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PHYSICAL THERAPY PRACTICE

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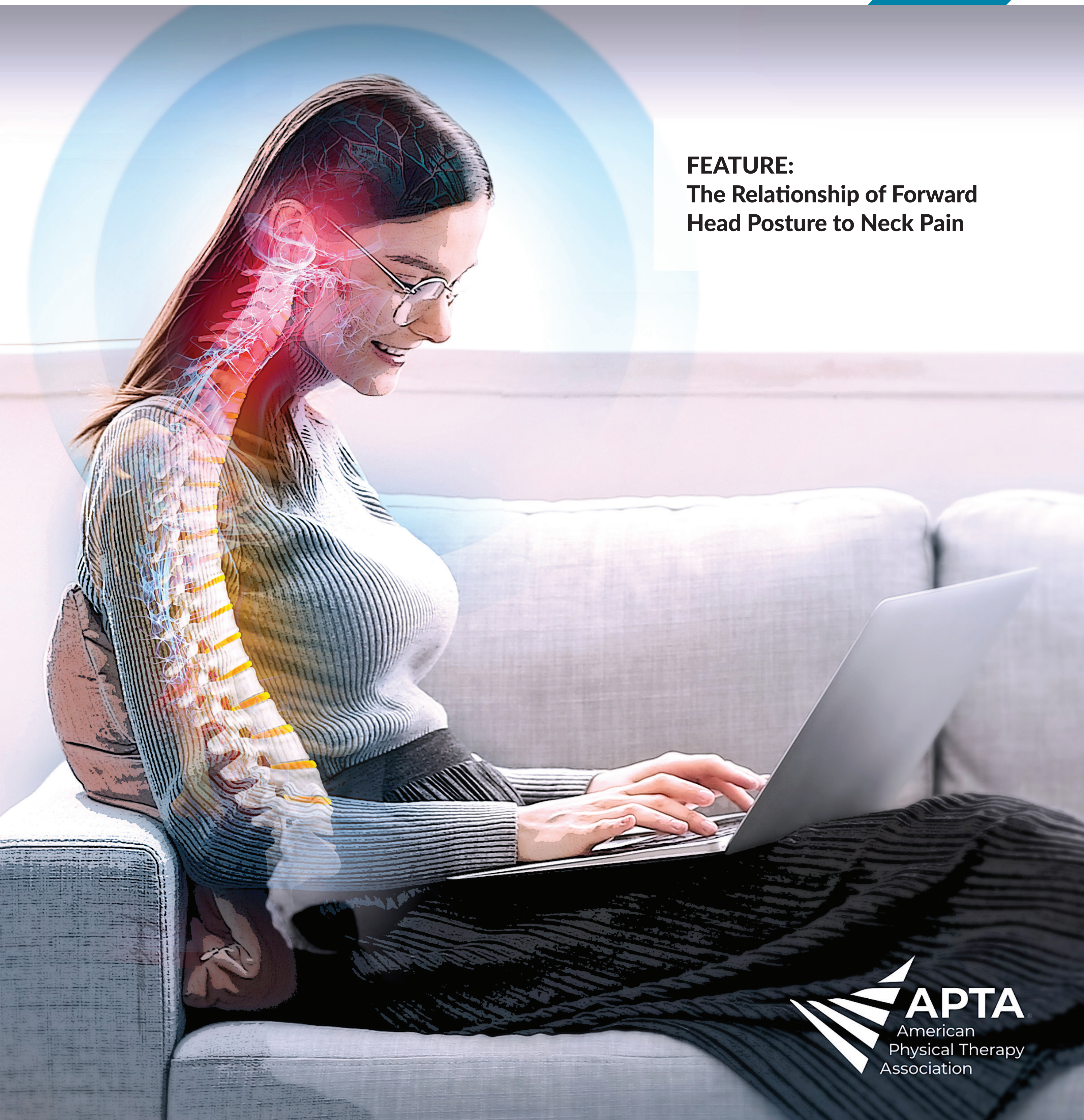

