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Optimizing Return to Learn Following a Sport-Related Concussion: A Quality Improvement Project

Dawn Ranns, DAT, ATC[1,2] & Tamara Valovich McLeod, PhD, ATC, FNATA[2,3]

[1]Limestone College, Gaffney, SC; [2]Athletic Training Programs, and [3]School of Osteopathic Medicine in Arizona, A.T. Still University, Mesa, AZ

ABSTRACT

Sport-related concussion (SRC) has been at the forefront of the sports medicine literature and media; however only recently has return to learn (RTL) been recognized as an important piece of a concussion management plan (CMP). A student's successful transition back to the classroom following SRC depends on the support, resources, and effective communication among the multidisciplinary team. This project focused on the assessment of current faculty knowledge, attitudes, and beliefs about concussion, the development of an RTL policy, and implementation of educational resources at a Division II institution. This project ran for 6 months, using 2 cycles of the plan, do, study, act (PDSA) methodology. An initial survey demonstrated faculty have a poor understanding of the behavioral and emotional signs and symptoms of concussion and that there was insufficient communication regarding student-athletes with concussion between faculty, staff, student-athlete, and administration. Initially, a RTL plan was developed and added to the existing concussion management plan (CMP), followed by the formation of a multidisciplinary concussion management plan (CMT). Finally, a one time in-person concussion education presentation was provided to faculty. Quantitative results from the post survey and semi-structured face-to-face interviews revealed improved communication among CMT members. One-hundred percent of faculty believed the brochure and presentation were helpful when managing a student with SRC. Faculty felt more knowledgeable and confident about academic adjustments and communicating with the CMT. Similarly, qualitative results from the in-person interviews with 8 faculty members revealed knowledge, confidence, and communication greatly improved; however, participants recommend additional education and a faculty resource page for concussion materials. This project demonstrated improvement in communication and efficiency in notifying faculty following injury minimizing time lag in academic adjustments. The RTL policy and faculty concussion education represents a simplistic, sustainable resource that could be replicated to other colleges.

Key Phrases
Policy and Procedure Development, Risk Management Mitigation, Collegiate and University Patient Population, Sport-related concussion, Return-to-Learn

Correspondence
Dr. Tamara C. Valovich McLeod, A.T. Still University, 5850 E. Still Circle, Mesa, AZ 85206.
E-mail: tmcleod@atsu.edu
Twitter: @TamaraCVMcLeod

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CURRENT MODEL

In 2017, the Center of Disease Control reported the incidence of sport-related concussion (SRC) as 2.5 million a year.[1] This injury is most common in persons ages 15-24 with a prevalence rate ranging from 16-24%.[2] Although SRC management has significantly improved in the last decade, return to learn (RTL) is a relatively new piece to concussion recovery. Presently, only Division I institutions are required to submit a formal written concussion management plan (CMP) to the NCAA that includes both RTL and return to play criteria (RTP). To date, RTL protocols have been based on limited consensus driven empirical data and their effectiveness and clinical implementation has not been widely assessed.

This quality improvement project took place at a small private college, with an undergraduate enrollment of 2,595 students and approximately 850 student-athletes. The college is located in a suburban area that sponsors intercollegiate athletics at the NCAA Division II level. With large roster sizes, the addition of several new sports in the last five years, and a number of at risk sports including football, men's and women's soccer, men's and women's basketball, wrestling, acrobatics and tumbling, and men's and women's lacrosse, there was an increase number of

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reported SRC. In 2015-2016 there were 14 reported SRC, 2016-2017 12 reported SRC, 2017-2018 36 reported SRC, and 2018-2019 58 reported SRC's. In the previous CMP, when a student-athlete suffered a concussion, the athletic training staff notified the academic dean who then informed the student-athlete's professors a concussion had occurred; however, communication was often delayed or omitted either by athletic training staff or by an academic dean's office.

Collegiate student-athletes often identify themselves directly by their achievements on the field as well as in the classroom, therefore the faculty perception is vital in identifying the recovery from SRC.[3] Faculty have the ability to positively or negatively impact a student's recovery depending on whether they will provide classroom support. The willingness of the faculty may be subjective by their preexisting knowledge of concussion, cognitively, physically, and behaviorally, and their beliefs about concussion.

While there is some evidence to suggest that short-term academic dysfunction occurs following sport-related concussion,[4-7] these seem to resolve and not impact long-term academic outcomes, as reported through end of year grade point average.[8] Specifically, Wasserman et al[5] noted higher academic dysfunction scores in the initial week following concussion compared to peers with extremity injuries and Swanson et al[7] reported academic difficulty among students with vision symptoms, hearing difficulty, and concentration issues.[7,9] Furthermore, surveys of student-athletes found that 27-90%[5] of students and parents reported difficulty completing homework or classwork during the recovery time following concussion.[5] When recovery is prolonged, there is a greater impact on perceived health status, with adolescent athletes reporting deficits in health-related quality of life related to school and cognitive functioning.[10]

During this quality improvement project the athletic training staff noticed once an initial e-mail was sent to an academic dean following a SRC there was no further communication with anyone about the academic performance of the student-athlete. During the 2017-2018 academic year there were 36 SRC reported to the athletic training staff. Thirty-three percent (*n* = 12/36) of student-athletes became ineligible for their sport during the recovery semester and 72% (*n* = 26/36) had a decrease in grade-point-average from Fall 2017 to Spring 2018. Sixteen percent (*n* = 6/36) of student-athletes were placed on academic suspension or withdrew from the institution. This data is consistent with the literature.[5,11] Over the course of the year, no faculty reached out to athletic training staff concerning a student's concussion or classroom needs. In addition, in reviewing the college policy for concussion management there was no information provided regarding RTL. Therefore, an initial survey was conducted of the college faculty in regard to understanding of concussion.

When the faculty were surveyed, 40% (*n* = 22/53) of respondents never received notification when a student-athlete they taught was diagnosed with an SRC (**Table 1**). This lack of communication between faculty, administration, and/or healthcare providers does not follow best practices. In addition, student-athletes seldom received guidance and resources upon returning to the classroom nor does a healthcare provider follow-up with the student-athletes to assess progress in the classroom. Faculty perception of student's class attendance, quality of class participation or attentiveness, effort put forth on exams and assignments as well as not knowing a student has suffered an SRC could affect the recovery and the academic success of students. Therefore, this quality improvement project focused on the assessment of current faculty knowledge, attitudes, and beliefs about concussion, the development of a RTL policy, and implementation of educational support to all stakeholders involved with the management of a student-athlete following SRC.

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Table 1. Faculty Demographics Baseline Survey

	N	%
Gender (n=52)		
Male	21	40
Female	26	50
Did not respond	5	10
Age (years) (n=42)		
20-29	5	12
30-39	10	24
40-49	10	24
50-59	9	23
60-69	6	14
70-79	1	2
Highest Level of Education (n=52)		
Bachelor's degree	3	6
Master's degree	24	50
Doctoral degree	23	46
Years of Teaching Experience (n=43)		
0-9	17	40
10-19	12	28
20-29	6	14
30-39	4	9
40+	1	2
Level of Schooling Taught* (n=50)		
Undergraduate	33	66
Post-baccalaureate – Master's level	7	14
Post-baccalaureate – Doctoral level	4	8
Not a teacher	5	10
Academic Division (n=49)		
Arts and Letters	18	37
Social and Behavioral Science	11	23
Natural Sciences	10	20
Professional Studies	6	12
Education and Physical Education	4	8
Additional Roles Filled (n=24)		
Academic Advisor	21	88
Dean	1	4
Department Chair	6	25
Coach	1	4
School Counselor	1	4

*Some Faculty Have Taught in Multiple Levels

PDSA CYCLE

Initially the author assessed the college faculty through the use of the *University Faculty Knowledge, Attitudes, and Beliefs about Academic Adjustments for Students with Concussion* survey to identify gaps in faculty knowledge about concussion and the academic adjustments. The survey is a modification from the validated beliefs, attitudes, and knowledge of pediatric athletes with concussion for (BAKPAC–AT).[12] Written permission was given from the original authors of the survey. The survey was available to the faculty for 19 days, April 23 to May 9, 2018. Following the completion of the survey the investigator analyzed the survey data to identify problems with the current system to facilitate the first PDSA cycle.

The project team consisted of one author, who was a full-time faculty member of the institution and the faculty athletic representative, with perspectives of key figures academically with the faculty and athletically with the athletic department. Following the assessment of the survey the plan was three-fold: 1. Develop a standardized institution CMP, 2. Develop a multidisciplinary CMT, and 3. Disseminate the results of the baseline survey and implement concussion education to the faculty. Following the development of standardized form for return to learn, a one-time concussion education presentation was developed for faculty, athletic staff, athletic training staff, student-athletes and the medical director for athletics. For the purposes of this QI project only faculty were assessed following the presentation. A cause and effect diagram illustrated in **Figure 1** was constructed based on the investigators' assessment of faculty knowledge from the baseline survey. A process diagram was developed to capture the current

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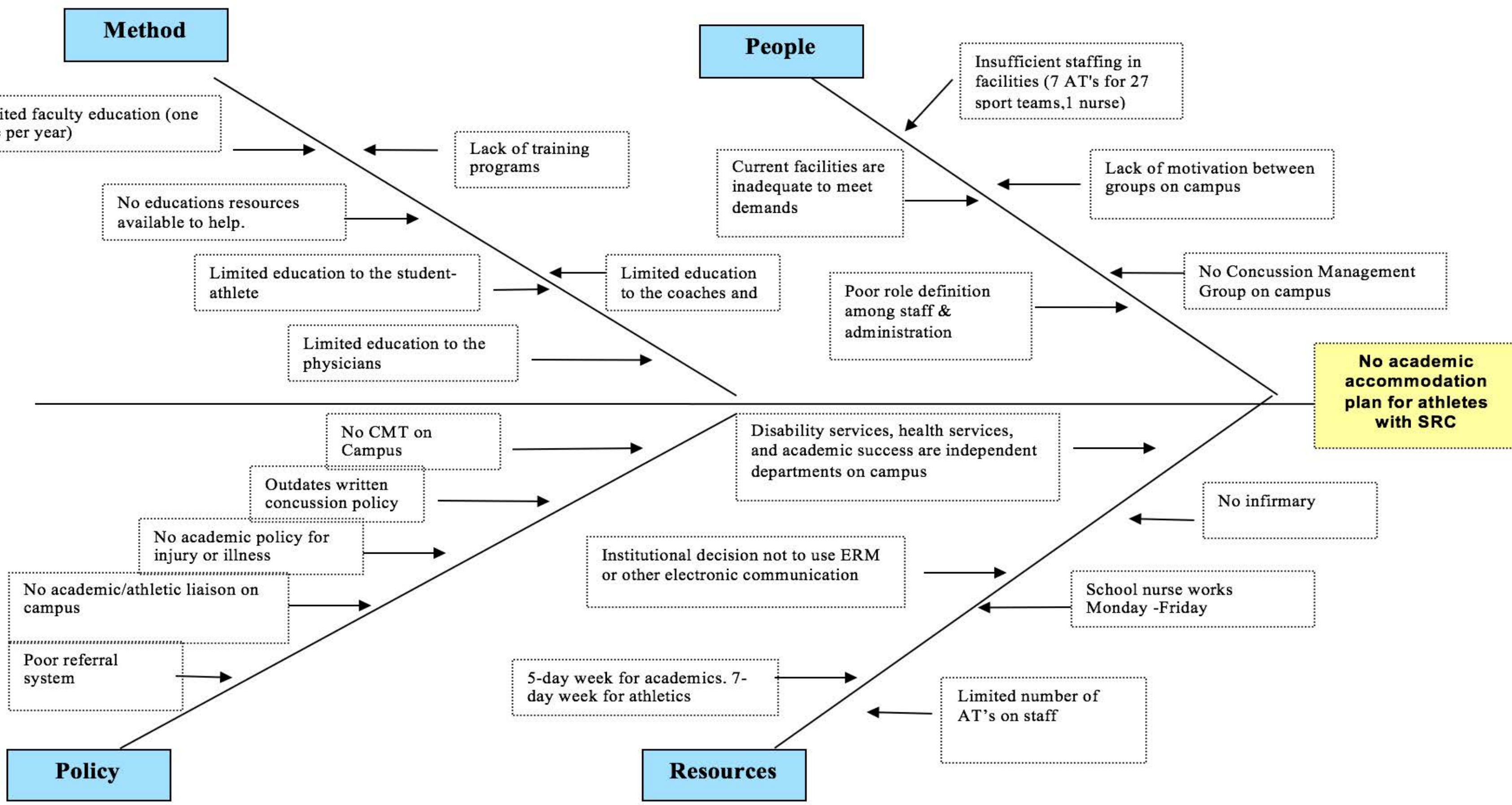
Figure 1. Cause and Effect ("Fishbone") Diagram



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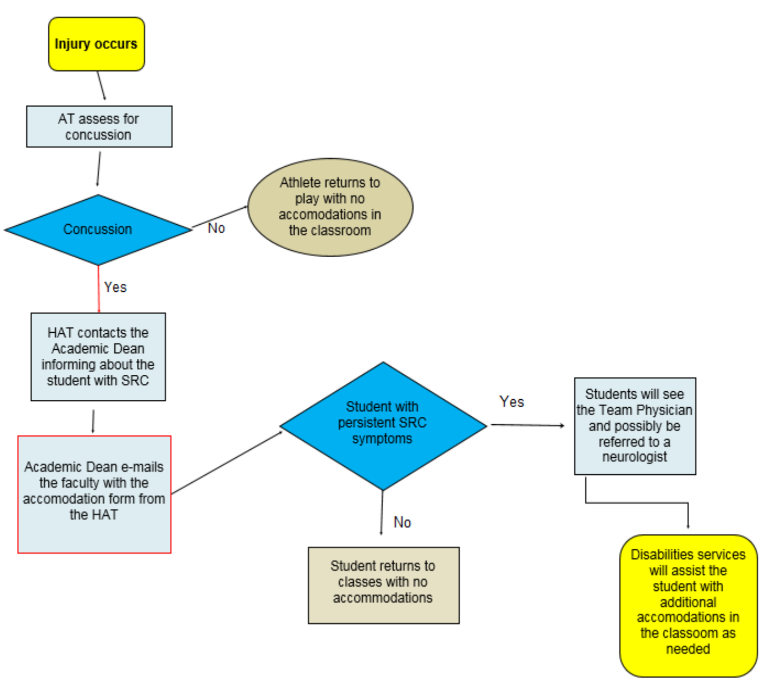
concussion management procedure for a student-athlete who suffers a SRC. An additional process diagram was developed including the ultimate goal of operation following a SRC and the RTL that is currently used when a student-athlete suffers a concussion. Both current and future institutional process diagrams are displayed in **Figure 2** and **Figure 3**. Implementation of the new flow chart in August 2018 has made the process more efficient by streamlining a student-athletes RTL and RTP, ultimately eliminates faculty's need to reach out to someone at the intuition when a student-athlete returns to the classroom.

It was clear by the initial assessment that faculty knowledge on concussion, academic adjustments, and collaboration between faculty and staff is limited. Most faculty recognized a concussion is serious; however, they lacked knowledge about cognitive rest and limitations following a SRC or the ability to provide appropriate academic adjustments for students. It was hypothesized improving faculty communication with various stakeholders and identifying their role on the CMT and providing academic adjustments for students, faculty would be more likely to provide assistance to students and student overall success will improve when returning to the classroom (**Figure 1**).

Figure 2. Previous SRC Flowchart



PDSA CYCLE 1

Following the baseline data collection from the initial *University Faculty Knowledge, Attitudes, and Beliefs about Academic Adjustments for Students with Concussion* survey and the cause and effect diagram it was identified that faculty lacked overall basic knowledge on concussion and applicable academic adjustments for students returning to the classroom following a SRC.

Plan

In August 2018, all faculty attended a single concussion education presentation and received a brochure about the new RTL policy for student-athletes following a SRC. During the Fall 2018 semester all student-athlete's suffering a SRC reported to the CMT to be assessed for their individual RTL plan. Faculty were informed via e-mail of student-athletes who suffered a SRC within 24-hours of injury on the institutions concussion awareness form. Student-athletes reported to the CMT bi-weekly for re-assessment until they are discharged from any RTL classroom adjustments. Faculty received updated information via e-mail within 24-hours following each student-athlete's appointment with the CMT as well as a discharge letter when the student no longer required adjustments in the classroom. From September to October 2018 faculty completed a post survey. Pre- and post-survey results were then compared to asses any changes in the faculty's knowledge, attitudes, and beliefs of SRC and academic adjustments.

Do

The initial intervention incorporated a single concussion education presentation and brochure to the faculty that included information related to 1. Basic concussion knowledge, 2. Appropriate academic adjustments for the classroom, 3. Personnel involved in the multidiscipline CMT, and 4. The eight stages of the RTL policy for the institution. In August 2018, all faculty at the

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institution were presented the concussion education and a concussion awareness brochure. From September 25 - October 12, 2018 faculty completed the survey with modifications to the original *University Faculty Knowledge, Attitudes, and Beliefs about Academic Adjustments for Students with Concussion* survey to determine if change occurred. The results were analyzed to evaluate the effectiveness of the educational presentation and brochure.

Study

A total of 157 faculty were e-mailed the survey, 45 responses, and 24 individuals completed the entire survey for a 15% response rate. Generalized analysis of results considered only the results of the 24 complete surveys; however, individual question analysis assessed all available information. All faculty agreed the educational presentation was beneficial. A majority of faculty would prefer a variety of alternative education mode such as links associated to concussion, recorded webinars, live webinars, and in-person presentations. Oddly, 43.48% (*n* = 10/23) of faculty would prefer not to receive any more information on concussion.

Faculty knowledge of symptoms associated with concussion improved in 11 of 22 symptoms, only 4 symptoms scored worse on the post survey. Symptoms related to emotions conveyed the greatest improvement of all symptoms. Faculty recognition of signs and symptoms of concussion is illustrated in **Figure 4**.

