies a task that is impaired. An MCID on the LEFS is an increase of nine points.[16] The DPS scale is a 16-item questionnaire measuring impairments, functional limitations, disability and quality of life. A score ≤ 23 is expected in healthy individuals. An established MCID on the DPA scale of nine for acute injuries and six for persistent injuries is the standard used to indicate meaningful change.[17] The GRoC is a visual 11-point scale used to quantify a patient's perceived progress over time (e.g., improvements, digressions). An MCID for the GRoC is an increase of two points.[18]

Outcomes were collected at regular intervals, as outlined in **Table 3**, and patients were considered for discharge when meeting the following criteria:

- NPRS ≤ 2 average of best, worst, current, forty-eight hours after last treatment
- LEFS ≥ 70

- DPA scale ≤ 23 within the last forty-eight hours
- GroC ≥ 4 from intake to twenty-four hours after final treatment

RESULTS

Patient One

After the first week of treatment (three treatment sessions), the patient achieved MCID for the NPRS, LEFS, DPA Scale, and reported a GRoC score of 3/5 (**Table 3**). Treatment continued for an additional week (three treatment sessions), until the patient experienced resolution of pain and met discharge criteria. Minimal clinical important differences were achieved for all NRS, LEFS, and DPA scale scores taken between intake and discharge, and a one-point increase on the GRoC at the time of discharge. At the fifteen-day follow-up, the patient remained pain free and continued to report improvements in function while remaining physically active. The patient reported no pain, no dysfunction, and a GRoC of five at six-month follow-up. **Table 3** contains initial, discharge and fifteen-day follow-up results of the postural assessment and how it changed over the course of treatment.

Patient Two

After the first week of treatment (three treatment sessions), the patient improved scores for the NPRS, LEFS, and DPA Scale. Minimal clinically important difference scores were achieved for both the NPRS and DPA scale, and an initial GRoC score of 3/5 was reported (**Table 3**). Treatment continued for an additional week (three treatment sessions), until the patient's symptoms improved and discharge criteria were met. Minimal clinical important differences were achieved for all outcome measures between intake and discharge, and a one-point increase on the GRoC at the time of discharge. At the fifteen-day follow-up the patient continued to experience decreases in pain and reported improvement in function while remaining physically active and participating in soccer activities. At the six-month follow-up, the patient reported no pain, no dysfunction, and a GRoC of five. **Table 3** includes a summary of outcome measures across all time points, and postural assessment results for initial, discharge and fifteen-day follow-up.

DISCUSSION

In this case report, MYK was effective in reducing pain and restoring function in an accelerated time frame for two athletes suffering from MTSS, without being removed from activity. Clinically significant results were achieved in both cases as measured by the NPRS, DPA Scale and LEFS after treating exclusively with this technique. Minimal clinically important differences were achieved in both cases across all collected outcome measures within three treatment sessions and again at discharge. Minimal clinically important differences were achieved in both cases across all collected outcome measures within three treatment sessions and again at discharge. Patient 1 remained pain free and self-reported excellent outcome measures at fifteen-day and six-month follow-ups. Patient 2 was fully functional with soccer activities and met discharge criteria with an average NPRS score of 1/10 at discharge. At the fifteen-day follow-up her average NPRS score was 0.33/10, the patient reported her worst pain (1/10) was re-produced only during particularly vigorous soccer activity. At the six-month follow-up, patient two reported being pain free and fully functional.

Currently, clinicians have various options to treat patients with MTSS. The evidence supporting traditional treatments (e.g., rest, ice, stretching, and strengthening exercises) is not promising, as pain and dysfunction recur with activity.[2,19] The use of limited activity in combination with traditional treatments and a gradual return to play progression can take up to one-hundred days for the patient to report resolution of symptoms.[19] Rest alone can take up to six weeks until a patient is pain free.[20] In this case report, two patients experienced significant improvement of symptoms in two weeks without activity limitations, and maintained long-term results.