FEATURE:
The Relationship of Forward Head Posture to Neck Pain

APTA
American Physical Therapy Association

ORTHOPAEDIC
PHYSICAL THERAPY PRACTICE

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In this issue

Regular features

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To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

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Onward and Upward

In my last message to you, I shared many of the activities and initiatives the Board had accomplished within a relatively short period. From July 27-July 30, 2022, we held our summer Board meeting in Alexandria, VA in the APTA Centennial Center. As a side note, if you have not been to the Centennial Center it is worth the stop to receive a tour if you are in the DC area or just passing through. This was a unique Board meeting with a shift in our traditional culture and function for our in person meetings. All of the activities during this meeting were either generative or strategic in nature and we pushed all fiduciary activities to our monthly Zoom calls. I am happy to share some of the activities and conversations that took place:

- Although the Board is already functioning at a very high level, there is always opportunities for growth and improvement. Therefore, we brought in an external consultant group that works closely with APTA, to provide some opportunities for the Board and staff to improve our ability to function at the highest level possible. The training exercise was very well received, which was evidenced by the immediate integration, throughout the rest of the Board meeting, for many of the concepts that were presented. Needless to say, everyone is looking forward to the follow-up sessions.
- In collaboration with faculty and students at the Marymount DPT program, the Board and staff participated in a Go-Baby-Go car build for mobility-impaired children. What an incredible experience for everyone that participated!
- APTA CEO, Justin Moore shared his perspective regarding future health care trends, including many that may impact physical therapy. This led to some valuable conversation regarding opportunities for how the AOPT could better support our members.
- APTA COO, Mandy Frohlich provided a presentation regarding the current APTA Strategic Plan and compared it to the current AOPT Strategic Plan. Common touch points and opportunities for collaboration were identified. Within the conversation, it became clear that there would be times that APTA would lead an initiative while the AOPT would provide support and with other initiatives, the AOPT would take the lead and APTA would provide the support.
- The AOPT Board and staff had a breakout session where they met for 60 minutes with a member of the APTA Executive Staff Leadership Team who had a related role/function to each Board/staff member's. The purpose of the session was to build relationships, discuss current initiatives/activities within each organization, and identify potential opportunities for collaboration. Following the individual sessions, we came together as a group for 45 minutes to report out, which led to some very rich additional conversation. I am confident that this session, both the individual and group conversations, will lead to more high level future engagement between the AOPT and APTA.
- We had a presentation by the Education Committee Chair, Eric Folkins that led into a great conversation regarding how we were going to reimagine the AOPT Education Committee. In the past, the focus of the committee has primarily been on managing the educational activities associated with CSM. Although this is a big job that is critical for the success of the AOPT, this limited focus of the committee does not promote all of the potential educational opportunities that our AOPT members would value and benefit from. Be on watch for more information regarding this initiative in the near future.
- The Board has committed to being a learning organization with focus/emphasis on utilization of data. AOPT staff provided us with a presentation of multiple dashboards they have developed to assist us with assessing a variety of different metrics in order to improve our decision-making. We will continue to fine tune and develop additional dashboards to assist us with our measurement for attaining valuable and relevant data.
- AOPT staff had engaged a Marketing Consultant to perform a high-level overview of our infrastructure to provide recommendations regarding the best way for the AOPT to move forward to be more efficient and effective within the area of marketing and advertising. The Board will digest and reflect on the recommendations. Results will be shared in the near future.
- The Board had an exciting, robust, and engaging generative conversation regarding potential future initiatives that will benefit our members. Many great ideas came out of the conversation that will be implemented in the near future, so be on the watch.
- As many of you know, 2024 will be the 50th Anniversary (Golden Anniversary) of the AOPT! One of my first duties when I took office was to appoint Bill Boissonnault as the Chair of the 50th Anniversary Planning Committee. Bill, along with his Committee and AOPT staff have been developing an incredible plan to celebrate this monumental event. Bill and Tara Fredrickson presented the proposed plans. The Board provided feedback and suggestions.

Believe it or not there is actually more that was accomplished. Some of it was valuable, but not worth providing details. Some of the activities are of great value and I am so excited to have the opportunity to share them with you in a future message, once they are better framed and firm.