Faculty knowledge on prevention, physical and cognitive sign and symptoms, treatment and management, RTL, and RTP increased in all categories. Results of improvement for physical and cognitive signs and symptoms and RTL are illustrated in **Figure 5**. More faculty were extremely knowledgeable and moderately knowledgeable in these areas than found in the baseline assessment. Faculty knowledge about concussion and a better understanding of academic adjustments were the greatest improvement. When asked how often the care of concussed student-athletes were discussed between the faculty and the CMT 65% (*n* = 17/26) of faculty reported always, 23.08% (*n* = 6) almost always, and 26.92% (*n* = 7) often. This was a significant increase from 33% (*n* = 11/27) of faculty reporting in the same categories. Communication improved between the faculty and the CMT. Faculty indicated that they received information on injured or ill students more often in the post survey, 77% (*n* = 22/24), than reported at baseline 36% (*n* = 8/22) resulting in a 41% increase in communication.

Familiarity with academic adjustments also improved. Initial baseline results indicate that 9% (*n* = 5/53) of faculty were not familiar, 43.40% (*n* = 23/53) minimally familiar, 35.85% (*n* = 19/53) were moderately familiar, and 11.32% were extremely familiar with academic adjustments. Post-survey results found all faculty (*n* = 24) were either moderately familiar 58% (*n* = 14/24) or extremely familiar 42% (*n* = 10/24) with academic adjustments.

There was a 10% increase of faculty who recognized the institution has an academic support team. Faculty were also more likely to recommend academic adjustments to a student after the educational presentation. At baseline 33% (*n* = 17/53) of faculty responded they *rarely* to *never* recommended academic adjustments; however; in the post-survey, all faculty (*n* = 23) responded they *always*, *almost always*, *often*, or *sometimes* recommend academic adjustments.

There continues to be a variety of responses in the post-survey when faculty (*n* = 16) were asked who is involved in the academic support team for concussion students. However, 100% of faculty surveyed recognized the CMT was part of the academic support team. Some of the weakest areas of recognition were the nurse 44% (*n* = 7/16), team physician 25% (*n* = 4/16), teachers and disability services each at 44% (*n* = 7/16). Faculty still do not fully know who the point person is to manage academic adjustments. Percentages on the baseline and post-survey improved by 8%, only raising the score to 52%. This is an area that indicates further education and growth.

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Act

Over the course of the Fall semester there were 36 total SRC. With a large number of SRC in future PDSA cycles there needs to be more than one person in the CMT that facilitates concussion assessment following injury. Initial, follow-up, and discharge paperwork to the faculty was time consuming and difficult to keep up with. Allowing more individuals in the CMT to contribute to the assessment and documentation in the Fall 2019 semester will allow some of burden to be lifted and more efficient communication may occur. Continuing to educate the athletic trainers, coaches, and other healthcare providers on the institutions RTL policy will also improve awareness. In the Fall semester student-athletes who suffered a SRC were still going to study hall, film, athletic practices, and weight lifting. Continued education will improve faculty and staff awareness of student-athletes with increased symptoms during various activities and allow them to more confidently adjust activities that could hinder recovery.

PDSA CYCLE 2

Plan

Following the results of the post-survey the plan was to assess 8-10 faculty member's comfort and satisfaction with: 1. The educational presentation, 2. The concussion awareness brochure, 3. The CMT, and 4. The eight stage RTL policy using a semi-structured face-to-face interview. The interview questions were a modification from the interview protocol used for the Perceived Outcomes of Web-based Modules Designed to Enhance Athletic Trainers Knowledge of Evidence Based Practice (**Table 2**).[13] Written permission was given from the original author of the interview questions. The aim was to recruit 8-10 faculty members to achieve saturation. Faculty members were selected for an interview if they had one or more student-athletes who sustained a SRC in a course Fall 2018.

Do

There were 18 SRC reported August - October 2018 that impacted 28 individual faculty members at the institution. A total of 8 faculty members volunteered to be interviewed (males 3, females 5). All faculty members were given pseudonyms to maintain participant anonymity. Demographics on the faculty interviewed are illustrated in **Table 3**.

The purpose of the in-person interview was to determine the effectiveness of an educational presentation and brochure on concussion management and academic adjustments following the RTL from a SRC. Specifically, the aim was to assess faculty perceptions of whether the implementation of educational presentation promoted immediate changes in a classroom.

Study

The results of the interviews revealed four underlining themes; 1. The knowledge gain and transfer from the presentation and brochure, 2. Increased communication and positive impact for the students, 3. Barriers in implementing academic adjustments, and 4. Suggestions for future improvements.

Overall the faculty were pleased with the presentation and brochure. The majority thought that the education was eye opening when thinking about concussion and RTL. One faculty responded, "having the presentation in a handout so that individuals who are visual learners can follow along while the presentation is going can be helpful. Additionally, having the brochure available both in a paper format and a digital format to refer back to, whether that's an e-mail or on the website could be helpful for faculty for a quick reference."

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Figure 4. Baseline and post-survey faculty knowledge of concussion symptoms

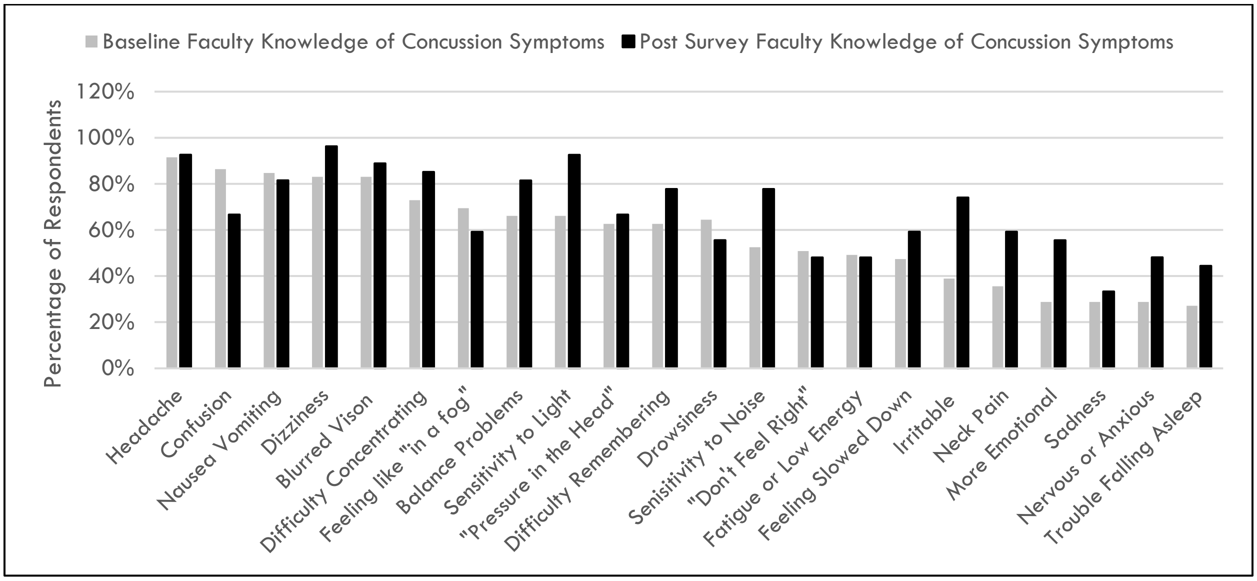

Figure 5. Knowledge of physical and cognitive signs and symptoms and return to learn at the initial survey and following the educational intervention.

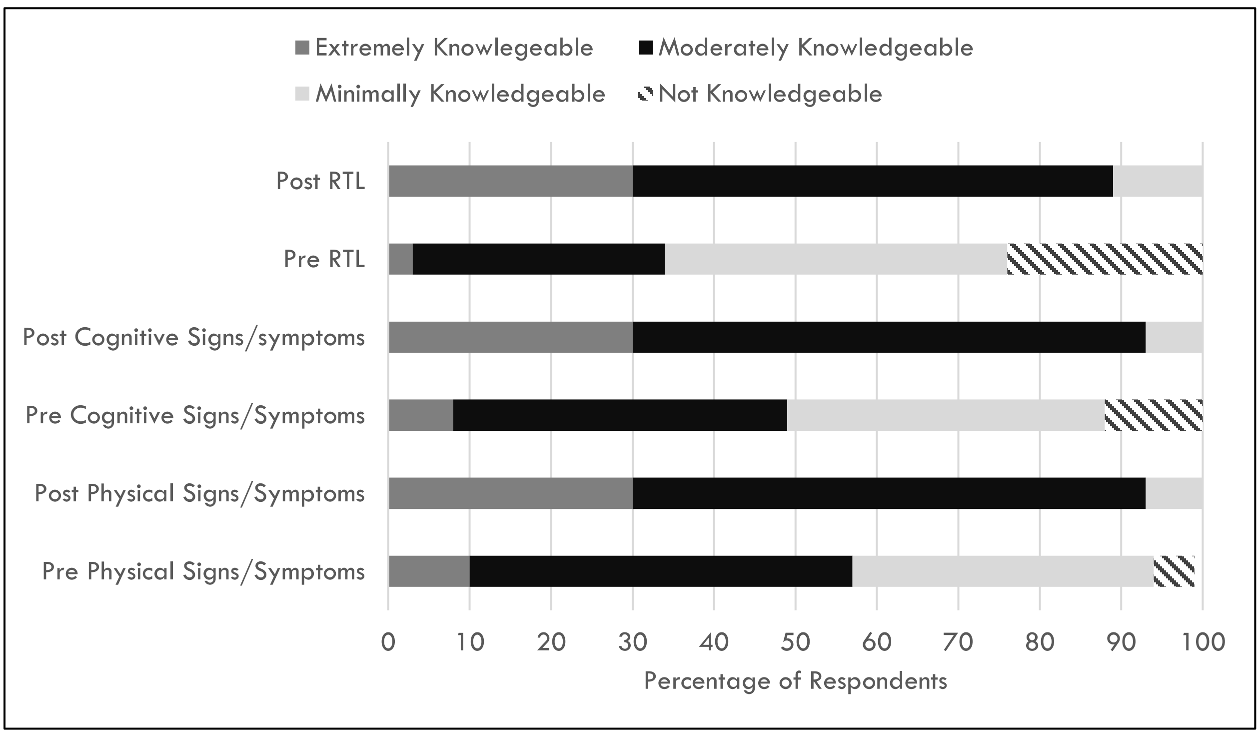

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Table 2. Interview Protocol Questions With Probes

1. Tell me a little about your background as a faculty member?
2. In what ways, if any, do you feel the presentation and brochure can be improved?
3. Did the concussion presentation and brochure change your perception about concussion in any way?
4. Do you feel that the concussion presentation and brochure had a positive or negative impact when a student returned to the classroom with a concussion? Please explain.
5. What concepts, if any, did you take from the concussion presentation and brochure that you implemented in your classroom with students returning to school from a concussion?
    a. Are there concepts you feel like you need more information on before you can implement?
    b. Are there any barriers preventing you from implementing adjustments into your classroom?
6. Do you feel that the communication has improved between various personnel when a student in you class has sustained a concussion?
    a. What about the return to learn process do you feel need to be improved?
    b. Do you feel there are ways to further improve the communication between personnel and student?
    c. Do you feel that you receive sufficient and timely information on the student who sustained a concussion as well as continued follow-up information throughout the process?
    d. Do you feel confident in the students Stage of RTL and the adjustments for the student each day?
    e. Is there anything that you would improve or change in the RTL policy or communication?
7. Are there any questions or topics I have not asked about that you would like to discuss?

Overall a majority of the faculty agreed they were more comfortable with making decisions in the classroom when one or more students returned following a SRC. The educational presentations made them more aware of the symptoms a student could experience in the classroom and the role of the faculty necessary for student with accommodations. Faculty recognized that small adjustments to the classroom such as; turning the florescent lights down, providing paper copies of the notes, and closing the door to decrease outside noise increased the student's attendance to class. One faculty states, "I think the biggest impact that I've benefited from is getting the update for each of my students so that if I have information that a student has to take short breaks, or if I need to dim the lights, or if a student has to wear sunglasses or a hat within the class to help them manage their symptoms."

Communication among medical personnel, faculty, staff, students, and administration was recognized as a barrier when students are injured or ill. Interview Question 6 focused on faculty perception of communication across the institution. All agreed that communication among faculty, the CMT, and students has increased this year. Faculty felt that students were being more proactive with their professors and notification of injury was being e-mailed with 24 hours of injury. Faculty were more aware of student injury and recognized the need to provide academic adjustments. Half the faculty agreed some sort of electronic information site would be helpful especially for faculty who only have 1 to 2 students return to their classroom following a SRC. One faculty agreed, "Communication has increased tremendously. We were getting nothing before. I didn't know who had a concussion. The new formula for getting those periodic reports is much improved." Most faculty agreed they were more aware of the student's injury and received timely updates on the students throughout the process; however, they were not confident about academic adjustments with all courses they teach and would like to see more information related to RTL.

All faculty members agreed the educational presentation and brochure had a positive effect on their ability to recognize the seriousness of concussion. One faculty responded "it helped more faculty members to realize that they needed to take concussion seriously. I think it helped to realize more of the symptoms that go with concussions, as well as some of the signs to look for. What I really appreciate is the increase in communication that's come from the CMT because now I know more about those students that have

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Table 3. Participants Demographics

Participant Pseudonym	Sex	Experience as a Faculty Member at Limestone	Primary Teaching Role	Method of Instruction
Julian Bailey	Male	1 year	Literacy library	On-line Classroom
Lora Lane	Female	7 years	Computer Science	On-line/Traditional
Vicky Perkins	Female	16 years	Athletic Training	Traditional Day
Cheryl Raines	Female	1 year	English	Traditional Day
Eva Moore	Female	5 years	English	Traditional Day
Sara Martin	Female	18 years	Biology/HS	On-line/Traditional
Alex Lamb	Male	6 years	Strength & Conditioning	Traditional Day

concussions as well as how they are progressing through the stages of RTL and RTP."

Half the faculty interviewed found at least one barrier to implementing academic adjustments in a classroom this year when a student returned following a SRC. Non-traditional courses that included science labs, discussion classes, activity classes, and on-line classes experienced that most difficulty with providing the student with academic adjustments necessary to attend classes.

Faculty agreed the educational presentation and brochure was a great first step to student success in the RTL following a SRC. However, the majority of faculty interviewed agreed it would be beneficial to have some sort of faculty resource page online they could refer to periodically.

Act

The faculty interviews revealed that communication had improved however, faculty are still not comfortable with classroom adjustments. Barriers to implementation included limited time and not knowing how to provide adjustments for course that are not taught as traditional day classes. Improvements for future PDSA cycles will include education on additional resources available for faculty that teach non-traditional courses such as discussion class, on-line classes, and science labs.

LESSONS AND LIMITATIONS

During the 40 weeks of this QI project there were several changes occurring at the institution. The inauguration of a new president and a complete football staffing change both took place mid-year in January 2018. Additionally, acrobatics and tumbling was added as a new NCAA sport for the Fall 2018 and the athletic training staff were in the process of transitioning from paper files and Sportswear to NExTT software system. One lesson that was learned was that the timing of the survey is extremely important to have a good response rate from the faculty. Unfortunately, the baseline survey was available to the faculty at a time when several other surveys were circulating through faculty e-mail. It also occurred at the end of the semester just before final exams.

Because faculty were not required to return to campus until the annual faculty staff meetings on August 16, 2018 the presentation was given after all Fall sport student-athletes had already been practicing. However, the presentation was held before the first traditional day courses started. Additionally, it was difficult to educate all faculty at one meeting because there are three methods of education at the institution; the traditional day program, on-line program, and off campus sites. Most of the student-athletes take courses in both the traditional day and on-line program. There were only a few problems with academic adjustments for the traditional day program in discussion based classes and biology lab. However, it was difficult to provide academic adjustments for students that took on-line course that required the student to use their cell phone or computer to complete all homework, assignments, projects, and exams for the course. This is an issue that is still not resolved especially when a student-athlete had prolonged symptoms beyond the two-week period.

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Finally, faculty attendance at the concussion presentation and acceptance and implementation of the new RTL policy may be a limitation of this project. Academic freedom in higher education protects the faculty in the classroom. Faculty have the freedom to express their views through speech, written, or electronic communication without reprimand. Academic freedom also protects faculty and students from punishment for disagreeing with administrative policies or proposals.[14] Faculty have the freedom to disagree with the new RTL policy for student-athletes returning to the classroom following a SRC. Fortunately, concussion and mTBI fall under the Americans with Disabilities Act which also protect the student.[15] Future education will provide faculty with additional long-term effects from SRC and the importance in providing students with academic adjustments as they recover. However, because of the high volume of stunt-athletes at the institution some faculty may become frustrated with the increased workload of accommodating a large number of concussed students.

CONCLUSIONS

Return to learn is still a relatively new addition to the concussion management plan with limited empirical evidence to support it. Although it is unclear if concussion education has sustainable long-term effects on knowledge, attitude, and beliefs, there have been short-term preliminary results of knowledge gains. This QI project identified a lack of a standardized CMP that included RTL. This QI project identified a lack of a standardized CMP that included RTL. This problem has been identified in the literature at other NCAA institutions and has led to an increase awareness and recognition for the importance of cognitive rest following injury as well as quick notification of injury and academic adjustments for successful student outcomes upon return to class.[3] At the college, this has hindered the development of a CMT, communication and notification to key stakeholders following injury, education about concussion to the staff, faculty, and administration, and proper academic accommodations necessary for student success. A *University Faculty Knowledge, Attitudes, and Beliefs about Academic Adjustments for Students with Concussion survey* was used initially to determine gaps with the faculty. Following the survey results a new CMP was drafted including a RTL plan. These changes were implemented in Fall 2018. In addition, an educational concussion presentation and brochure was provided to each faculty member. In October, 8 faculty members were interviewed to assess effectiveness of the educational concussion presentation and the user friendliness of the brochure and RTL plan in the classroom. Finally, a post-survey was provided to determine improvements in the QI project.