Table 3. Patient Outcomes

Patient One					
Outcome	Intake	1 week	Discharge	15 day Follow-up	6 month Follow-up
NPRS Ave.:	2.66	1	0	0	0
Worse	7	3	0	0	0
Current	1	0	0	0	0
Best	0	0	0	0	0
DPA Scale	41	16	2	0	0
LEFS	47	64	73	80	80
GRoC	-	3	4	5	5
MYK Posture	S1	-	C5	C6	-
Patient Two					
Outcome	Intake	1 week	Discharge	15 day follow up	6 month follow up
NPRS Ave.:	4.33	1.66	1	0.33	0
Worse	10	3	3	1	0
Current	3	2	0	0	0
Best	0	0	0	0	0
DPA Scale	36	9	6	0	0
LEFS	59	66	77	80	80
GRoC	-	3	4	4	5
MYK Posture	S1	-	C7/C8	C7/C8	-

NPRS- Numeric Pain Rating Scale; DPA scale- Disablement in the Physically Active Scale; LEFS- Lower Extremity Functional Scale; GroC- Global Rating of Change; MYK- Myokinesthetic

*= Minimally Clinically Important Difference

A previous history of MTSS has been linked to high recurrence rates.[2,21-22] Biomechanical, as well as structural abnormalities, are associated with lower extremity injuries causing dysfunctions along the kinetic chain.[20, 23-25] A visual observation of standing postures can help detect anomalies such as genu varum, pes planus, hyperpronated foot, increased forefoot and rear foot arch, which has been associated as intrinsic risk factors in patients with MTSS.[20,25-27] The changes brought about by the MYK treatment may have reduced intrinsic risk factors as they relate to posture and movement, resulting in long-term results.

The patients experienced clinically significant improvements across all measures (i.e., self-reported pain, disablement, and function) meeting discharge criteria after two weeks of treatment; compared to rest alone that may take up to six weeks.[20] At the end of the two-week treatment period, both patients experienced changes in previously dysfunctional postures. Within the S1 nerve root, patient 1 corrected two dysfunctional postures and patient 2 corrected four. Although patient 1 experienced fewer changes in posture, his pain was still eliminated. In patient 2, some postures within the S1 nerve root remained present at discharge, however enough postures were corrected to contribute to a combined positive effect on the system resulting in decreased pain and increased function. Theoretically, the summation of positional variations could have reduced stress loads in the lower kinetic chain. Additionally, changes may continue during activity as the CNS configures afferent and efferent communication, correcting unbalanced patterns until allostasis has been achieved. Corrected patterns may continue to have a positive impact on symptoms as the body continues to move, even if treatments are no longer administered.

Several limitations to the study warrant discussion. Internal validity may have been compromised as patient 1 reported a self-bias. The patient stated that he did not believe the treatment would resolve his condition, which might have resulted in delayed healing and extended treatment time. External validity is low since these two patients may not be generalized to larger populations. Further investigation into the effects of MYK with rest on MTSS is warranted. A larger-scale trial is needed to explore how postural changes affect the long- and short-term effects of MTSS.

CLINICAL BOTTOM LINE

The exact etiologies of MTSS are unknown, but risk factors associated with this syndrome are numerous. Conservative treatments focus on the local area of pain and do not address intrinsic risk factors. The MyoKinesthetic System, in comparison to traditional treatments, addresses postural risk factors to help prevent and/or decrease the signs and symptoms associated with the syndrome. As the number of risk factors decreased in both patients so did pain intensity. The results of this case report provide evidence of the short and long-term effects of MYK to decrease pain in two patients presenting with MTSS while remaining physically active. Through this case report we found that posture indeed may be an outward expression of the nervous system, encouraging clinicians to consider addressing structural compensations. A full-scale investigation of MYK is needed to determine its ability to effectively treat and address postural risk factors that lead to MTSS.