I am happy to answer your questions and I thank you for your support as we move forward with improving the practice environment for each of you!

Best Regards,
Bob

Editor's Note

In February, the *Journal of Physical Therapy* published a reflective Perspectives paper titled "Crises as the Crucible for Change in Physical Therapist Education" that I believe is a call to action for our profession.[1] As *OPTP* is a clinical journal, I would like to focus on what we can do as a profession in the clinic on an *everyday basis*. To summarize this article does not do it justice, so I encourage everyone to consider reading this article regarding what changes can be done in educating our students.

Nordstrom et al[1] suggest that our profession has faced 2 large shifts over the last several years, namely COVID-19 and systemic racism. Both shifts have changed all of us dramatically. Changed how we act and how we interact as clinicians with our patients and our families. Nordstrom et al suggest that to change our profession we must start with our students. As an educator, I agree with this statement, but in this editorial, I would like us all to consider how we as clinicians can change how we interact in the clinic, our profession, and our community.

As a clinician, you may work, like me, for an orthopedic outpatient clinic that requires mandatory modules to be completed on an annual basis. Some of these modules are well done and some are not so good. A recent module was on implicit bias and racism. As a white male, I see that I have had certain privileges growing up even though my family was a struggling lower middle-class family. Nordstrom et al[1] point out that evidence suggests that 60-80% of clinical outcomes are tied to the social determinants of health. The World Health Organization describes social determinants of health as the 'conditions people have born, grow, live, work and age in society'.[2] You probably see this in the clinic, like I do. I would like to assume that the patients I care for are able to follow my advice for changing behavior—involving sleep, nutrition, home exercise programs, posture, and resources that for the most part, I take for granted. This is just not so for many of our patients. We cannot assume that everyone has the same opportunities as we do as physical therapists and recognizing this in how we interact with our patients is important.

If you are reading this editorial, you are most likely an Academy of Orthopaedics member. Most of our profession decide to be a member of the APTA because of our interest in specific content areas like Orthopaedics. Less than 10% of us are actively engaged in our Academy and about the same number of our Academy votes for the newest leaders to run our Academy. Here is my call to action for you. Commit to one item that helps our profession in 2022. This can be through our Academy, APTA, AAOMPT, or any item that helps our profession. An example is to register for the Celebration of Diversity event at Combined Sections Meeting in San Diego that benefits the Minority Scholarship Fund. If you can't go to CSM, then contribute to the Minority Scholarship Fund. Do what you can to contribute to improving our profession through improving opportunities for the underserved.

Nordstrom et al[1] describe our preparation to become physical therapists as developing our hands and our clinical reasoning skills. I feel our Academy does this very well through our courses, monographs, CSM sessions, and opportunities for growth by being involved in our Academy. Nordstrom et al[1] also details that what we need to work on more is developing the habits of our hearts. Most of us entered our profession proclaiming that we want to join a profession that helps people. We do! We help people achieve their goals on a daily basis. Should we do more? Can we do more? Most of us give so much of ourselves that we believe we have nothing else to give. Here is my second call to action for you. Our communities need us. We need to ask ourselves what each of us can do to make our community a better place. A recent trip to a large metropolitan area provided me with a different perspective when I reflected what I learned from the Nordstrom et al[1] article, what I learned from my recent work module, and what I was observing all over this city. I saw a large number of people that need to be respected. That needed a smile or eye contact and a greeting. I saw a lot of people who would benefit from seeing a physical therapist for their mobility conditions. Take action in your community. We can impact society to improve the human experience and collectively, each of us can do our part.