Return-to-learn is a relatively new term in concussion management of student-athletes. This QI project provides insight related to faculty knowledge, attitude, and beliefs about SRC and suggests that a short-term education intervention can influence the level of communication across the campus. By providing an effective policy and line of communication and minimal changes to the environment we saw a culture shift among student-athlete's faculty, and administration relationships related to classroom support. We are incorporating the new policy into daily practice and are sharing ideas and methods via e-mail, in-person, and during faculty meetings. During the 2018-2019 academic year there were a total of 58 SRC. These student-athletes will to be re-assessed in the 2019-2020 academic year and monitored for any classroom support still needed. This QI project will continue to educate faculty on SRC and student-athletes classroom accommodated. Further investigation could include evaluation of will look at improving student-athlete, athletic staff, and medical professional knowledge, attitude, and belief of SRC to improve the CMP with regards to the RTP and student success.

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Figure 3. Current SRC Flowchart

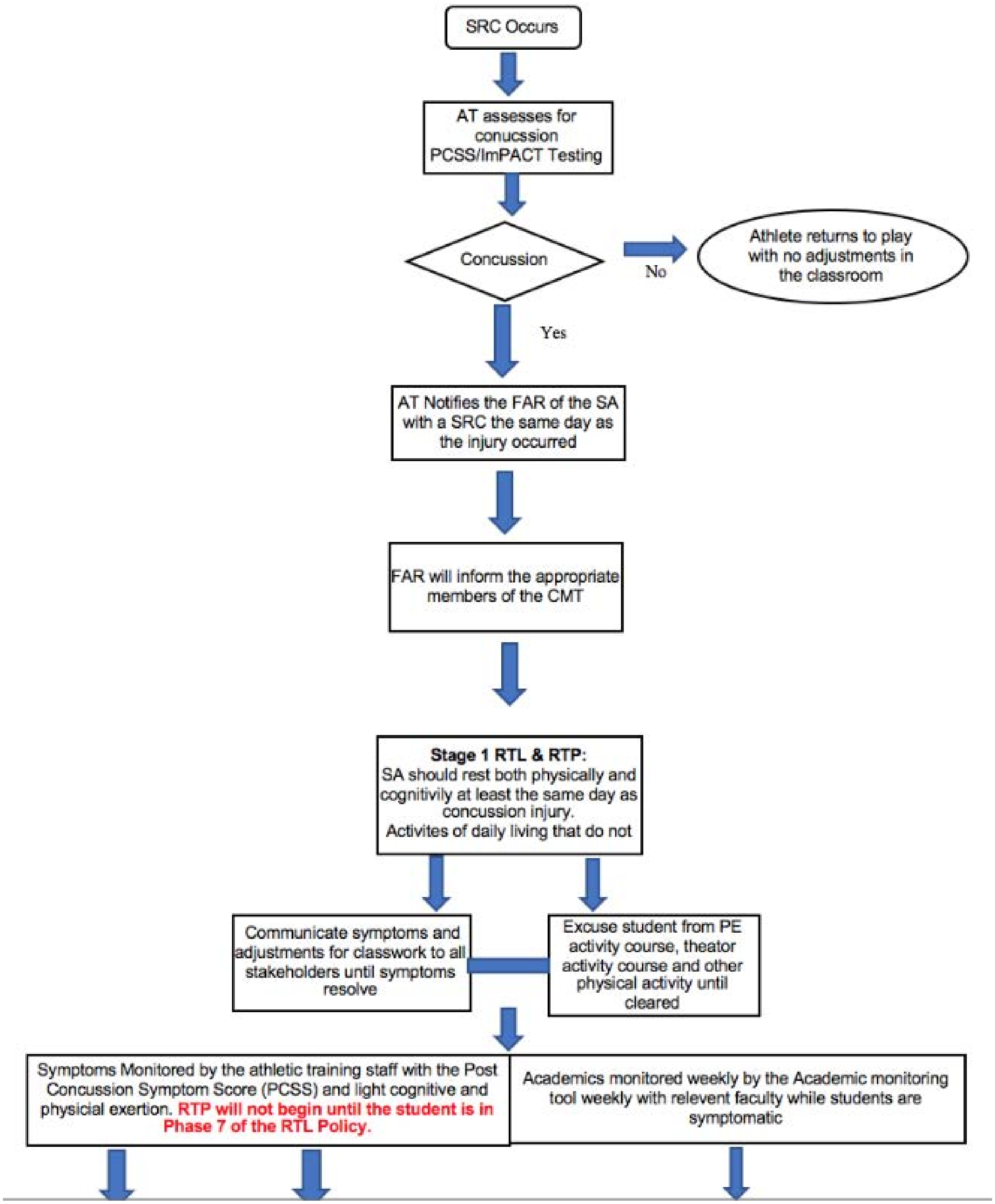

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Figure 3. Current SRC Flow Chart (cont.)

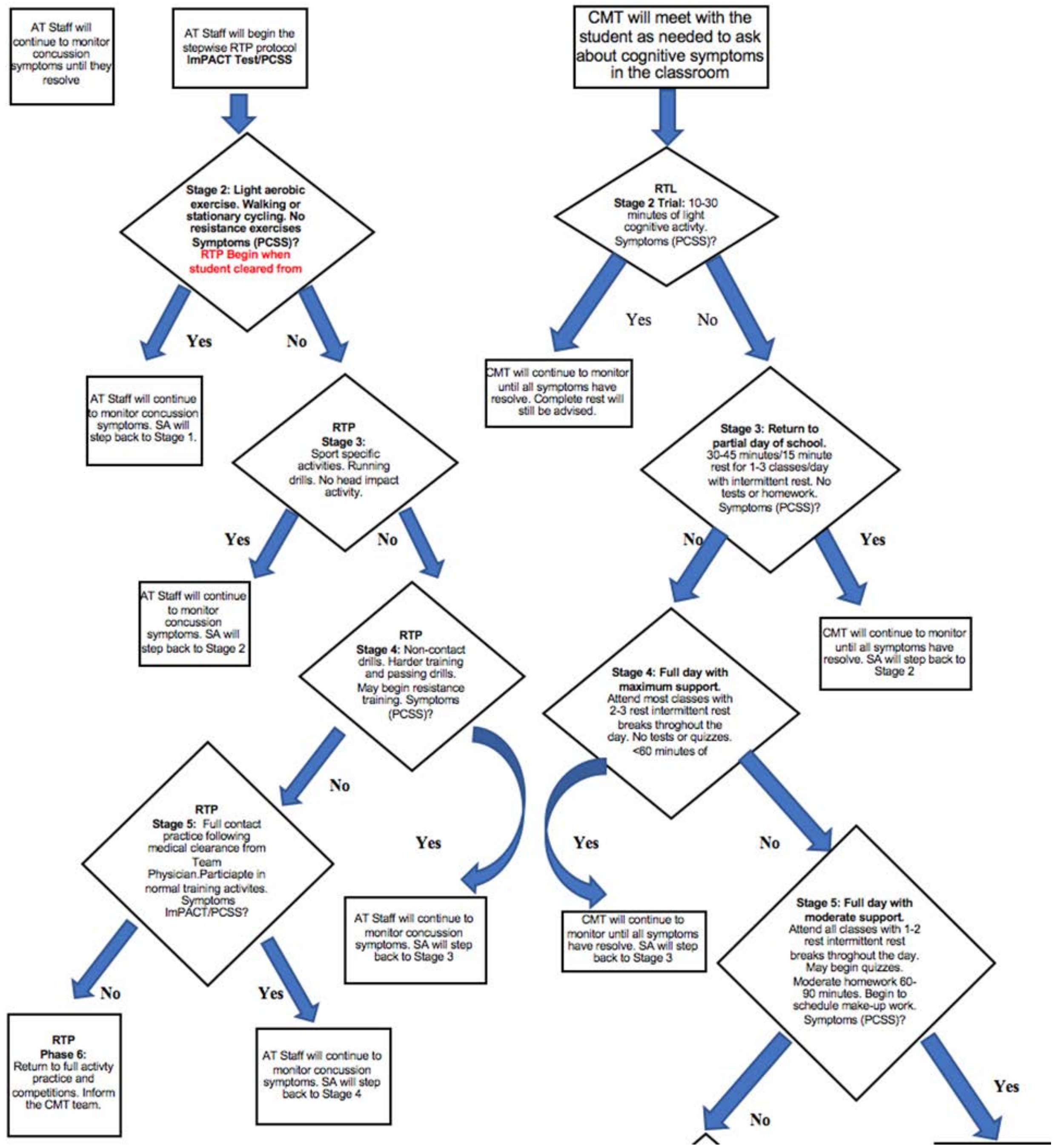
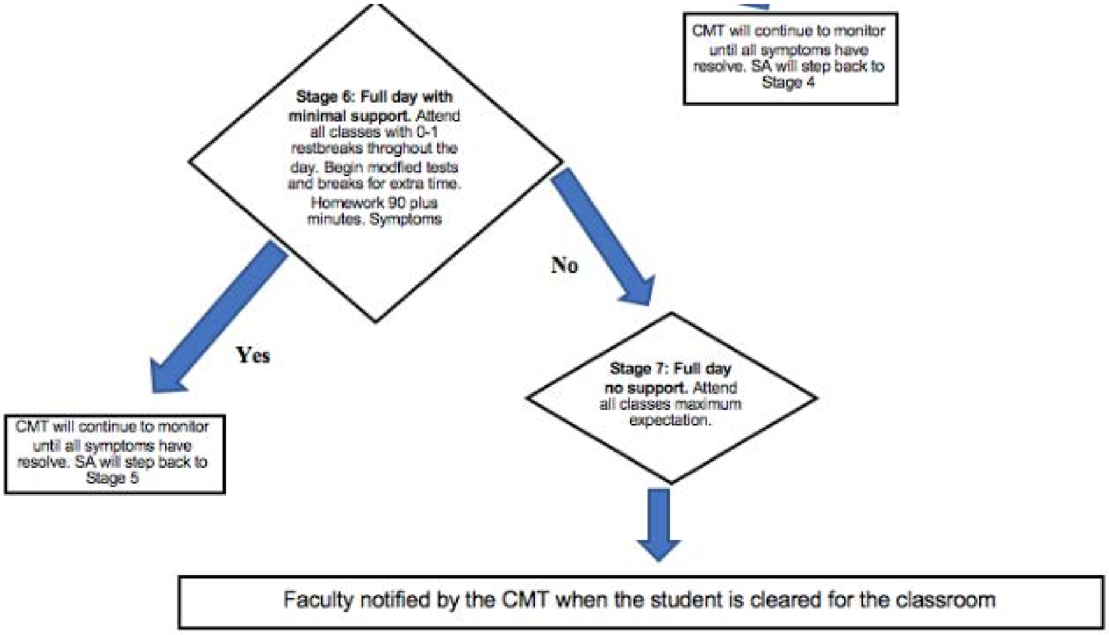


Figure 3. Current SRC Flow Chart (cont.)



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Point-of-Care Assessment at a Free, Out-of-Hours Orthopedic Clinic

Whitney M. Graves, DAT, LAT, ATC[1]; Zachary K. Winkelmann, PhD, SCAT, ATC[2]; Kenneth E. Games, PhD, LAT, ATC[1]
[1]Cumberland University, Lebanon, TN; [2]University of South Carolina, Columbia, SC; [3]Indiana State University, Terre Haute, IN

ABSTRACT

Access to healthcare is a challenge for many Americans living in rural communities. Hospital systems have created programs and developed models to improve access to care. However, documentation of the role of these clinics serving different populations and various types of communities is quite scarce. The purpose of this article is to describe the patient satisfaction and procedures assessed at the point-of-care during a 14-week, out-of-hours free orthopedic clinic in the Southeastern United States. One hundred and twenty-nine patients attended the orthopedic clinic and completed a patient satisfaction survey following their patient encounter. At the end of the 14-week, 89% (n=115/129) of the patients were highly satisfied with the staff and physician politeness and 100% (n=129/129) of patient encounters were highly satisfied with staff and physician professional manner. During this study, 72% (n=93/129) of patients reported that their injury and treatment plan was explained in an understandable manner, and 75% (n=97/129) of patient encounters reported that staff and physicians answered all of their questions in an understandable way. Of those surveyed, 95% (n=123/129) of patients reported that they were highly satisfied with the free clinic and the service that was provided. Overall, 96% (n=124/129) of patients reported that they would come back to the free, out-of-hours orthopedic clinic outside of just the fall football season. The point-of-care assessment described the number of x-rays taken, MRI's ordered, follow-up appointments scheduled, and potential revenue generated through surgeries scheduled during the 14-week time period. Moreover, the access to specialized sports medicine care has expanded to reach underserved populations such as pediatrics and those unable to miss work to seek healthcare. The results of this assessment have provided the orthopedic clinic staff and patients with data to support changes to improving patient-centered and low-cost healthcare visits.

Key Phrases
Clinic and Hospital Patient Population, Healthcare Economics (Value and Worth), Organizational and Personal Outcomes

Correspondence
Dr. Whitney Graves, Indiana State University, 3200 Belotes Ferry Road, Lebanon, TN 37087.
E-mail: wgraves@cumberland.edu
Twitter: @Whit_graves

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INTRODUCTION

In In the United States, a lack of insurance and underinsurance composes a significant national public health problem.[1] As of 2014, in the United States, 50.7 million individuals, 16.7% of the population, were uninsured and many more experienced barriers to obtaining health care.[1] Some of these barriers include: means/cost of transportation, lack of understanding with medical terminology, and wait time in the waiting room. Despite large gains in health coverage, some people continued to lack coverage, and the Affordable Care Act (ACA) remained the subject of political debate.[7] Attempts to repeal and replace the ACA stalled in summer 2017, but there have been several changes to implementation of the ACA under the Trump Administration that affect coverage.[7] In 2017, the number of uninsured rose for the first time since implementation of the ACA to 27.4 million.[7] Certain population subgroups have a low amount of health insurance coverage, including ethnic minorities, residents of southern and urban locations, and low-income households.[1] Specifically in the southern state of Alabama, 33% of its population is uninsured and the highest uninsured rate for the state is in southern Alabama near Birmingham.[2] There is a substantial need to provide health care for uninsured individuals in the United States and southern states such as Alabama in particular. Previous research has shown that one method to improve access to care is through free medical clinics, which has been cited to have high patient satisfaction feedback

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due to access to care.[3] At East Alabama Orthopaedics & Sports Medicine in Opelika, Alabama, the staff provided athletic training services to local secondary schools in the Lee County which includes Auburn, Alabama. Lee County, Alabama has a vast array of current socioeconomic status among residents with the 2016 median household income being $45,056 and predominantly White residents (67.9%).[4]

In the East Alabama Orthopaedics & Sports Medicine clinic, the patient panel is predominately lower and middle-class income status, and a high number of self-pay patients. According to the U.S. Census Bureau, the majority of patients seen in the East Alabama Orthopaedics & Sports Medicine clinic would be considered underserved. Opelika, Alabama is considered a rural area with about 15% of the population speak a language other than English. There is a 3.5% Hispanic population and 11.5% Korean population. About 15% of the population under the age of 65 has a disability, and about 15-20% of people under the age of 65 have no form of health insurance.[4] The poverty rate is at 30%. Twenty-three percent of the population for whom poverty status is determined in Lee County, AL (34,085 out of 148,121 people) live below the poverty line.[4] This number is higher than the national average of 14%. The largest demographic living in poverty is male between the ages of 18-24, followed by female between the ages of 18-24, and finally female between the ages of 25-35.[4] Additionally, the clinic serves an estimated 2,000 veterans from Lee County, Alabama. The cost of healthcare is sometimes a burden on the patients, and especially the student-athletes that the staff provides healthcare to. The student-athletes that we provide medical care make up a large percentage of the underserved community and often times these patients will not come in to see the physician to receive medical treatment due to the office visit or insurance co-pay costs. At East Alabama Orthopaedics & Sports Medicine, a patient's continuity of care is a concern as some patients abandon care due to outstanding balances or them not having the funds to come in and see the doctor.

East Alabama Orthopaedics & Sports Medicine clinic currently has a free orthopedic clinic outside of business hours. The facility serves patients on Saturday mornings outside of the normal clinic hours for 2-4 hours during the fall school semester as it aligns with football season. A typical patient load during one Saturday session is 20 to 25 student-athletes. The free orthopedic clinic runs for 14-weeks beginning the first Saturday following the start of football season and ending the Saturday after the Alabama state championship football game. The services provided at the orthopedic clinic include diagnostic imaging (x-rays), bracing, scheduling of MRIs at East Alabama Orthopaedics & Sports Medicine, full orthopedic evaluations, and concussion assessment. These services are provided and performed at no cost to the student-athlete or their family regardless of insurance status. The staff for the free orthopedic clinic included two orthopedic surgeons, one sports medicine physician with training in neurology, seven athletic trainers, an outreach coordinator, and administrative personnel. The staff was paid as part of their contracts for their services meaning that there were no upfront or recurring costs for stipends or salaries. Currently, the out-of-hours free orthopedic clinic lacks any form of patient survey or satisfaction assessment regarding the services provided from the staff. As such, the purpose of this point-of-care assessment was to explore the patient satisfaction, access to sports medicine services, and potential cost-benefit for the community.

METHODS

Prior to the start of the 2018 football season, the lead athletic trainer for the free, out-of-hours orthopedic clinic implemented a patient satisfaction survey for patients to complete following their visit. The patient satisfaction survey consisted of five questions measured using 5-point Likert scale with one additional yes/no item. This six-question instrument aimed to determine each patient's perception of the following constructs: (1) politeness and professionalism of personnel, (2) explanation and understanding of injury and

Table 1. Patient Satisfaction Survey

Question
Were our personnel polite and courteous?*
Did our personnel take care of you in a professional manner?*
Did we explain your injury and treatment plan in an understandable manner?*
Did we answer all of your questions in an understandable way?*
Overall, how satisfied were you with the free service you received from us?*
Would you come to a Saturday morning clinic outside of football season? #

* = Measured using Likert scale of 5=Highly Satisfied, 4=Satisfied, 3=Adequate, 2=Unsatisfied, 1=Very Unsatisfied, # = Yes/No item

treatment, (3) satisfaction of the free orthopedic clinic, and (4) if the patient would seek healthcare again from the facility. **Table 1** provides the items from the patient satisfaction survey.