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Total Motion Release® for Restoring Normal Knee Function after ACL Reconstruction: A Case Study

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ABSTRACT

The objective of this study was to illustrate the case of an intercollegiate soccer player who sustained a grade 3 anterior cruciate ligament (ACL) injury and underwent surgical repair at 4 months. The patient engaged in her regular daily activity prior to the surgical procedure. One week prior to surgery the patient produced 140° of active knee flexion and -1° of active knee extension, and scored 69.0 on the International Knee Documentation Committee Subjective Knee Evaluation (SKE). One day post-ACL reconstruction by semitendinosus autograft, the patient's knee range of motion (ROM) was 40° of flexion and 20° of extension and reported a score of 21.8 on the SKE. The patient began rehabilitation immediately following surgery with the goal to increase ROM of the involved limb. A Total Motion Release® (TMR ®) rehabilitation protocol was implemented for the first four weeks in lieu of a traditional ACL reconstruction rehabilitation protocol. Three sessions were completed each week over a four-week period, for a total of 12 sessions. Rehabilitation sessions consisted of 15 minutes of ice massage of the quadriceps with simultaneous quadriceps contraction/relaxation immediately followed by TMR ®. The patient ended each session with progressive exercise: 5 minutes of half rotations on the bike on day one, progressing to a 20 minute light jog on the treadmill by week four. Patient was re-assessed by the orthopedic surgeon at a one and six month post-operative follow-up appointments. Changes in flexion and extension ROM and SKE were assessed weekly prior to treatment to evaluate knee ROM. Four weeks following the TMR® protocol, knee range of motion was restored demonstrating the effectiveness of TMR®.

Key Phrases
Exercise, surgery, patient outcomes

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INTRODUCTION

Recovery from anterior cruciate ligament (ACL) reconstruction is a time-consuming undertaking both for patient and clinician.[1-14] In the past decade, researchers have studied and published rehabilitation protocols that vary in effectiveness and duration, with an average total timeline of 6-9 months to return to pre-injury activity.[1-8] In the first four weeks alone, patients can expect to spend anywhere from 30-150 minutes in a single rehabilitation session and complete several sessions per week.[2,8,12,14] Furthermore, neuromuscular electrical stimulation devices,[2,3,5,8,9,12,14] and continuous passive motion (CPM) machines are commonly used in addition to supervised rehabilitation sessions.[1,2,6-8,14] The CPM machine is sometimes used for several hours each day immediately following surgery with the goal to restore range of motion (ROM) quickly and avoid the formation of unnecessary scar tissue in the joint.[1-3,8,14]

Across the literature regarding ACL reconstruction rehabilitation protocols, patients achieved similar results by the fourth week after surgery. The patient should be capable of bilateral pain-free step-up progressions to 60°, stationary biking, swimming, and proprioception drills (e.g. balance boards).[1,4-9,11,13-15] To accomplish this, patients begin rehabilitation with a two-week post-operative phase that includes bracing and crutches, with the goal to reduce pain and swelling.[1-8] During weeks two through four, rehabilitation goals are to progress the patient to achieve weight-bearing with a normal gait, appropriate patellar mobility, and knee flexion ROM of 0° to 130°.[1-14] The most common rehabilitation exercises to achieve normal gait during the first four weeks begin with a straight leg raises and gait training.[1-6,8-12,14,15]

With such a strong emphasis on restoring joint ROM and muscular strength, it is important that clinicians have appropriate, effective, and time efficient tools to accomplish rehabilitation goals. In addition to local modalities (e.g., mobilizations, CMP), clinicians can incorporate techniques that utilize the central nervous system to improve ROM and increase strength at the involved joint and throughout the body. Total Motion Release® (TMR®) is a treatment approach that utilizes contralateral movements to influence neural coupling and the nervous system's interpretation of electrical signals to the injured body segment.[16] Referred to as cross education, this mechanotransduction is a means by which a movement force (e.g. stretching, resistance) applied to the muscle fiber can influence balance of the neuromusculoskeletal system, helping to re-align imbalances in strength and ROM.[17-19]