Respectfully submitted,
John Heick, PT, PhD, DPT
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The Relationship of Forward Head Posture to Neck Pain

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ABSTRACT

Background and Purpose: Forward head posture (FHP) is considered an integral part of a physical therapy examination for neck pain. Several methods are used to assess FHP from visual observation to devices such as the cervical range of motion (CROM) device. A gap in the literature exists in showing a correlation of FHP and the presence of neck pain. The primary purpose of this study is to determine if a relationship exists between the distances of FHP using the CROM device in those with or without neck pain. Additional aims explored whether FHP worsens with age and neck pain chronicity. **Methods:** Seventy-nine adults with and without neck pain participated, mean age, 49.4± *years*, age range 18 to 85 yrs. The Neck Disability Index (NDI) was completed and FHP assessed using the CROM. **Findings:** There was an inverse relationship found in that those participants who reported no neck pain had increased FHP. There were no differences between those with acute or chronic neck pain and age was not a factor. **Conclusion:** The relationship between neck posture and neck pain suggests there are more factors leading to cervical pain than posture alone.

Key Words: cervical range of motion, forward head posture, neck disability

INTRODUCTION

An estimated 17.9% of adults between the ages of 18 and 75 years, develop neck impairments every year leading to subsequent pain and disability.[1,2] Incidence of neck pain in the general population has been estimated to be 86.8%. It is commonly reported that an association between age and neck pain exists, with symptoms worsening with age.[2-4] Complaints of neck pain within occupations are most common in office and computer workers (57%), with high rates in health care and transit operators.[3] Risk factors for acquiring neck pain include age, gender, genetics, psychological health, and tobacco use along with occupations requiring prolonged sitting.[4,5] Contrary to belief, most individuals with neck pain do not experience complete resolution of their symptoms and disability.[1] Over 50% of patients with neck pain are referred to physical therapy from their general practitioner for conservative treatment and therefore comprise a large patient population seeking competent and effective evaluation and treatment by physical therapists.[6]

In clinical practice, postural assessment is frequently included as a first step when examining people with neck pain. Forward head posture (FHP) is believed to contribute to neck pain and is highly prevalent in people who sit for extended periods.[7-9] Forward head posture is defined as the anterior displacement of the head from vertical alignment of a straight line that passes through the external auditory meatus, the acromion of the shoulder, just behind the greater trochanter of the hip, the center of the knee joint, and through the lateral malleoli of the ankle.[10,11] This anterior displacement means that the supporting structures—bones, ligaments, and muscles—must support heavier loads due to the increased moment arm of the head resting in front of the shoulders in relation to the glenohumeral midline.[12,13] These structures must increase their tensile strength to support the anterior-displaced head leading to increased stress and strain on the body. Chronic FHP is associated with poor perceptional awareness of 'good' posture and is believed by many people to be a significant factor leading to neck pain.[14]

While FHP is often assessed by the clinician, it is a complex concept to objectively define.[15] Intrarater reliability of visual assessment of cervical spine postures is fair while interrater reliability is poor.[16-18] The cervical range of motion (CROM) device is a relatively inexpensive clinical assessment tool. The CROM device is a highly reliable tool for measuring FHP objectively in the hands of trained clinicians.[18]

Despite the common analysis of FHP in physical therapy evaluations, little research exists that objectively quantifies FHP when using devices such as the CROM instrument.[18] Visual observation remains a prominent method of FHP assessment in many physical therapy clinics however it is least reliable. There is no standard measure of FHP that correlates with forward head angles in the acute versus chronic neck pain populations nor do guidelines exist detailing the amount of FHP a physical therapist should intervene to prevent the development or decrease the severity of FHP as a contributor to neck pain. Physical therapists need to have robust and quantifiable measures when determining and recommending treatment options for patients. The primary purpose of this study was to examine whether a relationship exists between the distances of FHP using the CROM device in those with neck pain as compared to those with no neck pain. Additional aims were to determine (1) if those with neck pain have FHP ≥20.5 cm and those without neck pain have FHP <20.5 cm measured with the CROM device, (2) to investigate if the severity of FHP is greater in those with chronic versus acute neck pain, (3) does age play a factor in neck pain. Based on the current body of literature and practice, the authors hypothesize that individuals with neck pain will have FHP and those with increased chronicity of pain will have exaggerated FHPs.