Throughout the 14-weeks that the free orthopedic clinic was open, the lead athletic trainer administered a paper survey to each patient as they checked out. The patient satisfaction assessment was collected anonymously. Once the patient completed the survey, the patient placed their survey into a locked drop box near the exit of the East Alabama Orthopaedics & Sports Medicine clinic. This survey was given and completed by 129 patients. Following the 14 week data collection period, the lead athletic trainer compiled patient responses from the survey using Microsoft Excel. Concurrently, the lead athletic trainer also tracked all patient data and procedures during the office visit that the patient received. The patient data and procedures included the (1) reason for office visit, (2) body region being evaluated, (3) type of evaluation, (3) evaluation complexity, (4) radiographs taken, (5) MRI ordered, (6) surgery scheduled, (7) follow-up appointment scheduled, and (8) if the patient was a football player or non-football player. Upon completion of collecting patient data and procedures, along with the satisfaction surveys, the leader athletic trainer analyzed the data and compiled the findings for a presentation to physicians and East Alabama Orthopaedics & Sports Medicine stakeholders.

RESULTS

The study consisted of male and female middle to high school aged patients who participated in football, cheer, volleyball, tennis, and baseball. The major body regions evaluated during the data collection period were knee and shoulder. There were 121 musculoskeletal-based encounters and seven reported concussions. Overall, the majority of evaluation complexity that each physician documented was considered moderate level. Medicare defines an evaluation complexity of moderate level as face to face time spent with a patient requiring 20-25 minutes of care.[6] Ninety-six radiographs were taken in the clinic and thirty-three patient encounters required an MRI to be ordered. Ninety-four encounters deemed a follow up appointment was necessary and 38 re-check evaluations were documented. Seven surgical procedures were generated during this time frame.

Overall, the results from this study presented a positive effect and an increase in the number of radiographs taken, MRI's ordered, follow-up appointments made, and surgeries each physician obtained during that time period compared to not having a Saturday non- business hours clinic. The results also showed that overall patients were highly satisfied from the healthcare they were

Table 2. Procedures Performed During the Free Clinic

Procedure	Count	Cost	Total Costs Saved
Initial evaluation			
Low	0	$50	$ 0
Moderate	72	$75	$5,400
High	17	$100	$1,700
Re-Evaluation			
Low	0	$50	$ 0
Moderate	36	$75	$2,700
High	2	$100	$200
Radiographs taken	96	$50 - $100	$4,800 - $9,600

receiving. The patient satisfaction survey results identified that 89% (n=115/129) of patient encounters were highly satisfied with staff and physician politeness, and 100% (n=129/129) of patients were highly satisfied with the AT and physician professional manner. 95% (n=123/129) of patients reported that they were highly satisfied with the free injury clinic and services that were provided. Overall, 96% (n=124/129) of patients reported that they would come back to a Saturday morning clinic outside of the fall football season.

Moreover, the clinic potentially saved patients anywhere from $9,400 to $14,200, or $75 to $113 per patient (n=125).This was based on clinic procedure fees. In addition, the out-of-hours clinic could serve as a revenue stream for East Alabama Orthopaedics & Sports Medicine through referrals. In order to analyze if the free services performed to potential revenue from follow-up appointments, we calculated the potential revenue using the East Alabama Orthopaedics & Sports Medicine clinic costs for an MRI, surgical procedure, or a follow-up appointment in the clinic. In total, East Alabama Orthopaedics & Sports Medicine generated $32,900 to $39,900 from the 94 patients, or $350 to $424 per patient. To present this data to stakeholders, a cost-benefit ratio is recommended. For the specific out-of-hours clinic, a total benefit per patient on the low end of procedure fee estimate would be $350 and the cost was $75 which gives a positive benefit-to-cost ratio of 4.667.

We calculated this cost-benefit ratio by dividing the total benefit per patient (low end- $350) by the cost ($75). **Table 2** and **Table 3** provide details related to the procedures performed during the period, and the follow-up services scheduled with the potential revenue generated for East Alabama Orthopaedics & Sports Medicine, respectively.

CLINICAL APPLICATION

Providing patient-centered care is one of the most important things we can do in health care. The patient has options and can choose where to seek services to meet their healthcare needs. Measurement and understanding of the patient, caregiver, and family experience of healthcare provides the opportunity for reflection and improvement of healthcare and patient outcomes. Often times we, as healthcare providers, seem to forget what is really important for patient satisfaction. It is vital to review and reflect on Picker's Eight Principles of Patient-Centered Care in relation to our own practice.[5] It is important to involve patients in decision making, recognizing they are individuals with their own unique values and preferences.[5] Proper coordination of care can alleviate patients feeling vulnerable and powerless in the face of an illness or injury[5] In healthcare, patients expressed their worries that they were not being completely informed about their condition or prognosis. [5] Physical comfort will come after healthcare providers enhance patient education and information.[5] The level of physical comfort that patients report has a significant

Table 3. Potential Revenue for Follow-Up Appointments

Procedure	Count	Cost	Potential Revenue
MRI	33	$500	$16,500
Surgical procedure	7	$1,000 - $2,000	$7,000 - $14,000
In Clinic Appointment with Physician	94	$100	$9,400

impact on their experience with us as providers. Providing accommodation for family and friends and involving them in the decision-making process can enhance patient care and ease the overall patient experience for everyone. Providing patients with understandable information regarding medications, ongoing treatment, physical limitations and access to physical or financial support will supply patients a better continuity and transition to care. Finally, patients need to know they can access care when it is needed.[5] The ease and availability of scheduling appointments, accessibility to specialists and providing clear instructions on how and when to get referrals are all great examples of how we can enhance patients access to care.

Gaining a better understanding of patient satisfaction, while measuring actual care provided our clinic with greater insight on what areas of patient care need to be strengthened and what areas of patient care we are excelling in. After reflecting on Picker's Eight Principles of Patient Centered Care and our patient satisfaction survey results that was completed in this study, we were pleased to see that our clinic was on the right tract for providing optimal patient centered care. This project has opened opportunities to reach the underserved population, student athletes, and working men and women who cannot get away from their job during the Monday thru Friday work week; and also allow for quality healthcare visits. The result of the cost-benefit ratio demonstrates that the potential revenue generated from 75% (n=94/125) patients (age 18-24) that referred to the East Alabama Orthopaedics & Sports Medicine clinic for follow-up services will be greater than any "lost" costs incurred by offering the out-of-hours free clinic. As such, the clinic has not only brought a reduced healthcare option to the student-athletes in the county, it also provides a valuable revenue stream to the clinic. In addition, the gains from this project has demonstrated that East Alabama Orthopaedics & Sports Medicine provides an experience that is highly satisfied by the patients.

After compiling all of the data, the report was presented to East Alabama Orthopaedics & Sports Medicine stakeholders and physicians. During the presentation, the possibility of extending the free Saturday morning clinics beyond the football season was proposed. During the collaborative discussion, the stakeholders and lead athletic trainer discussed the pros and cons of an extension of providing the out-of-hours clinic during the spring and summer months. After reviewing the results and patient satisfaction responses, the group came to an agreement that the community would greatly benefit from extending the out-of-hour clinic services, while providing East Alabama Orthopaedics & Sports Medicine an opportunity for community outreach. The increased volume of patients from opening a clinic on Saturday also increases the surgical load and patient visits for physicians, which in turns increases potential revenue to the clinic. We do acknowledge that there are still barriers to care for patients with no insurance regarding follow-up care. Future research should look at different models to continue follow-up patient care for those with no insurance in order to better educate clinics on how to provide the best patient centered care for this population. We suggest that clinics providing outreach and per diem athletic training services consider creating an out-of-hours clinic using a similar model to improve the access to care for the population, which improves the chance that patients come back for further care in turn generating in increased revenue stream.

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Graston Technique® as a Treatment for Patients with Chronic Plantar Heel Pain

Troy R. Garrett, EdD, LAT, ATC, EMT[1] & Peter J. Neibert, PhD, LAT, ATC[2]
[1]University of Northern Iowa, Cedar Falls, IA; [2]Dixie State University, St. George, UT

ABSTRACT

Use of Instrument-Assisted Soft Tissue Massage has increased in popularity, and the plantar fascia is a superficial tissue that may benefit from this treatment. The objective of this study was to determine the effectiveness of Graston Technique® (GT) for decreasing pain and increasing function in participants with chronic plantar heel pain over a six-week period. A single blind, pretest-posttest control/comparison group design, with a sample of 22 adults (5 males, 17 females) was utilized. Participants were assigned to three groups: GT/stretching, effleurage/stretching, and stretching only. After completion, effleurage/stretching and stretching only groups were later offered GT with posttest scores recorded. Participants were pretested/posttested using the Foot Health Status Questionnaire (Foot Pain, Foot Function, and General Foot Health), McGill Pain Questionnaire, and Visual Analog Scale. A posttest Kruskal-Wallis analysis between the three groups demonstrated a significant difference of the Visual Analog Scale between the GT/stretching and effleurage/stretching groups. From pre to posttest, Wilcoxon Test resulted in GT/stretching group significantly improving in 4 out of 5 variables, with effleurage/stretching significant in 1 out of 5, and stretching only demonstrating significance in 3 out of 5. Friedman's Test for effleurage and stretching only groups resulted in significant differences in all the variables when GT was later administered. The mean differences between pre and posttest for the groups demonstrated a minimal important difference of 4 out of 4 variables for GT/stretching, 2 out of 4 variables for effleurage/stretch, 2 out of 4 variables for the stretching only group. Participants improved in variables measured over a six week treatment of GT. This was both shown to be not only statistically significant, but clinically significant utilizing minimal important difference.

Key Phrases
Instrument assisted soft tissue massage, chronic plantar heel pain, manual techniques

Correspondence
Dr. Troy Garrett, University of Northern Iowa, 2351 Hudson Road – HPC 008A, Cedar Falls, IA 50614-0244
Twitter: @tgarrettatc

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INTRODUCTION

Chronic plantar heel pain (CPHP), previously referred to as "plantar fasciitis", is one of the most common causes of heel pain, accounting for approximately 11-15% of all foot disorders.[1] CPHP typically results from repetitive micro trauma or excessive overload to the fascia.[1] Individuals most prone to this condition are middle-age women,[2] and those with high body mass index.[2] CPHP has been shown to have a negative impact on foot health and overall quality of life resulting in functional disabilities.[3]

Historically, CPHP has been described as a painful heel with inflammation of the plantar fascia at its origin.[1] In recent years, research has suggested that plantar heel pain is rather a non-inflammatory degenerative fasciosis.[4] Snider et. al, [5] conducted histological examinations of surgical biopsy specimens and found degenerative tissue markers such as collagen necrosis, angiofibroplastic hyperplasia, chondroid metaplasia, and matrix calcification. Others observed similar findings on histological examination such as, "marked thickening and fibrosis,"[6] and "fiber fragmentation in association with myxoid degeneration."[4] However, no markers for inflammation were found in these studies.

Numerous interventions have been utilized for treatment of CPHP, which include, heat,[7] cryotherapy,[7] non-steroidal anti-inflammatory drugs,[7] heel pads/cups,[8] night splints,[9] low-dye arch taping,[10] plantar fascia specific stretching,[11] calf stretching,[12] steroid injection,[13] extra-corporeal shock wave therapy,[14] platelet-rich plasma injection,[13] and myofascial trigger point therapy.[15] Unfortunately, not all patients experience a resolution of symptoms following these treatment interventions.

In recent years instrument assisted soft tissue massage (IASTM) has grown in popularity and usage among clinicians working with active populations.[16-21] It has been hypothesized, for degenerative tissue conditions such as tendinosis and fasciosis, that IASTM reinitiates the inflammatory response by creating controlled microtrauma in the affected tissues.[16,22] It has been further hypothesized that this controlled microtrauma to degenerated tissue ultimately results in tissue maturation and remodeling.[16,17,23-26]

While numerous case studies have been published regarding the GT (Indianapolis, IN) with chronic degenerative disorders, [16,18-21] there is only one case series study of plantar heel pain on multiple participants.[23] The effectiveness of IASTM on CPHP has not, to our knowledge, been studied in a randomized group design. Therefore, the purpose of our study was to determine the effectiveness of instrument-assisted soft tissue mobilization, specifically the GT (GT), for the treatment of patients suffering from CPHP. We hypothesized that GT would be more effective at decreasing foot pain and increasing foot function with patients suffering from chronic plantar heel pain when compared to a placebo and stretch only protocol.

PARTICIPANTS

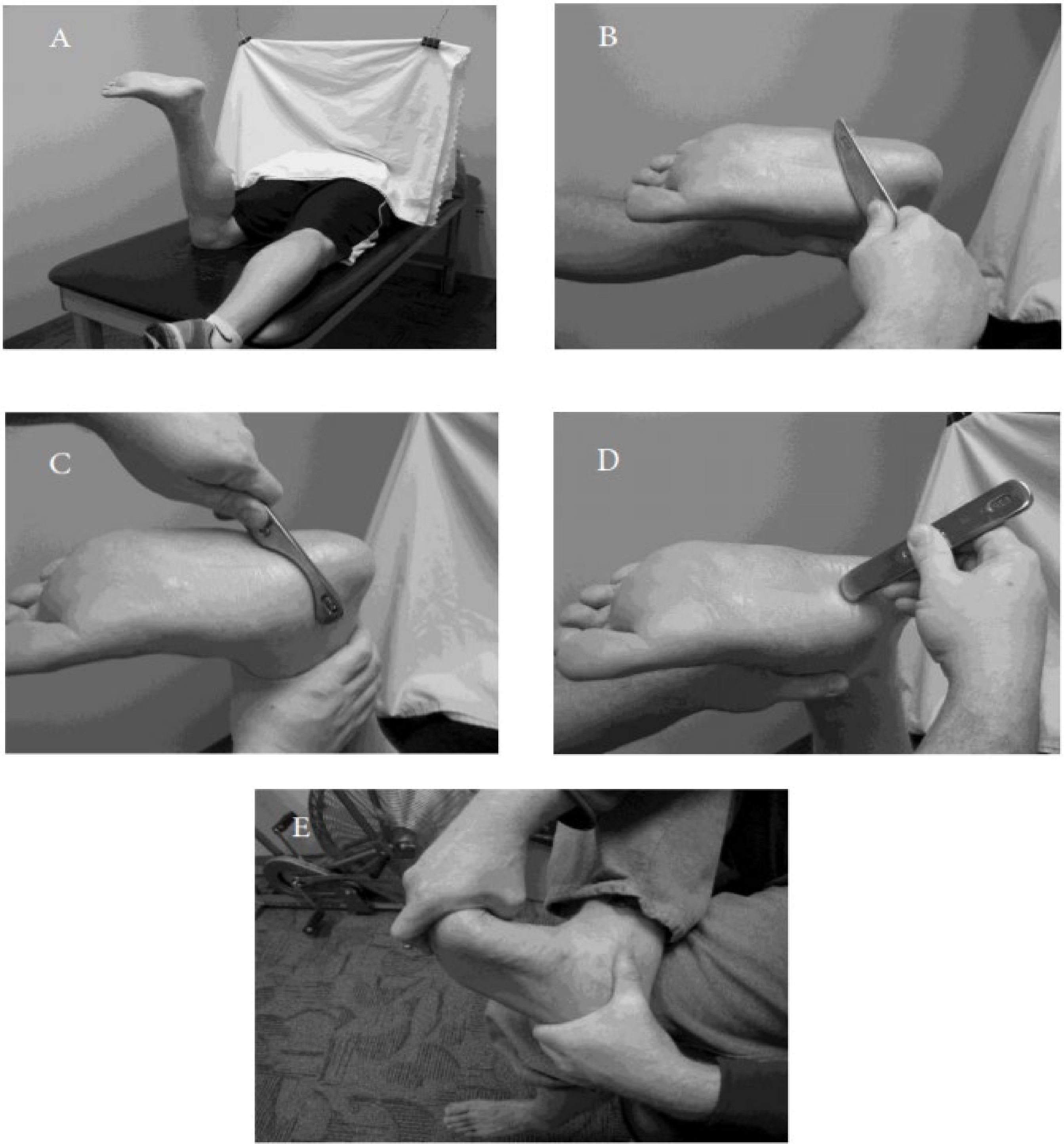
Following Institutional Review Board approval, volunteers were recruited for a period of 10 months. Of the 44 patients screened, 28 met the inclusion criteria and agreed to participate (**Figure 1**). Overall, 7 men and 21 women with CPHP symptoms (age = 46.45 ± 12.5 years, Body Mass Index = 30.45 ± 6.13) were enrolled. Four participants discontinued intervention, due to scheduling conflicts (n=2) and due to not tolerating the GT (n=2). Also, two participants (n=2) were later excluded from the analysis because they were later diagnosed with a pathological bone spur of the calcaneus, therefore, they were deemed ineligible for inclusion in the study. Of the remaining 22 participants, 7 were assigned to the GT/stretching group (2 males and 5 females, 48.5 ± 13.8 years), 7 were assigned to the effleurage/stretching group (2 males and 5 females, 44.6 ± 13.3), and 8 were assigned to the stretching only group (1 male and 7 females, 46.1 ± 10.4 years).