TMR® attempts to sustain a dynamic center of gravity as part of a unified system by treating imbalances in the body.[17,20] Patients with pain, deficiencies, or impairments in one area of the body can be influenced by movements performed elsewhere in the body. The technique incorporates the use of contralateral exercises to the unaffected side to promote therapeutic results in the affected side.[17] Although TMR® research is still in its infancy, some researchers have provided insight into the positive effects of TMR® on shoulder pain, range of motion, and muscle re-education, while reducing rehabilitation session duration.[20-23]

This case study includes the outcomes of a rehabilitation protocol in which a patient was treated with TMR® following ACL reconstruction surgery to restore normal knee range of motion.

PATIENT INFORMATION

The patient was a 20-year old female intercollegiate soccer player who suffered an injury of her left (non-dominant) knee during a game via a non-contact mechanism attempting to decelerate to avoid a collision with an opponent. The patient was referred to an orthopedic surgeon for magnetic resonance imaging (MRI) which identified an isolated Grade III ACL sprain. The patient underwent a semitendinosus autograft surgical reconstruction approximately four months later. The four month delay was contributed to a combination of the patient's schedule and insurance authorization. The patient did not implement a detailed pre-surgery rehabilitation protocol except for activities of daily living and general conditioning. The patient reported to the clinic one week prior to surgery to assess her function prior to surgery.

Outcomes utilized to assess knee function were range of motion (ROM) with goniometer[1,3,5-8,9,11-13] and the International Knee Documentation Committee Subjective Knee Evaluation (SKE).[2,24,25] Initial outcomes were assessed one week prior to surgery and were repeated one day post-surgery and weekly for four weeks. Outcomes were also assessed at the one month and the six month follow-up.

Active flexion and extension ROM of the knee were measured using a standard goniometer (scale marked in 1° increments; model 12-1002; MeyerDC™, Hudson, OH). The same clinician conducted flexion and extension measurements prior to the commencement of the rehabilitation session at the beginning of each week.[13,26] The ROM measurement was performed as follows:

- Flexion: The patient started in a supine position with full knee extension and the hip in neutral. The axis of the goniometer was placed on the lateral epicondyle of the femur. The proximal arm was placed at the midline of the femur aligned with the greater trochanter. The distal arm was placed at the midline of the fibula and aligned with the lateral malleolus and the fibular head. The patient then flexed the knee as far as possible while flexing the hip.[1]

- Extension: The patient started in a supine position with full knee extension and the hip in neutral. A bolster was placed under the ankle. The axis of the goniometer was placed on the lateral epicondyle of the femur. The proximal arm was placed at the midline of the femur aligned with the greater trochanter. The distal arm was placed at the midline of the fibula and aligned with the lateral malleolus and the fibular head.[1]

The SKE is a patient-completed questionnaire designed to detect improvement or impairment of symptoms, function, and sports activities due to a variety of knee conditions (e.g. ACL injuries).[2,24,25] The SKE form is divided into three domains: 1) symptoms (i.e., pain, stiffness, swelling, locking/catching, and giving way); 2) sports and daily activities; and 3) current knee function and knee function prior to knee injury. These domains are comprised of 18 items (1 for current knee function, 1 for sport participation, 7 for symptoms, and 9 for daily activities). Responses vary for each item. Item 6 requires a yes or no response. Items 1, 4, 5, 7, 8, and 9 use 5-point Likert scales. Items 2, 3, and 10 use 11-point numerical rating scales by which the responses to each item are scored using 0 to indicate the lowest level of function or highest level of symptoms, and the highest number to indicate no symptoms and full function. Items 2 and 3 are related to pain and the responses are scored in reverse where "Constant" is assigned a score of 0, and "Never" is assigned a score of 10. The response to item 10a is not included in the overall score as it relates to pre-injury function. The results are summed (excluding item 10a) and the score transformed to a scale ranging from 0 to 100 (**Figure 1**). Higher scores represent higher levels of function and lower levels of symptoms, with a score of 100 interpreted as no limitations and no symptoms.[24]

$$\text{SKE Score} = \left[\frac{\text{Sum of Items}}{\text{Maximum Possible Score}}\right] \times 100$$