METHODS

Following Winston Salem State University IRB approval, a comparative observational design was performed. Recruitment took place at Winston Salem State University, Super Senior Day at the Hanes Hosiery Community Center in Winston Salem, NC, and Mount Airy Senior Health Fair in Mount Airy, NC. Participants were offered a chance to win a $25 gift card for their participation. Exclusion criteria included age under 18 years, neurologic impairments that prevented the ability to hold the neck and head upright, resting tremors of the neck and head, surgical fusion of the cervical spine, and cervical or shoulder surgery in the past 3 years. A priori power analysis was not performed however a power analysis was calculated with the analysis of variance (ANOVA).

Participants were divided into 3 groups according to their history of neck pain: no neck pain, acute neck pain, and chronic neck pain. The authors chose to use commonly defined terms for acute neck pain as pain present ≤3 months and chronic neck pain as lasting >3 months.[2,3,10] Those participants in the pain-free neck control group were included if they had no reported neck pain in the last 3 years. Participants in the neck pain groups were included if they had a history of acute or chronic neck pain of at least 3 or more months duration.

Participants were provided a written description of the study that outlined test procedures, purposes of the study along with detailing how the data and photographs were to be used. Following the completion of a written consent form, participants completed a questionnaire regarding age, occupation, and history of neck pain. Additionally, participants completed the Neck Disability Index (NDI) questionnaire. According to a systematic review by MacDermid et al,[19] the NDI is a valid and reliable measure for people with acute and chronic neck pain stemming from various conditions including musculoskeletal, neural, traumatic, or non-traumatic events, and it is appropriate for both clinical and research purposes.[19] In a systematic review by Pietrobon et al, the NDI was one of only a few scales to be revalidated in different study populations.[20]

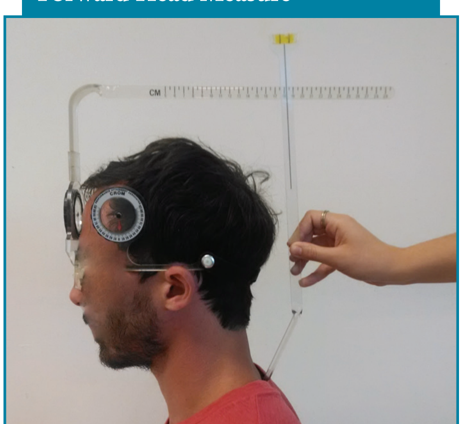
One researcher was responsible for data collection ensuring that exclusion and inclusion criteria were followed. A second researcher was responsible for operating the CROM instrument. Each researcher completed the same task with all participants Unintentional bias was reduced by having the researcher in charge of the CROM instrument blinded as to the demographic information and NDI questionnaire responses.

Head position was measured using the CROM device following the methods applied by Garrett et al.[18] The CROM is a highly reliable and valid tool for clinical use.[18] Participants were asked to remove eyeglasses if worn to allow the CROM device to rest comfortably around their head while resting above the ear. They assumed a sitting position in a backed chair with hands relaxed in their lap, with hips and knees at approximately 90°, and weight equally distributed on the seat. The researcher aligned the CROM instrument over the bridge of the nose and ears and fastened the Velcro straps located posteriorly to secure the device to the head. The forward head arm was attached to the instrument at the bridge of the nose. The participants head was then positioned so that the sagittal dial meter read zero to achieve horizontal placement of the head and ensure that the eyes are directed straight ahead as performed by Garrett et al[18] (**Figure 1**).

The same researcher palpated the C7 spinous process and placed the inferior foot of the vertebra locator on the C7 spinous process. The vertical alignment of the vertebra locator was ensured using the bubble level, adjusting until the bubble on the superior head was within the marked center position. Participants were instructed to keep the eyes looking straight ahead and to protrude and retract the lower cervical spine 3 times. After performing this movement pattern, the participant was told to "allow your head to assume its most comfortable resting position." The researcher recorded the measurement in 0.5 cm increments representing the point reached the 90° intersection of the vertebra locator and the forward head arm.[18] A total of 3 trials was recorded for each participant, the trials were averaged.