Individuals were included in the study if they had a physician (M.D., D.O., or D.P.M.) clinical diagnosis of CPHP that resulted in pain and discomfort for at least 3 months; with no corticosteroid injections within 30 days of participation. Individuals were excluded from participation if they reported having a history of diabetes; pathological bone spurs of calcaneus; any past plantar fascia release surgery; or any acute plantar fascia injuries. Cancer, burn scars, rheumatoid arthritis, polyneuropathies, chronic regional pain syndrome, or other conditions known to be contraindications to GT also resulted in exclusion from the study.[22]

INTERVENTIONS

Carey et al[22] states that the basic components of the GT are: (1) 3-5 minutes of active warm-up, (2) 8-10 minute GT treatment, and (3) specifically targeted tissue stretches. For the warm up, the participants were placed on a stationary bike, then asked to cycle for 5 minutes, at a comfortable pace appropriate to their level of fitness prior to the treatment intervention. Participants then removed the shoe and sock of the involved foot and assumed a prone position on the treatment table. A drapery was attached to wires hanging from the ceiling between the levels of the waist to mid-thigh to ensure visual blinding to the treatment (**Figure 2A**).

Figure 2: (A): Blinding of the participant during interventions. **(B)** GT instrument #4. **(C)** GT instrument #2. **(D)** GT instrument #3. **(E)** Plantar Fascia Sp ecific Stretching as defined by DiGiovanni et. al.[1]



The knee of the involved foot was flexed to 90°, while the investigator supported the ankle proximal to the malleoli, maintaining the ankle in a neutral position. GT emollient (Indianapolis, IN) was applied to the plantar surface of the foot for all participants. For the GT/stretching group, one of three certified athletic trainers (ATC) level M1 certified Graston Technique® providers (years of GT experience = 4.17 ± 2.02) performed a predetermined protocol of: 4 minutes of GT instrument #4 (**Figure 2B**), the large convex instrument; 3 minutes of GT instrument #2 (**Figure 2C**), the medium concave instrument; and 3 minutes of GT instrument #3 (**Figure 2D**), the small convex instrument, for a total of 10 minutes. All certified providers were instructed to provide pressure to the participants comfort level, while performing sweeping strokes from anterior to posterior and posterior to anterior[22] from the calcaneus to the metatarsal heads of the plantar surface. Participants were monitored and encouraged to report if the treatment was too painful or caused a high level of discomfort. Treatment was focused on areas where adhesions were discovered through the GT instruments. When using GT instruments, if adhesions are detected, a vibratory sensation is felt by the clinician.[22]

The effleurage/stretching group participants were placed in the same prone position following the warm-up. However, after the emollient was applied, the investigator provided light touch effleurage with the fingertips, from the calcaneus to the metatarsal heads, for 8 minutes. Investigators were instructed that the effleurage was to be very light for sensory effects and not deep enough to cause mechanical effects to the tissue. For the stretching only group, participants were placed in the same position. Emollient was lightly applied for 10 seconds, the ankle was held in the same neutral position for 8 minutes without any additional contact to the plantar surface. A towel was used to remove the emollient at the end of the timed treatment for each group.

Each session, for all participants regardless of treatment group, was concluded with plantar flexion specific stretching as described by DiGiovanni et al.[11] The participant assumed a seated position, crossed the involved foot over the uninvolved leg, stabilized the calcaneus with the contra-lateral hand, and stretched the plantar fascia by forcibly extending the toes at the metatarsal heads with the ipsilateral hand (Figure 1E). The investigator confirmed successful stretching by verifying tautness of the medial plantar fascia. Participants performed 10 stretches holding each for 10 seconds.[11] Participants were scheduled for 11 more sessions (2 per week, not on consecutive days). All the participants were instructed not to perform any additional plantar fascia specific stretching outside of their scheduled treatment sessions. This information was repeated after each treatment session. In addition, patients were told there were no restrictions in physical activity or activities of daily living.

At the end of the 12th session all participants completed posttest survey instruments of the Foot Health Status Questionnaire, McGill Pain Questionnaire, and Visual Analog Scale. Participants of the effleurage/stretching and stretching only groups were offered the investigative GT treatment for another 12 sessions as the GT/stretching group, with 12 out of 15 eligible participants electing to receive the treatment. Of the three that declined, two had no interest in receiving GT, one later voluntarily discontinued. This group of (n=12) received a second round of posttest survey outcome measurement after the 12th GT session.

PROCEDURES/OUTCOME MEASURES

This study was a single blind, randomized pretest-posttest control/comparison group design, in which individuals with CPHP were randomly assigned to one of three interventions: (1) GT of plantar fascia plus plantar fascia specific stretching (Graston/stretching); (2) effleurage of the plantar surface of the foot plus plantar fascia specific stretching (effleurage/stretching); (3) and the only stretching group (received no treatment) plus plantar fascia specific stretching (stretching only). Participants underwent 2 treatment sessions a week (not on consecutive days) for 6 weeks, totaling 12 sessions. The Foot Health Status Questionnaire, McGill Pain Questionnaire, and Visual Analog Scale were administered before and after the 6 week intervention for all 3 groups. After the posttest, the effleurage/stretching and stretching only groups were offered the investigative treatment in the same manner as the Graston/stretching group for an additional 6 weeks. The independent variable was treatment type, with gender being controlled by randomization. The dependent variables were foot function, foot pain, and general foot health (from the Foot Health Status Questionnaire) and also foot pain of two other instruments (McGill Pain Questionnaire and Visual Analog Scale).

Participants were recruited from local podiatry clinics and by a university-wide online advertisement. Four local podiatry clinics with 8 doctors of podiatry provided letters of support for this study. Patients with a clinical diagnosis of CPHP were given an envelope with an enclosed recruitment flyer including the contact information of the investigators. Potential participants were instructed to contact the investigators if they were interested in participation. Upon making contact, a telephone interview was conducted to determine if inclusion and exclusion criterion were met.

Following the telephone interview, participants were scheduled to meet an investigator at the athletic training research laboratory, where the: consent form, list of contraindications, and a medical release form (to verify CPHP diagnosis) were signed. Specific information such as treatment interventions, full design of the study, and to which group assigned was withheld from the participants during the screening process and throughout the treatment intervention phase of the study. Initial pretesting survey outcome instruments consisting of the Foot Health Status Questionnaire, McGill Pain Questionnaire, and Visual Analog Scale were completed.

Foot Pain, Foot Function, and General Foot Health were utilized. Foot Health Status Questionnaire scores were calculated using the Foot Health Status Questionnaire Data Analysis Software© (Version 1.03). Numerous sources have shown strong content validity and reliability, with Cronbach α ranging from .85 to .88[28] with appropriate factorial structure and high internal consistency and test-retest reliability, ICCs ranging from .74 to .92,[28,29] with specific sensitivity to patients with CPHP.

The McGill Pain Questionnaire long form consists of 20 groups of words describing pain, with the participant circling the word in each subsection that best applies and then an ordinal ranking score is tabulated.[30] The range of the total McGill Pain Questionnaire score is 0 for “no pain” and 76 being the maximal score for the “worst pain”. Test-retest reliability of multiple studies report a correlation of $r > .70$.[31]

The Visual Analog Scale is a 10 cm line that states “No Pain” on the left, and “Worst Pain Imaginable” on the right. Participants are instructed to make a vertical mark on the scale best describing their pain within the last 24 hours. The score is measured from the distance from the left border to the vertical mark in millimeters. Visual Analog Scale scores were tabulated by an individual independent of the study measuring the distance from the left (no pain) to the vertical mark made by the subject in millimeters. Test-retest reliability has been reported as high as r=.94, with correlations ranging from .61 - .92 when compared to pain scales using words for validity.[32]

Landorf and Radford[33] examined the minimal important difference (MID) which is defined as the amount of improvement needed that was deemed important to the patient, for the Foot Health Status Questionnaire and Visual Analog Scale, specifically for patients with 'plantar fasciitis.' For the Foot Health Status Questionnaire, the minimal important differences were reported as: 14 for Foot Pain, 7 for Foot Function, and 9 for General Foot Health. For the Visual Analog Scale, 9 millimeters of improvement was reported as the minimal important difference.[33] MID data for the McGill Pain Questionnaire has not been reported in the literature.

Statistical Analysis

Non-parametric tests were utilized to analyze the data. A Kruskal-Wallis test was conducted to determine differences between the three treatment groups at pretest, and later at posttest. Any significant differences was analyzed with a Mann-Whitney U test. Within group differences between pretest and posttest for each of the five variables was calculated utilizing Wilcoxon Signed Ranks Test. Effleurage/stretching and stretching only group was computed together from pretest to posttest to post GT with Friedman's Test. Alpha was set at $P<0.05$ for all tests, with Post Hoc for Friedman's test having Bonferroni correction set at 0.0167.[34] All data were analyzed on IBM SPSS Statistics 24 (Chicago, IL).

RESULTS

To test for homogeneity between the groups, a Kruskal-Wallis test was conducted to analyze the pre test scores. There were no significant differences between the groups on all the dependent variables: Foot Pain $H(2) = 2.73$, $p = 0.25$, $r = .58$, Foot Function $H(2) = 1.16$, $p = 0.55$, $r = .24$, General Foot Health $H(2) = 0.95$, $p = 0.62$, $r = .20$, McGill Pain Questionnaire $H(2) = 1.47$, $p = 0.47$, $r = .31$, and Visual Analog Scale $H(2) = 1.90$, $p = 0.36$, $r = .40$. A posttest analysis between the three groups resulted in a significant difference with Visual Analog Scale $H(2) = 8.78$, $p = 0.012$, $r = 1.87$. Post Hoc Mann-Whitney test demonstrated a significant difference for Visual Analog Scale between the GT/stretching and effleurage/stretching groups ($p=0.011$).

Within groups significance was measured utilizing the Wilcoxon Signed Ranks test and are displayed in **Table 1**. Four of the five variables of the GT/stretching group were found to be significant. One out of 5 variables were significant for the effleurage/stretching group. The stretching only group was significant on 3 out of 5 variables. Mean differences within groups from baseline to posttest along with 95% CI and MID data are reported in **Table 2**.

The effleurage/stretching and stretching only groups were offered GT after the initial posttest, and 12 out of 15 participants received the treatment. Data for the two groups were combined, and Friedman's test was conducted between pretest (baseline), post effleurage or stretching only, and following the administration of GT. Data for Friedman's test is displayed in **Table 3**, as the combined effleurage/stretching and stretching only groups demonstrated significant differences after GT, utilizing the Bonferroni Correction level of significance.

DISCUSSION

The purpose of this study was to determine the effectiveness of instrument-assisted soft tissue mobilization, specifically the GT, for the treatment of patients suffering from CPHP. The results showed significant Kruskal-Wallis posttest

Table 1: Within Groups Baseline to Post Test Wilcoxon Signed Ranks Results.

Variable	Graston/stretching				Effleurage/stretching				Stretch only			
	Baseline mean±SD	Post mean±SD	Sig	Effect Size	Baseline mean±SD	Post mean±SD	Sig	Effect Size	Baseline mean±SD	Post mean±SD	Sig	Effect Size
Foot Pain	41.0±14.1	75.2±13.6	*0.028	0.58	27.5±16.3	40.3±32.0	0.173	0.36	47.4±27.7	59.2±27.0	0.26	0.28
Foot Function	58.9±23.6	91.9±8.6	*0.018	0.63	41.1±37.4	50.8±34.0	*0.042	0.54	53.9±21.6	72.6±27.1	*0.011	0.63
General Foot Health	40.0±28.2	65.4±26.4	0.058	0.5	26.8±39.2	31.1±39.4	0.414	0.21	38.1±33.1	29.1±29.5	0.144	-0.36
MPQ	29.6±10.3	13.4±9.7	*0.043	0.54	22.8±11.7	24.0±12.0	0.866	-0.04	28.8±18.1	15.5±11.5	*0.012	0.63
VAS	47.8±20.0	13.9±10.2	*0.018	0.63	63.1±18.7	63.7±31.6	0.865	-0.04	51.4±25.8	24.1±16.2	*0.017	0.59

* = $p<0.05$
Foot pain, foot function, and general foot health are categories of the Foot Health Status Questionnaire, where 100 equals optimal foot health.
MPQ=McGill pain questionnaire is scored with 0 being no foot pain and 76 as maximal foot pain.
VAS=Visual analog scale is scored with 0 being no foot pain and 100 as maximal foot pain.

Table 2- Mean Differences and 95% Confidence Intervals Between Baseline and Post-Test.

		Foot Pain	Foot Function	General Foot Health	MPQ	VAS
Graston Technique®	Mean	42.5	32.8	25	14.8	35
	(95%CI)	(11.9,58.1)	(12.5,56.25)	(-12.5,75.0)	(-2,29)	(13,54)
Effleurage	Mean	11.9	12.5	10.6	-0.75	-3.5
	(95%CI)	(-6.3,33.1)	-	-	(-17.0,12.5)	(-29,37)
Stretch Only	Mean	10.6	18.8	-16.3	13.3	27.3
	(95%CI)	(-12.5,39.1)	(12.5,28.1)	-	(4.5,23.0)	(7.5,46.5)
MID[33]		14	7	9	NA	9

MPQ=McGill Pain Questionnaire; VAS=Visual Analog Scale; MID=Minimal Important Difference. - = Calculation not possible due to small amount of differences between baseline and posttest (n<=5).

Table 3. Friedman Mean Ranks for Effleurage/Stretching and Stretching Only Groups with additional Graston/Stretching treatment (n=12).

	Pre Test 1 post hoc 1v2	Post Test 2 post hoc 2v3	Post Test 3 post hoc 1v3	Freidman sig
Foot Pain	1.46 (0.068)	1.71(0.004)*	2.83 (0.003)*	0.001
Foot Function	1.08 (0.001)*	2.08 (0.008)*	2.83 (0.003)*	0.000
General Foot Health	1.71 (0.496)	1.50 (0.005)*	2.79 (0.008)*	0.001
MPQ	2.75 (0.061)	2.17 (0.004)*	1.08 (0.002)*	0.000
VAS	2.58 (0.069)	2.33 (0.003)*	1.08 (0.002)*	0.000

*= Bonferroni Correction to 0.0167 level of significance. MPQ=McGill Pain Questionnaire; VAS=Visual Analog Scale

differences between the GT/stretching and effleurage/stretching groups with the Visual Analog Scale. Within group pre- post-test comparison revealed significant differences with the GT/stretching group in 4 out of 5 variables. The effleurage/stretching group showed significant differences in 1 out of 5 variables, and stretching only was significant with 3 out of 5 variables.

Additionally, we found a bimodal response utilizing the Minimal Important Difference (MID) as reported by Landorf and Radford[33], who report the MID of the scores for Foot Health Status Questionnaire and Visual Analog Scale for CPHP (14 points for Foot Pain, 7 points for Foot Function, 9 points for General Foot Health, and 9 points with the Visual Analog Scale). The GT/Stretching group exceeded the MID in all 4 variables that report MID data. Effleurage/Stretching group exceeded the MID with 2 out of 4 variables, and the Stretch only group also exceeded on 2 out of 4 variables.

The unexpected positive effects for the effleurage/stretching and stretching only groups may be a result of the plantar fascia specific stretching which was performed for all three groups. The GT Manual[22] recommends that a therapy session ends with a period of stretching the treated tissue. DiGiovanni[11] has reported benefits with plantar fascia specific stretching compared to Achilles stretching during an eight week program, which therefore may explain the improvements among all three groups. However, the effleurage/stretching and stretch only groups improved significantly with all measured variables utilizing Friedman's analysis (**Table 3**) after completing the GT regimen. Therefore, there appears to be a trend of improved outcomes when utilizing GT combined with plantar specific stretching for the treatment of CPHP.

To date, only one study[23] utilizing GT for CPHP with multiple participants, has been published. Their findings are similar to this current study, where they found significant improvement for pain and function from baseline to follow-up. However, due to the case series design and the lack of a control group, a cause-and-effect relationship could not be established. In addition, different outcome instruments, treatment durations, and stretches were used in the design of this study. Therefore, caution should be used when comparing Looney et.al.[23] with our results due to methodology differences, and comparing a case series to randomized comparison group design.

While there is limited published research using GT as a treatment intervention for CPHP, there are positive benefits[16,18-21] for the treatment of other chronic disorders. Sevier et al[19] reported improvements in function and pain when comparing a treatment intervention consisting of transverse friction massage, phonophoresis, stretching, and cryotherapy with a GT intervention for the treatment of lateral epicondylitis. In a case report of a 40 year old patient presenting with chronic Achilles tendinopathy, Miners and Bougie[21] reported improvements in self-reported pain and function following an 8 week intervention of GT, Active Release Techniques, eccentric exercise and static gastrocnemius/soleus stretching. One noticeable limitation of each of these case reports is the combination of several treatment modalities in the treatment of the patients. Therefore, it is difficult to determine if the GT was responsible for the improvements in pain relief and function. In a systematic review conducted by Cheatham et al[35] looking at the efficacy of IASTM as an intervention to treat various pathologies, they similarly concluded that a lack of treatment protocol homogeneity makes it difficult to determine the effects of IASTM in general. Cheatham et al[35] also report that no IASTM study has ever reported a significant difference between control or comparison groups and IASTM groups. In contrast, we found a post-test significant differences with the Visual Analog Scale between our GT/stretching and effleurage/stretching groups.

Schaefer and Sandrey,[18] examined the effects of GT in conjunction with a dynamic balancing treatment (DBT) program on outcomes associated with chronic ankle instability; they found no significant difference between the groups. The GT/DBT group demonstrated an increase in functional outcomes as did the other groups in the study. Thus, it appears that GT offers some benefit in the treatment of other chronic conditions in addition to this study with patients suffering from CPHP.

This study was limited by the small sample size (n=22). In addition, it was also limited by a lack of a repeated-measures design, therefore only an immediate follow-up after the intervention. Therefore, no long term results are known for our study population, including the rates of recurrence or a need for any additional intervention. The sample population represented the group that is most susceptible to chronic plantar heel pain, consisting of people of middle age with elevated body mass index, so our results may not represent young healthy athletes, and not patients with acute plantar fascia injury. The participants represented a population with an average age in the mid 40's with a body mass index averaging 28-30, which is above the obese range of greater than 25. It has been previously reported that a population of higher body mass index and over age 40 are more susceptible to suffering from CPHP.[2] The participants were not monitored for activity levels during the duration of the intervention. This study was also limited by the inequality of males (n=5) to females (n=17) as participants. The methods of this study limited the GT treatment to the use of 3 instruments with basic sweeping strokes. Future research needs to be completed regarding different GT strokes, different foot and ankle positions, and the use of more advanced GT techniques. Future research should also incorporate more objective instruments, such as plantar fascia thickness via diagnostic ultrasound to supplement the subjective scales.