Figure 1. SKE Score Calculation

INTERVENTION

Total Motion Release® can be implemented using a set of standardized movements, or by testing and treating with any movement of choice. The standardized procedures of TMR® consist of repetitively recording a patient-rated numeric scale of dysfunction between zero (e.g., no pain, tightness, or impaired function) and 100 (e.g., extensive pain, tightness, or impaired function) during active movement through the TMR® screening which includes six primary exercises known as the Fab 6.[17] The Fab 6 movements, developed by the TMR® originator Tom Dalonzo-Baker, include arm raise, arm press, trunk twist, leg raise, sit to stand, and bent knee toe reach (**Figure 2**).[17] The patient performs each exercise bilaterally and assigns a score to each movement for each side. The motion with the greatest bilateral discrepancy as perceived by the patient is treated first. Treatment consists of sets of repetitions and/or end-range holds of the Fab 6 movements performed to the good side. Scores are re-evaluated after every two to three sets, until a patient-reported score of 5 or below is achieved. The Fab 6 is then repeated and rescored, and the next most discrepant movement is treated until balance is achieved across all movements.[21,23,27,28] Modifications of the Fab 6 or additional movements can be incorporated to accommodate a patient's limitations or needs.

Figure 2: Fab 6 evaluation movements.[30]

During the first week, which included the inflammatory phase of healing, the patient was instructed to use crutches to assist with weight bearing as tolerated. The patient was permitted to ice for pain but did not engage in any other forms of treatment or pain medication for the first week. Intervention commenced one week after surgery and the patient began attending rehabilitation sessions three times per week, and did so for the next four weeks. The patient began each session with a 15-minute ice massage of the quadriceps to produce a hypoalgesic effect,[29] while simultaneously isometrically contracting then relaxing the quadriceps of the affected limb with the knee in full extension (**Figure 3**).

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Figure 3. Ice massage over the quadriceps of the affected leg while simultaneously contracting and relaxing for 15 minutes.

Immediately following the ice massage, TMR® was used with straight leg raises (**Figure 4**). Progression was indicated when the patient's score decreased to 25 or less. As the patient progressed, knee hyperextensions (**Figure 5**) and the Fab 6 "Sit to Stand" movement were incorporated (**Figure 6**). The patient completed the movements on the injured side reporting a score between 0 (i.e., no symptoms and full function) and 100 (i.e., very symptomatic and no function). Because the patient reported the injured limb to have lower function, she performed the TMR treatment exercises on the uninjured side. The treatments consisted of either 3 sets of 10 repetitions and/or 5 holds for 30 seconds and were determined based on the ease to the patient. After each series, the patient completed the exercise on the injured side and reported a new score. During session one, the patient ended by performing self-paced half revolutions for 5 minutes on a stationary bike enabling the knee to flex and extend to 90° (**Table 1**). The patient progressed appropriately and by the eighth session was capable of 20 minutes of full rotations on the stationary bike. She progressed from the bike to the treadmill and at the end of the four week time frame, the patient was jogging at a 5 mph pace at a 0° incline for 10 minutes on the treadmill (**Table 1**). In addition to her treatment sessions, the patient was instructed to perform the entire treatment series of TMR® each day at home.

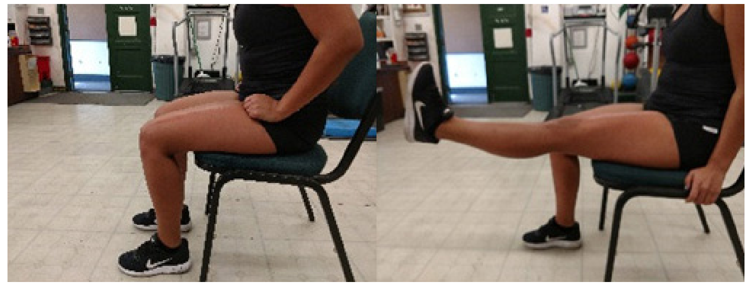

Figure 4. The starting (left) and ending (right) positions for the straight leg raise

Figure 5. The starting (left) and ending (right) positions for the leg extension.