CLINICAL APPLICATION

To our knowledge, this study is the first randomized pretest-posttest control/comparison group design investigating the use of GT plus plantar-fascia specific stretching as an intervention for CPHP. Consequently, our findings shed light on the use of GT as a potential treatment of CPHP. It is our recommendation that clinicians take a multifaceted approach to treating patients with CPHP which includes GT along with Plantar Fascia Specific Stretching[11] and other traditional treatment methods.[36] Future research should focus on multicenter randomized controlled trials incorporating IASTM specifically regarding CPHP.

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Treatment of Scapular Dyskinesis with Reflexive Neuromuscular Stimulation: A Case Report

Alli Z. Powell, DAT, AT[1] & Russell T. Baker, PhD, DAT, AT[2]
[1]Colorado Mesa University, Grand Junction, CO; [2]University of Idaho, Moscow, ID

ABSTRACT

Scapular dyskinesis is an abnormal movement of the scapula due to poor motor control of the surrounding musculature and can lead to other glenohumeral pathologies. The pathology results in the lateral tilting of the scapula during many glenohumeral joint movements and weight-bearing activities of the upper extremity (i.e., plank). The typical conservative treatment protocol focuses on strengthening surrounding musculature and is often a lengthy protocol. A weakness of strengthening protocols is the failure to address the motor function of targeted muscles at the level of the central nervous system (CNS) to restore dynamic stability and motor control. Reactive Neuromuscular Stabilization (RNS) is a novel treatment that targets the CNS to address motor control impairments to restore the normal muscular and joint stability and function. *Purpose:* The purpose of this case study was to demonstrate the efficacy and the outcomes of using RNS as a treatment for dysfunctions such as scapular dyskinesis. A 20-year-old female intercollegiate swimmer presented with significant mid-back pain that failed to resolve without treatment. The patient was diagnosed with scapular dyskinesis as well as presented with a number of postural concerns, trigger points, and pain with multiple activities. The initial protocol for treatment for this patient was a standard conservative treatment protocol focused on strengthening. After six weeks of treatment without improvement, the clinician modified care to include RNS. Following three treatments across seven days, the patient's symptoms decreased significantly and the patient met discharge criteria. At an eleven-month follow-up, the patient's improvements were maintained. The patient in this case report demonstrates the effectiveness of RNS while treating scapular dyskinesis and the importance of recognizing the cause of the dysfunction early within the evaluation.

Key Phrases
Diagnostic testing and physical examination, upper extremity, patient-reported outcomes, manual techniques

Correspondence
Dr. Alli Powell, Colorado Mesa University, 1100 North Ave. Grand Junction, CO.
E-mail: azeigel@gmail.com

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INTRODUCTION

Scapular dyskinesis (SD) is defined as irregular motion of the scapula.[1-2] Scapular dyskinesis is often evaluated visually by the clinician from a posterior view with the patient performing active glenohumeral (GH) motions.[1-5] The scapula provides stability to the GH articulation through the contraction of the surrounding muscles to centralize the rotation of the GH joint.[1-2] The position of the scapula adjusts to overhead activity by moving in the following motions: protraction, retraction, elevation, depression, and rotation. When the scapula fails to move synergistically with the GH joint, compensatory and dysfunctional movement patterns are created.[1] Most abnormal movement patterns of the scapula have been suggested to result from poor functioning of the stabilizing muscles of the scapula.[1,3] Increased protraction at the medial border of the scapula during GH motion, such as horizontal adduction, flexion, and abduction are some of the most common signs of SD.[3] The abnormal movement, when not caused by long thoracic nerve damage, is typically thought to result from hyper-activation of the upper trapezius in conjunction with decreased activation of the lower trapezius and serratus anterior.[6] Though nerve damage to the long thoracic and spinal accessory nerves may result in decreased muscular function, the commonality of these pathologies as the cause of the dyskinesis is less than 5%.[1] Other common causes include thoracic kyphosis, clavicular fracture nonunion, high-grade AC joint instability, or soft tissue inflexibility.[2]

Conservative treatment is the most commonly recommended course of action in cases of SD;

however, if nerve damage is present, surgical intervention may be indicated.[4] Most non-operative rehabilitation includes mobility exercises of the thoracic spine and shoulder (e.g., stretching, joint mobilizations, thoracic mobility exercises), closed and open chain strengthening exercises (e.g., push up plus, serratus anterior ceiling punches), and other reactive exercises (e.g., catching and throwing) targeting the improvement of motor control. A few concerns with conservative rehabilitation of SD is lengthy treatment protocols (i.e. weeks to months); and a primary focus on strengthening only the surrounding musculature of the shoulder girdle instead of focusing on neuromuscular reeducation and the restoration of dynamic stability and functional movement patterns.[7]

As a proposed cause for SD is poor motor control and a loss of dynamic stability, along with over activation of related musculature, a neuromuscular re-patterning technique such as Reflexive Neuromuscular Stabilization (RNS) seems appropriate. This technique was derived from a treatment called Reactive Neuromuscular Training (RNT). The concept of RNT is to restore dynamic stability and motor control post-injury with rehabilitation techniques which target the central nervous system (CNS). As the CNS reacts to a stimulus to create joint stability, there is a conversion from conscious thought to unconscious.[8] Rather than cue the patient verbally and have discussions regarding what they are doing incorrectly, the goal of RNT is to exacerbate the dysfunctional movement with an external stimulus to bring a more clear perception to the patient of the error that is occurring.[9] When using RNT, a clinician applies an external stimulus to the patient's body to promote an unconscious response by the CNS to produce the appropriate motor response and correct the faulty movement pattern.[10] Where RNS deviates from RNT is modification to make the process more 'reflexive' than 'reactive' to enhance the unconscious and reflexive response that a physically active patient needs to produce during activity to maintain dynamic stability.[11] Let us take for an example, when a patient performs a squat they have a significant valgus collapse. When using RNT we may utilize an elastic band around the patient's knees as a constant force that they are pushing against as they squat to force the patient to engage appropriate knee and hip stabilizers throughout the movement. In contrast, when switching to an RNS mindset of treatment, the clinician would apply the valgus force at the patient's knees with varying amounts of force and at unexpected times to force the patient's reflexes to initiate and correct the faulty movement pattern with their reflex to the stimulus. Again, the largest difference is having a constant and known force they are reacting to versus and changing and unexpected force their reflexes must engage in to correct the movement pattern.

Currently, there are no studies regarding the application of RNS and SD and only a few studies have been published on the application of RNS or RNT; thus, little is known about the application of these techniques in patient care. Therefore, the purpose of this case study was to report the outcomes of incorporating RNS into the rehabilitation program of an intercollegiate swimmer diagnosed with SD who had failed to improve using traditional conservative methods. The patient gave informed consent to participate in the study as well as was informed that the data collected would be submitted for publication. This study was approved by the Institutional Review Board.

PATIENT INFORMATION

Patient

The patient was a 20-year-old female Division I intercollegiate swimmer who presented with right upper back pain and no known mechanism of injury. She described experiencing her current pain for approximately six months. Her pain was isolated to the right medial border of the scapula with a gradual onset and no known mechanism of injury. When the symptoms initially began, her primary complaint was experiencing pain at the end of inhalation. When the pain started, the patient was home for the summer (i.e. between spring and fall semesters) and used self-treatment consisting of three months of complete rest from activity and occasional superficial heat without resolution of her symptoms. The patient reported to the Athletic Training clinic after four months of unresolved symptoms for the start of the fall semester.

The initial examination revealed pain along the medial aspect of the right scapula during inhalation, while sitting in good posture, or while wearing a backpack. The patient did not reveal any red flags for cancer, chronic illnesses, or family history of illnesses. She had experienced pain in the upper right back eight months previously when she was lifting weights, however, the pain resolved without treatment. She reported the current episode as "feeling different" and unrelated to the current condition. She was not taking any medication for the discomfort and had no other reports of treatment. Her reported worst pain on the Numerical Pain Rating Scale (NPRS) was a seven out of ten when sitting erect and at the end of an inhalation. A zero on the NPRS is classified as no pain, whereas a ten is classified as the worst pain imaginable.[12] Disability was measured using the Disablement in the Physically Active (DPA) Scale, which is scored from zero (no disability) to 64 (maximum disability).[13-14] The patient reported a disability score of 28 on the DPA Scale on the initial evaluation. The Patient Specific Functional Scale (PSFS) was utilized to identify activities within her daily life that were causing pain. This scale utilizes a score between zero (cannot perform) to ten (no problem performing).[15] Her three primary painful activities were breathing (4 out of 10), sitting up straight (4 out of 10) and wearing a backpack (6 out of 10).

The examination did not reveal signs of inflammation, ecchymosis, or deformities surrounding the area of pain. Her natural posture was forward head, forward shoulder, and increased kyphosis. The postures were exacerbated in a seated position. In a seated position, visual evaluation of the patient's breathing revealed all of the motion for inhalation stemming from the chest rather than from the diaphragm. To test breathing functionality, the clinician used a modification of the Manual Assessment of Respiratory Motion (MARM) test.[16] The modification of the MARM test was done via palpation and observation to assess the 3-Dimensional movement of the trunk and chest during inhalation and exhalation. The clinician placed their hands along the patient's mid to low back with the thumbs parallel to the spine and fingers splaying laterally (**Figure 1**). While the patient completed normal inspiration/expiration, the clinician felt for the motion of breathing to either be lateral, superior, anterior, and/or posterior. A normal pattern consists of lateral, anterior, posterior, and limited superior motion.[17] This patient revealed a primary upward motion in breathing, with absent posterior and lateral motions with inhalation.

Tender points (TPs) at the middle portion of the insertion of the rhomboid minor, superior portion of the insertion of the rhomboid major, middle

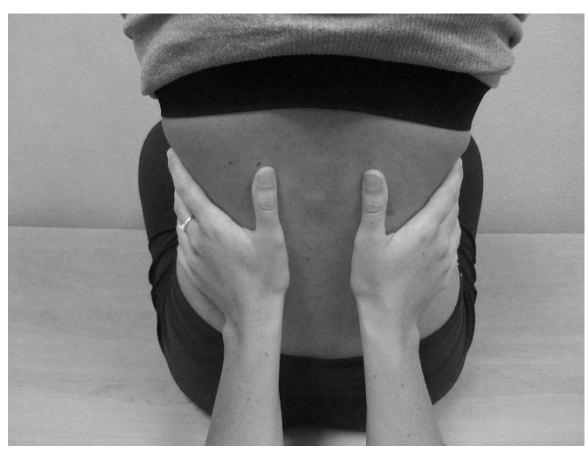

Figure 1. Hand Positioning for Modified MARM Test

trapezius superior portion of the insertion and superolateral muscle belly, and serratus posterior superolateral muscle belly were identified with palpation. Differentiation of the musculature was determined through active contractions of the muscles. In addition to reporting TPs, the patient stated that she generally felt "tighter" on the right medial aspect of the scapula, compared bilaterally. The patient also reported tenderness to palpation at the first and second ribs with a superior to inferior pressure posterior to the clacivle and on the posterior aspect of the eleventh and twelfth ribs in a supine position.

Range of motion testing was performed and revealed no limitations or pain with any of the following active range of motions (AROM) at the shoulder: flexion, extension, internal rotation (IR) at a 90-90 position, external rotation (ER) at a 90-90 position, abduction, horizontal adduction, or horizontal abduction. Observation during AROM testing revealed the patient had substantial SD on the right side that was most prominent with flexion, abduction, and horizontal adduction (**Figure 2**). The following passive ranges of motion (PROM) at the shoulder were equal bilaterally, within normal limits, and non-painful: flexion, extension, IR, ER, horizontal adduction, abduction and horizontal abduction. Strength testing of the rotator cuff muscles, deltoid, pectoralis major, biceps brachii, and triceps brachii were all 5/5 and non-painful when compared bilaterally. The right rhomboids had decreased strength, 4/5, when compared bilaterally.

Figure 2. Scapular Dyskinesis Pre-Treatment

The patient displayed a positive sulcus sign bilaterally and SD on the right when in a push up plus position both in non-weight bearing and weight bearing positions. Based on the lateral scapula slide test (LSST), the patient met the established threshold, 1.5cm to be a positive test, of difference during 90 degrees of abduction and was .2cm and .3cm from the threshold in the positions with hands on hips and at 90 degrees horizontal adduction while standing to indicate SD (**Table 1**).[1,18-19] Each measurement was taken from the spinous process even with the inferior angle of the scapula for each motion. The LSST was performed with the patient's hands by her side, progressed to hands on the hips, and 90 degrees of abduction. Though the LSST is designed exclusively for those three motions, the clinician also measured the differences when the patient completed horizontal adduction. The Apprehension and Relocation, Empty Can, and Gerber Lift Off tests were negative. Neurological screening and function was within normal limits. Based upon these findings, the patient was classified with right SD and conservative rehabilitation was initiated without limitation in activity levels.

INTERVENTION

The first six weeks of treatment and rehabilitation consisted of a combination of moist heat packs (MHP), Positional Release Therapy (PRT), breathing retraining, Primal Reflex Release Techniques (PRRT), instrument assisted soft tissue mobilization (IASTM), massage, strengthening, and stretching. Treatment sessions began with MHPs to stimulate blood flow to the affected area, and to help increase patient relaxation and comfort. After the application of

Table 1. Measurements Taken in the Scapular Slide Test (cm)

	Left	Right	Left	Right
Arm Position	Day 1		Day 3	
Down by sides	9.5	9.5	9.5	9.5
Hands on hips	8.9	10.2	8.9	8.9
90 degrees abduction	10.2	7.6	10.2	10.2
90 degrees horizontal adduction	12.7	14	12.7	12.7

the MHPs, PRT was used to release the TPs present during the initial evaluation. Following PRT, breathing retraining exercises were used to restore normal diaphragmatic breathing. The techniques utilized were a combination of breathing exercise developed by Michael Grant White[20] and PPRT techniques developed by John Iams, and were selected because of positive clinical outcomes experienced by the treating clinician during previous patient care.[21] The breathing exercise was similar to the traditional "clam shell" exercise for hip external rotator strengthening (**Figure 3 and Figure 4**). However, the breathing component required the patient to attempt maximal exhalation (i.e., "blow all your air out") and then move through full hip external rotation with the top leg while holding their breath throughout the motion. Once the knees returned to the starting position, the patient was cued to inhale. The length of the count varied by the patient's ability to hold her breath. When the patient returned to the starting position, the required response was to have the patient take a "gasping" breath, meaning the patient felt as if she could not hold her breath any longer, thus taking a large reflexive inhalation.

Figure 3. Starting and Ending Position of the "Clam Shell" Exercise

The PRRT technique was then used to address the patient reported rhomboid tightness. Initially, a facilitation technique was used on the rhomboids due to the forward shoulder posture of the patient; however, the technique did not produce improvement, so the clinician then inhibited the rhomboids in an attempt to decrease pain and tightness. Next, IASTM and massage were used to reduce remaining TPs on the affected side rhomboid major, rhomboid minor, upper and middle trapezius, and serratus posterior, as well as to restore function and ROM. Therapeutic exercises were used to improve muscular control and strength of the serratus anterior and lower trapezius muscles to improve scapular stabilization within a functional movement pattern (**Table 2**). Finally, a stretching regimen was used to release tight anterior musculature and improve posture.

Over the first six weeks of therapy, the patient would complete this therapy protocol 1 time per

Figure 4. "Clam Shell" Exercise Motion

Table 2. Frequency and Duration of Each Rehabilitative Exercise Performed

Exercise	Times per Week*	Weeks Performed	Duration
Low row/ scapula pinches with a red resistance band	2-3	2	3x8-10
Supine Scapular Retraction	1-5	2	2x8
Standing Scapular Retraction Against Exercise Ball	1-5	3	2x10
Scapular control exercises (patient holding a weighted ball and moving into flexion, horizontal adduction, horizontal abduction & abduction)	2-3	4	3x30 seconds
Push up plus on BOSU	2	3.5	3x8
I's, Y's, T's	2	3.5	2x8
Horizontal adduction with 3lb weighted ball with RNS	2	1.5	3x10

*Times per week varied weekly based on availability and travel

day and four days per week, on average. During this time, the patient reported short-term pain relief and TP reduction. The patient typically reported a decrease in pain following each treatment session; yet, the pain and TPs returned without any substantial improvement by the end of a two-hour swim practice or by her next visit. When a treatment was provided prior to practice, the patient reported a resolution of her complaint, but it would only remain resolved through 50 to 75% of the practice period (~2 hours). Treatment provided on non-training days followed a similar pattern, but usually increased the duration of her pain resolution from approximately 90 minutes to 3 hours. During these six weeks, discernible improvements in the patient's strength and dyskinesis were recorded (**Table 4**). Due to the lack of consistent and long-lasting patient-reported or disease-oriented improvement, the clinician re-evaluated the patient and decided to add RNS to her established rehabilitation protocol. The clinical reasoning for this choice focused on the belief the patient's functional motor patterns (i.e., stability) were not being addressed at the subconscious level, and a more reflexive neuromuscular intervention was needed to normalize movement patterns and postures at the subconscious level.

The initial treatment goal for utilizing RNS was to decrease SD during standing horizontal adduction because this was the most difficult movement for the patient and movement with the most SD. The patient continued to use MHP prior to beginning exercises because she felt the MHP helped to decrease pain and increase her mobility. The treatment protocol was MHP, RNS with horizontal adduction in standing, I's, Y's, T's in a prone position on two of the days, push up plus on a BOSU ball on one day, while the patient also continued to stretch the pectoralis muscles in a doorway as she had been doing daily.

The clinician first applied an anterior to posterior stimulation for RNS to various places on the anterior aspect of the patient's body (i.e., upper 1/3 of the sternum, middle of the sternum, xiphoid process, upper abdomen, lower abdomen, and bilateral ASIS) as the patient was standing and performing horizontal adduction. While the clinician applied the anterior to posterior force via hand pressure, the patient was instructed to close her eyes and not allow the clinician to push her backwards. The response the clinician was testing for was the largest decrease in the SD during one repetition of horizontal adduction with the external stimulation. Once the location of pressure that was the most responsive in decreasing SD the patient was found, she was asked to continue to keep her eyes closed, to react to the stimulus without anticipation, and told to not let the clinician push her backwards. Once the patient reacted, she then performed the active horizontal adduction while the stimulus was sustained (**Figure 5**).

On the first day of treatment with RNS, the patient performed two sets of ten repetitions with the pressure in the middle of her sternum. A third set was completed with the patient closing her eyes and imagining the pressure on her chest before completing the movement. When the patient imagined the pressure, the elimination of dyskinesis was consistent with the clinician applied force. Days two and three of RNS consisted of the same treatment, but on these days, the patient performed one set of ten repetitions with clinician generated force, while the second and third sets were done with the imagination of the pressure. The NPRS was collected pre and post each treatment, PSFS was collected pretreatment, and the DPA Scale was collected at day one, at discharge (day three), and eleven-months post-discharge. The patient denied taking any medications for pain and maintained her activity level throughout the course of the new treatment protocol. The patient was treated two consecutive days, then 6 days later for the third treatment. She responded well to treatment without increased pain during and after treatments. The patient did not return to the clinic until 6 days following the third treatment. At this time, the patient reported near resolution of symptoms, was able to swim throughout an entire practice without pain returning, had an improved physical exam (e.g., no tender points, improved scapular positioning, negative special tests), and met established discharge criteria. Discharge criteria had been previously established as the ability to maintain normal scapular stabilization throughout functional movements (without RNS), an average NPRS score of one out of ten or below,[22] and a PSFS of a nine out of ten or higher[23] with intercollegiate swimming and conditioning activity.

Figure 5. Scapular Dyskinesis was Eliminated when Pressure was Applied to Mid Sternum

RESULTS

Prior to using RNS as a treatment, the patient had received 26 days of treatment over six weeks without substantial or lasting improvements then after just three treatment sessions with RNS involved in the treatment protocol the patient met established discharge criteria (**Table 3** and **Table 4**). At this time, a full re-evaluation was performed, intake data was collected, and no treatment was performed. The physical exam revealed the scapular slide test was equal bilaterally. The patient's primary chest breathing pattern was still present in a seated position, but diaphragm activation was now present measured through modified MARM test. The TPs on the insertion of the rhomboid major and insertion, muscle belly of the middle trapezius, and eleventh and twelfth ribs were no longer present during palpation. The TP at the middle portion of the rhomboid major was still present, but the patient reported tenderness to be mild (2/10)

Table 3. Patient Reported Outcomes Prior to RNS with Horizontal Adduction

	Tx Day 1	Tx Day 11	Tx Day 21
NPRS - Current	**8**	**7**	**4**
NPRS - Best	**5**	**7**	**4**
NPRS - Worst	**8**	**7**	**5**
NPRS - Average	**7**	**7**	**4.33**
NPRS –Post	**6**	**6**	**3**
DPA Scale	**28**	**15***	**-**
PSFS	**7.75**	**7**	**7.6**

*Clinically significant difference; Abbreviations: DPA Scale- Disability of the Physically Active Scale; PSFS- Patient Specific Functional Scale (0=unable to perform, 10= fully able to perform); NPRS- Numeric Pain Rating Scale at current, best within past 24 hours, worst within last 24 hours, average of current, best and worst (0=no pain, 10=worst pain); Pre-Tx: Pre-treatment; Post-Tx. Post-treatment; N/A: Not applicable

Table 4. Outcome Measurements After RNS with Horizontal Assuction

	RNS Tx 1	RNS Tx 2	RNS Tx 3	6 day F/U	2 wk F/U	11 mon F/U
DPA Scale	22	N/A	16	N/A	N/A	4
PSFS	8	N/A	7	9.5*	N/A	10
NPRS- Current Pre-Tx	4	4	4	1	2	0
NPRS-Current Post Tx	2	3	2	N/A	N/A	N/A
NPRS- Change	2*	1*	2*	N/A	N/A	N/A
Scapular Slide Test- Horizontal Adduction	1.3 cm	N/A	N/A	N/A	0 cm	0 cm

*Clinically Significant Difference; DPA Scale- Disability of the Physically Active Scale; PSFS- Patient Specific Functional Scale (0=unable to perform, 10= fully able to perform); NPRS- Numeric Pain Rating Scale at current, best within past 24 hours, worst within last 24 hours, average of current, best and worst (0=no pain, 10=worst pain); Pre-Tx: Pre-treatment. Post-Tx. Post-treatment; Scapular Slide Test- Horizontal Adduction: Number is different between affected and unaffected; N/A: Not applicable

compared to initial measures (4/10). The patient also continued to experience tenderness at the first and second ribs. The patient's natural sitting posture was still forward head, forward shoulder, and increased kyphosis; however, these postures were not as noticeable as those found during the initial exam. The patient also reported it was easier to maintain good posture, and she could now do so without experiencing pain. Additionally, the previous SD that was noted with flexion, abduction, horizontal adduction, and in a push up plus position was no longer present. Based on the physical exam and patient outcome findings, the patient was released to full activity (i.e., swimming, dryland training, and weight lifting) without further treatment, but was monitored throughout the remainder of the swim season. Follow-up measurements were collected at 2 weeks and 11 months post-discharge (**Table 4**).

Detailed evaluation of patient outcomes utilizing RNS treatment revealed the patient demonstrated a change in pain that met the minimal clinically important difference (MCID) on the NPRS after Day 1, but it took 3 visits for this change to be maintained between treatment sessions (**Table 4**).[24] Functional improvement followed a similar pattern based on PSFS scores. The patient did not report sustained functional improvement until after the third treatment. However, once this was reached, the patient retained her functional improvement all the way through the 11 month post-discharge follow-up. Additionally, the patient's scapular winging improved. At the initial exam, the patient displayed a 1.3 cm difference side to side of scapular winging with horizontal adduction; at discharge, the patient had an even distance from medial border of the scapula to spinous process with active horizontal adduction (**Table 1**). As with the other measures, this improvement was maintained at the 11-month follow-up visit.

DISCUSSION

Rehabilitation for SD commonly targets the decreased activation of the serratus anterior and middle trapezius.[25] Worsley et al.[26] used a general rehabilitation program to retrain scapular stabilizers over a course of ten weeks. The researchers found the serratus anterior and lower trapezius could successfully be retrained over ten weeks, and scapular motion was nearly equal to a healthy population after the protocol was completed.[26] The long-term benefits of this program are unknown as data was collected prior to intervention and immediately post the ten week protocol.[26]

In this case study, the initial focus was on relieving pain through soft tissue treatments, and improving scapular motion through increased strength and muscle activation of the para-scapular musculature. After minimal improvement, the intervention shifted towards restoring optimal movement patterns of the scapula using a reflexive neuromuscular approach. Unlike exercise-based therapy, RNS may be beneficial from an evaluative and treatment standpoint because of the immediate restoration of a functional movement pattern when the clinician applies an external force.[27] If the functional movement pattern is not restored, either the wrong force is being applied (e.g., not enough force, wrong location) or RNS is not indicated.[9,27] The location or amount of force may vary from patient to patient; though, when indicated, the treatment should produce an instantaneous, noticeable, and long-lasting improvement in movement.[27]

The proposed theories behind the success of RNS are based on influencing the central nervous system (CNS) with subconscious and reflexive movement which restores motor control and dynamic stability. Reflexive Neuromuscular Stabilization was derived from the term RNT, which was first proposed by Voight and Cook.[28] The primary objective of the treatment is to trigger the subconscious process of recruiting the appropriate musculature to establish a proper movement pattern(s).[8,10,28]

When using an RNS treatment, the external stimulus is provided in varying forces at varying times throughout a dysfunctional movement. With RNS, the goal remains to recruit the CNS to establish appropriate recruitment strategies of involved musculature in particular movements or activities by reflexively re-patterning the neuromuscular system. In this case study, the treatment was applied to the sternum with a varying amount of force and frequency, requiring the patient to react more reflexively to an unexpected stimulus, as opposed to anticipating a consistent resistance, which helps the reaction to become subconscious. Borsa et al.[29] also explained when a motion or stimulus is repeated, the brain stores these movements or stimuli, and then has the ability to access the response unconsciously. Through applying RNS, restoring the functional movement, then having the patient go through the functional movement over a number of repetitions that functional movement can now be maintained without conscious thought.

Currently, there are no published studies or case reports on utilizing RNS for SD; however, there are published reports on the use of RNT or RNS to address other dysfunction or pathology. The ability to functionally complete a previously poor motor pattern without conscious thought was elicited in a case study using RNT for apparent hamstring tightness.[27] The patient in this case was tested on a variety of hamstring extensibility measurements and was classified with hamstring tissue extensibility dysfunction (TED). After one treatment of RNT during multi-segmental flexion, for the patient experienced substantial improvements in all ROM measurements immediately following the intervention. Not only were the gains in all ROM testing improved, but the gains in motion were enough to be within the normative ranges for each ROM measurement tested after a single intervention.[27] The patient also maintained the improvements, which exceeded the gains expected from the stretching literature, at the five-week follow-up without further intervention.[27] Similarly, in another case study, RNS was used in conjunction with the Mulligan Concept for a young patient with multidirectional instability of the shoulder, who had recently sustained a subluxation.[11] In this case, the clinician performed a Mulligan Concept mobilization with movement followed by RNS to restore full pain-free ROM after one visit. The patient was discharged in 6 visits, returned to football activities, and did not suffer a re-injury during that season.[11] Additionally, RNT has been reported to be beneficial in a case report on Anterior Cruciate Ligament (ACL) deficiency.[28] Over the course of eight visits, the patient experienced a large increase in strength that could only be explained by neuromuscular adaptations as opposed to true strength increases.[28] Traditional strength gains require several weeks to occur, whereas neuromuscular adaptations within the body occur during the first six weeks of training.[28] Further, when movement patterns changes, or the abolition of patient complaint, occur immediately with RNS application during a treatment session, it seems most likely that the mechanism of action is drive by a neurological change. Thus, of the in-treatment session changes and the overall improvement over eight treatment sessions, indicate rapid neuromuscular adaptations as opposed to traditional drivers of strength improvements from exercise.[28] While these three cases suggest RNS may be an effective intervention, reports on the effectiveness of RNS on SD could not be identified in the literature. In the current case, applying RNS required a contraction of anterior chain muscles, in particular the abdominal muscles, to initiate stabilization before the patient tried to move the arm. The reflexive contraction, and subsequent stabilization, corrected faulty stabilization patterns allowing for more ideal functional movements (e.g., shoulder horizontal adduction). The serratus anterior and lower trapezius are typically the muscles not activating appropriately with SD.[6] It is hypothesized that activating a reflexive stabilization pattern (e.g., spinal stabilization) with RNS created the proper stability for the serratus anterior and lower trapezius to be properly coordinated to stabilize the scapula properly. Throughout the three days of treatment with RNS, the application of RNS immediately produced improvement (e.g., pain, scapular positioning), but it took until after the third treatment for the motor pattern to become ingrained enough for the patient to maintain her improvement during and after activity.

Due to the paucity of research on RNS, the ideal treatment parameters (e.g., number of treatments, sets, repetitions) required for the best treatment results are unknown. In addition, ideal locations for stimulus during RNS, or any variance across different areas of the body, functional movements (e.g., are complex movement patterns more difficult to restore), or pathology are also unknown. It is quite possible that different pathologies or movement patterns will require different parameters (e.g., differences in treatment time, frequency, duration) to produce effective patient outcomes. For example, multi-segmental flexion, a uniplanar motion, required only one treatment to produce maintained resolution of a patient who present with a hamstring TED.[27] In contrast, a patient with a deficient ACL completed eight days of treatment with RNT, and may have needed more, to fully resolve the patient’s condition. In this case, the patient did not only have one dysfunctional motion, but instead needed to restore functional movement through multiple complex movement patterns. Though the motions that needed restoration were complex, only three treatments of RNS were necessary for a case of SD to meet discharge criteria and maintain these improvements at 11-month follow-up (**Table 4**).

The presented case provides preliminary evidence that RNS may be an effective treatment option, at least as an adjunct therapy, for patients with SD. Future research needs to be completed on RNS to determine the effectiveness of the treatment as an adjunct or individual treatment. Additionally, future research should be performed to determine the appropriate dosage of RNS to restore and maintain functional movement patterns.

CLINICAL BOTTOM LINE

The results of this case study provide initial evidence of the potential benefit of utilizing RNS. The reflexive nature of RNS, and the description of its use in this case study, may help clinicians utilize the technique to inform their clinical decision-making in determining when or how to use RNS or RNT in therapeutic rehabilitative programs. In this case, after adjusting the treatment protocol to include RNS as the primary intervention, the patient reported clinically significant improvement in pain and function. The patient reported clinically significant improvement and did not believe she needed additional treatment after three days of RNS treatment. She remained fully functional and with reduced pain 2 weeks and 11-months post conclusion of the treatment after a multi-modal conservative rehabilitation program had failed to produce meaningful improvement over 6 weeks. Based on these results, further research on the use of RNS with SD is warranted to determine effectiveness, but this case may serve as a clinical guide for incorporating RNS into patient care.

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The Mulligan Concept in the Treatment of Anterior Knee Pain

Karla S. Judge, DAT, LAT, ATC[1]; Alan Nasypany, Ed.D., LAT, ATC[2]; Russell T. Baker, PhD, LAT, ATC[2]; and James May, DAT, LAT, ATC[2]
[1]Idaho State University, Pocatello ID; [2]University of Idaho, Moscow, ID

ABSTRACT

The purpose of the disablement model case study was to describe the case of a collegiate basketball player suffering from anterior knee pain (AKP). The patient had been experiencing AKP while participating in pre-season basketball related activities (playing, weight lifting, and conditioning) for approximately six weeks. As the intensity increased, the pain became intolerable. Previously, the patient had missed a significant amount of off-season workouts due to surgery for an upper extremity injury sustained during the competitive season. The patient reported tenderness at the inferior pole of the patella, and at the tibial tuberosity. There was no joint line tenderness, swelling, tissue temperature change, crepitus, or joint locking identified during the initial assessment. Manual muscle testing revealed decreased strength and pain at the inferior pole of the patella and the tibial tuberosity with the long sitting straight leg raise, as well as seated knee extension. Patient reported outcome measures were used to establish a baseline of pain and function. The Disability of the Physically Active Scale, the Numeric Pain Rating Scale, and the Patient Specific Functional Scale were used to identify patient-centered, as well as clinician-centered changes produced by the treatment intervention. Recording of outcome measures took place at the initial assessment, after the initial treatment intervention, two days after the initial intervention, and one and two weeks after the initial intervention. Outcome measures reflected a positive result for the decrease of pain with basketball activities, as well as activities of daily living. Evidence supports the use of mobilizations to treat tendinopathies, joint positional faults, and neuromuscular motor control. While evaluating and treating patients with the Mulligan Concept MWM, the clinician receives immediate feedback regarding the efficacy and potential success of the intervention strategy. The purpose of this case study was to describe the application of the Mulligan MWM philosophy and tibial internal rotation (TIR) technique while treating a patient complaining of AKP in an intercollegiate athletic training clinic.

Key Phrases
Manual techniques, patient-reported outcomes, mulligan concept, sub-therapeutic dose

Correspondence
Dr. Karla Judge, Idaho State University, 921 South 8th Ave, Pocatello, ID, 83209
Email: judgkarl@isu.edu

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INTRODUCTION

Anterior knee pain (AKP) is a common complaint in athletics.[1] Multiple conditions can produce pain at the anterior knee and an accurate assessment is necessary to direct proper treatment. Patellar tendinopathy, patellofemoral pain syndrome, quadriceps tendinopathy, chondromalacia, synovial plica, bursa and meniscal lesions can all present as AKP.[1] Poor motor control of the hip, pelvis and knee has also been identified as a possible cause of AKP.[1-7] Ultimately, loss of efficient motor control of hip abductors, adductors, extensors and knee flexors may lead to poor joint kinematics, resulting in AKP. [2-7,12,14,15] The Mulligan Concept (MC) was developed on a positional fault theory, which is based on the belief that minor malalignment of joint surfaces may be present, resulting in swelling, stiffness, and pain.[12-18] The Mobilization with Movement (MWM) may address this minor joint malalignment, as well as help create a more ideal neurophysiological environment for improved motor control and pain-free movement strategies.[15] A MWM has been defined as a "sustained passive accessory force/glide to a joint while the patient actively performs a task that was previously painful".[15] The force is applied parallel to the treatment plane and should be a light, gentle force, just enough to improve motion and reduce pain. During assessment, the clinician will identify the direction of the force applied to the joint line in order to produce a positive outcome.