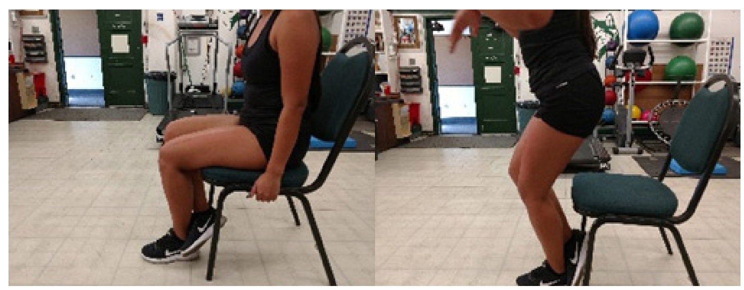

Figure 6. The starting (left) and ending (right) positions for the sit to stand.

OUTCOMES

At the end of 12 TMR® sessions, the straight leg raise had improved from an initial patient-reported score of 70 to a final score of 0. The knee hyperextensions and sit to stand had improve to a score of 5 from an initial score of 60 and 80, respectively (**Table 2**). The patient achieved 99.0% of pre-surgery extension and 96.4% of pre-surgery flexion. The patient had achieved 98.3% of their initial SKE score. At the one-month after the TMR® rehabilitation protocol, the patient's knee flexion was at 100% (140°) and extension increased 1° (-2°) from pre-surgical scores. The SKE scores improved 36%

Table 1. Comparison of TMR® to a Traditional Rehabilitation Protocol for 12 sessions over four weeks after surgery.

Traditional		TMR®	
Sessions	Exercises	Sessions	Exercises
1-3	Arm Ergometer for Cardiovascular Fitness†	1-12	15 minutes ice massage with quadriceps contractions
1-3	Wall slides‡	1-4	Straight Leg Raises for a maximum of 6 series*
1-3	Patellar mobilization 30 to 50 times per day	2-12	Knee Extensions for a maximum of 6 series**
1-3	Gait Training†	5-12	Sit to Stand for a maximum of 6 series*
1-3	Bike for ROM†	1-2	5 minutes half revolutions on the stationary bike
1-3	Quadriceps long-arc (90°-45°)‡	3-11	20 minutes full revolutions on the stationary bike
1-3	Straight Leg Raises‡	12	10 minutes treadmill at 5mph at 0° incline
1-3	Step-ups in pain-free range‡		
1-3	Proprioceptive/balance training‡		
4-6	Portal/incision mobilization as needed‡		
4-6	StairMaster†		
4-6	Wall squats†		
4-6	Wall sits†		
4-6	Prone hangs‡		
4-6	Patellar mobilization in flexion‡		
4-6	Stationary Biking†		
7-12	Tibiofemoral mobilizations‡		
7-12	Continue balance and proprioceptive activities‡		
7-12	Increase intensity of stationary bike†		
7-12	May add treadmill walking and/or elliptical†		
7-12	Advance intensity of pool program as tolerated		

* Series: 3 sets of 10 repetitions on the unaffected side followed by one set of 10 repetitions on the affected side.
** Series: 5 repetitions holding each for 30 seconds on the unaffected side followed by one repetition at a 30 second hold on the affected side.
† 10 to 30 minutes
‡ 3 sets of 10 repetitions (3 times per day)
Adams, Biggs, Rosenberg, Saka, Shaw, Shelbourne, van Grinsven

from the initial intake prior to surgery. At the six month follow-up, knee flexion and knee extension were also measured at 140° and -2° respectively (**Table 3**). During week three, the patient reported an incident in which she was struck in the knee resulting in a minor regression.