Two acronyms help guide and define proper application of the MC MWM.[12-18] First, identified in **Table 1** is the PILL acronym. Pain free, Immediate, and Long Lasting identifies the desired result of the mobilization technique. The most important part of the PILL acronym is the pain free aspect of the mobilization. If pain is not eliminated, then small changes in direction (addition of a minor rotation) or force (increase or decrease) can be made to improve symptoms. An immediate improvement of pain-free range of motion (ROM) is expected at the time of the mobilization. If the results are not long lasting, changes should be made regarding the number of sets or repetitions used during the mobilization.[15]

Table 1. The Mulligan Concept PILL Acronym for Performing a Mobilization with Movement[12-18,21]

P	Pain free: the immobilization should be pain free
I	Immediate: reduction of pain and increase of functional activity
LL	Long Lasting: the result of the mobilization should have a long lasting effect in reduction of pain

Second, **Table 2** identifies the CROCKS acronym, "Contraindications, Repetitions, Overpressure, communication, Knowledge, Sustain/sense/skills/success", which guides the technique and expectations of the mobilization for both the clinician and patient.[12-18] The clinician should possess knowledge of the indications and contraindications of joint mobilization techniques, in general, as well as specific knowledge regarding the MWM technique to ensure a safe intervention.[12-18] Joint health and any underlying pathology also need to be clearly understood to avoid exacerbating any existing condition, such as fractures, rheumatoid arthritis, or poor skin integrity. Sets and repetitions may vary depending on treatment area, length of dysfunction, and treatment calendar.[12-18] For example, spinal manipulations are treated with fewer repetitions than peripheral joints or in patients presenting in severe pain.[12-18] One set of three repetitions would be used for the first intervention for a spinal mobilization, while a peripheral joint may be treated with three sets of six to ten repetitions.[12-18] Overpressure added to the end of the active mobilization is believed to aid in providing optimal recovery.[12-18] Communication between the clinician and the patient is imperative. The clinician must explain the process of the mobilization, and the patient must be able to communicate if any pain is experienced during the mobilization.[12-18] Finally, a clinician possessing proper skills will sustain the mobilization through the entire ROM in order to have a successful treatment intervention.[12-18]

Table 2: Mulligan Concept "CROCKS" acronym for guidelines and expectations of a mobilizations with movement.[12-18,21]

C	Contraindications: do any conditions exist that would limit the use of joint mobilization
R	Repetitions: three sets of ten repetitions are used for treating the extremity joints
O	Overpressure: passive overpressure is applied by either the patient or the clinician at the end range of movement
C	Communication: between the clinician and the patient about the treatment, techniques and expectations before the intervention begins. During the intervention the patient should report any pain.
K	Knowledge: the clinician should possess knowledge of joint planes of motion being treated
S	Sustain, sense, skills, and success: using common sense and clinical skills, the mobilization should be sustained throughout the movement in order to attain success.

A common mobilization used for AKP is the tibial internal rotation (TIR) MWM. The TIR MWM is often the first technique clinicians will utilize to treat reported pain and/or dysfunction at the knee.[12-15, 17, 18] The TIR MWM technique includes a clinician-directed rotational mobilization force added to the patient-directed flexion and extension movement across the treatment plane (the tibial plateau).[12-15] The TIR MWM can be reinforced with a tape application that may be worn until the patient's return to the clinic in 24-48 hours (standard precautions for tape application must be considered).[12,14,15] The desired effect of the tape is to sustain the mobilization effect and apply continual neurological input for more ideal motor control.15 The mobilization and tape application are intended to enable pain free movement and motor control by addressing the malalignment of tibial external rotation, decreasing medial hamstring inhibition, and decreasing pain.15 Short term re-training of motor control can have a prolonged positive effect on pain and therefore is important to facilitate pain free movements, while treating painful and restricted joints.7

The MC MWM can also be incorporated into the patient assessment as well as an intervention tool.15 Along with observation, palpation, functional and special tests, the application of a single set of six repetitions ("sub-therapeutic dose") of the MWM can provide valuable information. A decrease of pain during the sub-therapeutic dose of MWM can indicate to the clinician that the MWM could produce a successful outcome.15 A decrease of pain with the knee flexion movement will indicate the MWM is clinically indicated to treat the AKP and assist in re-establishing joint alignment and motor control.

PATIENT INFORMATION

The patient was a 19-year old male intercollegiate basketball player. He was a 6'1", point guard weighing 205 pounds. During the past off-season, this patient had undergone surgery for an upper extremity injury which limited his ability to participate in summer conditioning activities. He reported to the athletic training clinic with a primary complaint of intermittent AKP pain for approximately six weeks. Low level knee pain began shortly after the start of fall semester workouts. Initially, the patient had been able to participate in basketball activity, weight lifting, and conditioning. As the intensity of conditioning increased, the patient became unable to participate in basketball-related activities. The patient had been self-treating with patellar strapping and ice, which is a treatment he used previously when he experienced AKP.

DIFFERENTIAL DIAGNOSIS AND EVALUATION

The patient presented with point tenderness to palpation at the tibial tuberosity and the inferior pole of the patella with his knee resting in extension. The patient denied complaints of tenderness, locking, or popping of the joint line. The patient also denied any previous Osgood-Schlatter or Sinding-Larson-Johansson diagnosis by a medical professional. No crepitus was present. There was no point tenderness or temperature changes along the length of the patellar tendon. All passive and active ROM were within normal limits (WNL) at the hip, knee, and ankle bilaterally. Trunk flexion, extension, and rotation motions were WNL and pain free. Bilateral lower extremity manual muscle testing resulted in 3/5 with pain reported at the inferior pole of the patella during the long sitting straight leg raise and seated knee extension, while all other muscle tests resulted in 5/5. The patient presented with normal patellar alignment, and both Clarke's sign for patellofemoral irritation and the patellar apprehension tests were negative. At the completion of the assessment, the differential diagnosis included: patellar tendinopathy, dysfunctional patellar tracking, Hoffa's fat pad irritation.

BODY STRUCTURE AND FUNCTION

The long sitting straight leg test was used as the client specific impairment measure (CSIM).[15] The CSIM is a baseline test that is easily and safely reproducible in the clinic, prior to any functional or dynamic movement based testing. The CSIM is used to assess the treatment effects regarding pain or function. The test should be patient-centered and meaningful to the patient.[15] The long sitting straight leg test was used for the CSIM for this patient due to the painful result of the manual muscle testing during the initial assessment.

After completion of the functional and special tests, the clinician included a "sub therapeutic dose" (1x6 repetitions) of the MC TIR MWM to identify if the joint mobilization could produce a positive effect on the patient reported pain.[15] Incorporating a sub-therapeutic dose of the mobilization into the assessment allows the clinician to determine if a MWM is clinically indicated.[15] During the sub-therapeutic dose, the patient reported a pain-free MWM and immediate decrease in painful knee flexion. As the sub-therapeutic MWM dose matched the PILL response, the clinician determined the MC TIR MWM was clinically indicated to treat the patient's AKP.

The patient had been self-treating his AKP over the preceding four days with no improvement of symptoms. He experienced pain at 110° of knee flexion, as well as seated knee extension and while performing a straight leg raise. After the positive result of the sub therapeutic dose of TIR MWM, the clinician was encouraged to proceed with a full intervention before scheduling further diagnostic testing.

Prior to the examination, three patient-oriented outcome measures were administered to establish a baseline to measure the effect of patient care. First, the disability of the physically active scale (DPAS)[23] was used to identify physical impairments, functional limitations, and quality of life changes that have taken place due to the injury.[23] It has been designed to provide descriptive themes that are clinically meaningful to athletes. The DPAS has shown to be reliable, valid and responsive in the evaluation and monitoring of physically active patients.[24] Second, the patient rated his pain on a 0-10 scale "least pain to most pain" using the numeric pain rating scale (NRS).[25] The NRS has shown to be a sensitive and valid instrument in detecting changes in pain.[25] Third, the patient completed the patient specific functional scale (PSFS)[26] to identify movements that are important to him in daily or sport activities (descending stairs, single leg landing, weight lifting, kneeling). The patient graded his ability to perform each activity on a scale of 0-10 "poor ability to best ability". The PSFS has shown to have excellent test-retest reliability and is sensitive to changes.[26] The treating clinician compared initial and follow-up scores at pre-determined intervals (initial, two days, one week, two weeks). The results at the initial and follow-up intervals are listed in **Table 3.**

Table 3: Initial Assessment and Follow-Up Scores of AKP

	Initial	2 days	1 week	2 weeks
DPAS	19	8	0	0
NRS	5	0	0	0
PSFS:				
1)descending stairs	4	9	9	10
2)single leg landing	4	9	9	10
3)weight lifting	4	10	10	10
4)kneeling	4	8	8	10

DPAS-Disability Of Physically Active Scale; NRS-Numeric Pain Rating Scale; PSFS-Patient Specific Functional Scale

Results of the outcome measures were used to assess if changes have met minimal clinically important difference (MCID) standards.[27] An MCID is considered the minimum change that takes place as a result of the intervention that is important to both the patient and the clinician.[27] To be considered MCIDs, changes include a pain decrease of six points for chronic pain (pain present for more than 6 weeks) or nine points for acute pain (pain present for less than 6 weeks) on the DPAS, a decrease of two points on the NRS and a three point change on the PSFS.[23-27]

ACTIVITY AND PARTICIPATION

The patient had been participating in pre-season individual workouts, weight lifting, conditioning, and playing unsupervised basketball for four weeks with AKP until the pain became unbearable the day prior to reporting for assessment. The patient did not feel the AKP was affecting his personal relationships or limiting his social activities.

ENVIRONMENTAL AND PERSONAL FACTORS

The patient was, however, very concerned about missing more team activities, as he had been unable to participate in any activities during the summer months. He had been the starting point guard and was anxious that he would lose his role on the team. His AKP was also affecting his ability to sit in class comfortably and to walk up and down stairs to his apartment.

INTERVENTION

To perform the MWM, the patient's left foot was placed on a non-rolling stool with the knee and hip flexed to 90°. A chair may be placed near the patient for balance if he/she feels uncomfortable standing on unaffected limb. **Figure 1** illustrates the starting position for the MWM.

Prior to the mobilization, the patient reported 7/10 pain at the tibial tuberosity with the knee flexed to 110°. To complete the MWM, the clinician placed one hand medially around the superior tibia close to the joint line without contacting the tender tibial tuberosity and the other hand grasped the lateral portion of the proximal tibiofibular joint. **Figure 2** illustrates the starting hand position to perform the TIR MWM.

The clinician applied internal rotation of the tibia and maintained the rotation throughout the entire ROM as the patient moved through available pain-free knee flexion and returned to the starting position **(Figure 3).**

During the MWMs, the clinician communicated with the patient regarding any discomfort that may have occurred guided by the CROCKS acronym. The intervention continued with two more sets of the MWM, following the treatment recommendation of three sets of 10 repititions.[11-19] After the completed treatment, the patient reported 0/10 pain at both the inferior pole of the patella or tibial tuberosity. The CSIM, long sitting straight leg raise, was also reassessed with the patient reporting a NRS score of 0/10 (MCID for pain) and the MMT was assessed as 5/5. Pain scores and knee flexion ROM changes are described in **Table 4.**

Table 4: Pain Level and ROM Available Prior to, During and After The MWM was Performed

Test Intervals	NRS	Knee Flexion ROM
Before MWM	7	110°
After sub-therapeutic dose of MWM	4	110°
After 1st set of MWM	4	120°
After 3rd set of MWM	0	128°

NRS-Numeric Pain Rating Scale; ROM-Range of Motion

The MC guidelines recommend applying tape to reinforce the mobilization, assisting proprioceptive accommodations to the length and load of the new joint position created through the MWM intervention.[12-15,17,18] The tape application is intended to mimic the MWM as the patient goes about their daily activities. While standing, the knee is placed in slight flexion (10°) and full internal tibial rotation. The clinician applies the tape by starting laterally at the proximal fibular head, matching the MWM direction and force, and crossing to the medial aspect of the tibia in a spiral fashion. The tape application continued superiorly, on the posterior knee to the lateral thigh.[12-15, 18] The patient reported the tape application resulted in the same joint position sensation as the hands-on mobilization. **Figure 4** illustrates the completed tape application.

OUTCOMES

BODY STRUCTURE AND FUNCTION

The patient returned after the weekend (two days after the initial intervention) for a follow-up visit to assess the changes to the MWM and the PILL

Figure 1: Starting Position for TIR MWM

Figure 2: Clinician's Hand Placement to Perform TIR MWM.
Right hand is encompassing the head of the fibula while the left hand contacts the medial tibia. Both hands avoid contacting the tender tibial tuberosity.

Figure 3: Maintaining Manual Contact Throughout the Mobilization

Figure 4: Tape Application Following TIR MWM. Small wrinkles of the tape may arise as the skin shifts under the adhered tape.

response, as well as monitor any adverse effects the tape may have had on his skin. [12-20] At the first follow-up, the patient reported 0/10 pain during daily activity over the preceding two days, and reported a score of eight on the DPAS (MCID). The clinician repeated bilateral manual muscle testing resulting in 5/5 for all motions, including seated knee extension, which had previously been recorded at 3/5 with pain at the inferior pole of the patella. The clinician performed another intervention of 3x10 mobilizations followed by a new tape application and the patient was advised to return to the athletic training clinic for follow-up care as needed. To continue to collect patient centered outcomes, the patient was asked to return at one week intervals, unless there was a return of painful activity sooner. At the first one week interval, the patient reported 0/10 tenderness at the inferior pole of the patella and at the tibial tuberosity. A TIR MWM was not performed at the one week interval due to the patient reporting pain-free activity. At the final outcome collection two weeks after the initial intervention, the patient remained pain-free. Both the patient-reported DPAS and NRS were recorded at 0/10, while the PSFS activities all were recorded at 10/10. Due to the patient reported responses on the outcome measures, TIR MWM was not performed at the second week follow-up visit. The patient was discharged with the understanding he should return to the athletic training clinic if there was a return of either pain or dysfunction.

ACTIVITY AND PARTICIPATION

The patient had not participated in any physical activity for two days following the initial intervention. He reported pain-free activities of daily living, which included walking up and down stairs and sitting in class. At the follow up visit two days after the initial intervention, the clinician recommended modified return to basketball activity, suggesting he participate in individual workouts, weight lifting and half the volume of each running workout as pain permitted. The patient determined that he would increase his activity as long as he was pain free and had returned to full basketball activities and reported 0/10 pain with all activity.

ENVIRONMENTAL AND PERSONAL FACTORS

The patient was very anxious to return to activity due to his extended time away previously. His non-basketball painful activities (descending stairs and sitting in class) had decreased immediately and were completely eliminated within two days. While it was recommended he slowly return to activity through modified workouts, he felt he could fully participate as he remained pain free. He reported for follow up visits as scheduled, was truthful about his activity level and was responsive to completing the patient-based outcome forms.

DISCUSSION

Anterior knee pain is a common complaint with many causative factors including acute injury, congenital malalignment, poor motor control of the hip, pelvis, knee and core, as well as poor foot posture.[1-7] Poor motor control of the hip, knee and pelvis may result in an internally rotated femur, with an accompanying externally rotated tibia, creating joint dysfunction.[2-5,14,15]

Utilization of the MC MWM in this specific case study produced positive results which are consistent with results found in a review of the tenets and prescription of MWM by Hing, Bigelow and Bremner in the November, 2008 New Zealand Journal of Physiotherapy.[13] The common significant results were reduced pain levels, increased strength and functional improvements when compared to placebo.[13] The application of an internal rotation force on the tibia as the patient moved the knee through flexion and extension resulted in decreased pain and a change of faulty joint arthrokinematics. The MC TIR MWM is a gentle, pain-free intervention strategy for addressing symptoms associated with

AKP.[11-15,17] Proper application of a sub-therapeutic dose within the initial assessment indicated the MWM could be clinically effective due to the production of the PILL effect.[15] The tape application is believed to prolong the mobilization effect by providing a constant stimulus on the joint proprioceptors.[12-15]

The clinician must be well-versed in the contraindications for joint mobilization before applying any mobilizing force on a joint surface, with a complete understanding of arthrokinematics and skills to sense changes in joint mobility. Application of a MWM allows the patient to provide feedback to the clinician throughout the treatment. If the patient reports pain, the clinician should pause at the starting point, reposition the hands, making sure hand placement, direction, and pressure is comfortable to the patient, however, if the patient reported pain persists, the MWM would be discontinued. Following the MC guidelines, a MWM treatment intervention should be pain-free and the reduction of pain should be immediate.[11-19,22]

Utilization of patient-reported outcome measures can provide the clinician with information regarding the patient's pain and function, along with the identification of the patient's quality of life that may be overlooked if not specifically assessed throughout the patient care process. Making a concerted effort to appreciate how the injury is impacting the patient's daily life outside their sport (e.g., transportation, food preparation, attending classes, personal relationships, completing school work) provides the clinician with a higher level of understanding of the patient's overall well-being. Pain and disability scales provided information regarding improvements that were important to the patient (pain-free basketball, climbing stairs to apartment), as well as to the clinician (decreased pain and increased range of motion).[23-27] Identifying and testing a CSIM prior to and after an intervention is effective in determining if important changes have taken place that are relevant to both the clinician and the patient.[15] Continued monitoring of pain and dysfunction through patient-reported outcome measures is important to determine the immediate and lasting effect of the MWM intervention. While the outcome measures were collected for only two weeks until the patient was released to full activity, he was monitored daily for any return of pain or dysfunction. Prolonged outcome collection would have produced a more viable conclusion to the efficacy of the TIR MWM technique.

CLINICAL BOTTOM LINE

This case study was produced in an effort to highlight a successful intervention for one patient reporting AKP. The MC MWM is a treatment intervention guided by easy to follow acronyms for the desired outcome (PILL) and the technique of each intervention (CROCKS). The technique allows the patient and clinician to communicate throughout the mobilization to ensure a pain-free intervention, and the importance of the pain-free aspect of the mobilization cannot be understated. If the PILL effect had not been produced during the sub-therapeutic dose, the MWM would not have been clinically indicated.[11-17] The tape application was used to prolong the mobilization and provide continued neurophysiological input to aid in the success of the intervention.

Careful assessment and clinical reasoning must take place in order to determine the proper intervention for each patient. This patient had symptoms consistent with those of patellar tendinopathy which had not improved with his treatment of ice and rest. He did report positive initial results during the assessment with the sub-therapeutic dose of the MC TIR MWM. The improvement in pain scale and muscle testing results are subjective from both the patient and the clinician, and may be a limitation of this case study. A change in joint arthrokinematics is believed to directly affect both pain and strength results of the MC TIR MWM.[12-15,17-18,22] Further case studies and controlled trials are needed to further investigate clinical efficacy. The incorporation of the MC MWM into an athletic training practice can be a powerful treatment paradigm that may produce positive results.

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