DISCUSSION

The purpose of this study was to explore the effects of a rehabilitation protocol that included TMR® on knee range of motion after ACL reconstruction. Researchers have indicated an ACL reconstruction patient should achieve greater than 110° of flexion and full knee extension by the

Table 2. Patient's TMR® Pre and Post Session Scores

		Straight Leg Raises		Knee Hyperextension		Sit to Stand	
Week	Session	Pre	Post	Pre	Post	Pre	Post
1	1	70	55	NA	NA	NA	NA
	2	55	15	60	55	NA	NA
	3	15	10	70	55	NA	NA
2	4	10	0	40	25	NA	NA
	5	NA	NA	25	20	80	50
	6	NA	NA	10	5	50	40
3	7*	NA	NA	50	45	35	30
	8	NA	NA	45	40	45	30
	9	NA	NA	30	20	15	10
4	10	NA	NA	10	5	15	10
	11	NA	NA	10	5	10	5
	12	NA	NA	5	5	5	5

* Patient experienced a minor hindrance when a person ran into her knee.

Table 3. Patient's Knee Range of Motion and Subjective Progress

Timeframe	Flexion	Extension	SKE Score
1 week pre-op	140°	-1°	69.0
1 day post-op	40°	20°	21.8
1 week post-op	50°	22°	24.1
2 week post-op	110°	13°	34.5
3 week post-op	130°	10°	44.8
4 week post-op	135°	0°	67.8
1 month follow up	140°	-2°	94.3
6 month follow up	140°	-2°	96.6

fourth week of rehabilitation following ACL reconstruction surgery. [2,4-7,9,13] In this case study, the patient achieved greater than 110° of flexion and full knee extension by the end of the four weeks of TMR®. One month following TMR® the patient added an additional 5° of flexion and -2° of extension which was maintained at the six-month follow-up (**Table 3**).

A direct comparison of the time to completion for traditional rehabilitation elements and the protocol including TMR® is provided in **Table 1**. Rehabilitation exercises were included if they have been established in the literature and are widely used in patient practice for rehabilitation to increase ROM following ACL reconstruction.[1,4-7,9,15] The TMR® protocol for the patient in this study was an effective method as compared to traditional rehabilitation, but was less time-consuming and required less exercises.[1,4-7,9,15] Traditional rehabilitation averaged over 90 minutes per session three to five times per week for four weeks,[1,4-7,9,15] and can include home exercises performed 3 times per day. In contrast, TMR® averaged less than 45 minutes per clinical session three times per week for four weeks, as well as daily at home, and generated the same patient outcomes as a traditional protocol.

Cryotherapy was incorporated for yielding therapeutic effects associated with the decrease of motor nerve conduction. The amount of the multiple action potential denotes the amount of nerve fibers that responds to an appropriate stimulus.[29] Therefore, the diminution of this parameter after the cold application could infer an escalation in the activation threshold of some nerve fibers, as well as the blocking of the fibers more sensitive to cooling.[29]

Although the results were successful, some limitations exist. Goniometric measurements were not blinded and could have decreased outcome validity.[27] To determine the greatest effects of the protocol used in this case study, additional research is necessary using a larger number of participants randomized into TMR® and traditional rehabilitation groups. Future researchers should blind the individuals measuring outcomes to the group assignments.

CLINICAL BOTTOM LINE

Total Motion Release®[17,20-23,28] was an effective treatment to restore knee ROM following ACL reconstruction surgery that took less time per treatment session than traditional ROM techniques.[1,4-7,9,15] Ice massage while simultaneously contracting and relaxing the quadriceps may have contributed to stimulating the muscle fibers.[30] The stationary bike also assisted with the patient's ROM.[1,4-7,9,15] TMR® can be a practical, less time-consuming alternative for clinicians attempting to improve a patient's ROM after ACL reconstruction.

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