Descriptive statistics included mean and standard deviation for age, forward head average in centimeters and NDI scores. Frequency and percentages were calculated for history of neck pain and chronicity of neck pain. Individuals were divided into 3 groups for comparison between those without neck pain, with neck pain ≤3 months and >3 months. One-way ANOVAs were performed to determine if there were differences in forward head measures and the NDI between groups. Post-hoc analysis was performed using Bonferroni multiple comparison tests to distinguish differences between specific groups. Chi-square coefficients were determined for the association between the presence of FHP (≥20.5 cm) and history of neck pain. A Pearson coefficient was calculated to determine the correlation between forward head averages and NDI scores. Means were considered significant if $p \leq 0.05$.

Figure 1. Example of Cervical Range of Motion Measure to Illustrate Forward Head Measure



RESULTS

A total of 79 participants were initially recruited with 4 participants excluded due to previous cervical fusion or cervical surgery, leaving a total sample of 75 participants. The average age was 48.4, ranging from 18 to 85 years. The average NDI score was 15.8 and the average forward head CROM measurement was 20.0 cm across all subjects (See **Table 1** for values by group). Frequency analysis of neck pain during the past 3 years found 64% (n=48) of participants reported having neck pain in the past 3 years. Sixteen percent of the participants had neck pain ≤3 months, 44% had neck pain >3 months, and 40% had not had neck pain within the past 3 years. Forty-five percent had FHPs ≥20.5 cm, while 55% (n=41) had postures below 20.5 cm (**Table 2**). There was no significant association between the FHP groups and neck pain groups, (Chi=4.587, $p=.101$). However, there was a significant, but small relationship between the NDI total and the forward head measure (CROM) of $r = -.331$ ($p=.004$). This relationship is demonstrated in **Figure 2**.

There was a significant difference between the neck pain groups for the NDI ($p \leq .001$, $\eta_p^2 = .29$. A Bonferroni multiple comparison test found that significant sub-group differences were between the no pain in 3 years group and those with chronic neck pain (>3months) ($p \leq .001$). There was also a difference between the 3 groups for the average forward head measure ($p=.009$, $\eta_p^2 = .12$. Like the NDI, the only sub-group difference was between the no pain in 3 years group and the chronic pain group ($p=.008$).

DISCUSSION

This study found that there was not a significant difference in FHP angle measured between those with neck pain and those without neck pain. This was contradictory to the working hypothesis that those with neck pain would have increased FHP. Additionally, study results found no relationship between acute (<3 months of pain) versus chronic neck (>3 months of neck pain) pain and FHP angle. This too was inconsistent with our working hypothesis that increased chronicity of neck pain would exacerbate FHP.[5,22] It is frequently reported that patients with FHP also have neck pain and likely the postural deficit is a contributory factor in their symptoms.[5] It

Table 1. Mean, Standard Deviations, Minimum and Maximal Values for Age, Neck Disability Index, and Forward Head Position by Neck Pain Groups

		N	Mean	Standard. Deviation	Minimum	Maximum	95%CI	Sig
AGE	≤3 months	12	41.9	21.97	18	76	27.70 ± 55.88	
	>3 months	32	47.5	19.39	18	75	40.48 ± 54.46	
	No neck pain	29	52.3	23.26	20	85	43.50 ± 61.19	
	Total	73	48.5	21.44	18	85	43.49 ± 53.50	
NDI	≤3 months	12	16.25	5.802	11	33	12.56 ± 19.94	
	>3 months	33	18.79	5.716	10	33	16.76 ± 20.81	≤.001
	No neck pain	30	12.30	2.950	10	24	11.20 ± 13.40	≤.001
	Total *	75	15.79	5.614	10	33	14.49 ± 17.08	≤.001
FHP	≤3 months	12	19.583	3.0071	14.5	24.3	17.6 ± 21.49	
	>3 months	33	19.136	2.4838	13.5	23.2	18.26 ± 20.02	.008
	No neck pain	30	21.228	2.7128	17.2	28.0	20.22 ± 22.24	.008
	Total	75	20.044	2.8046	13.5	28.0	19.40 ± 20.69	.009

*p ≤ .001
Abbreviations: NDI, Neck Disability Index; FHP, forward head posture

Table 2. Neck Pain Groups by Forward Head Classification

			Forward Head Groups	
			< 20.5°	≥ 20.5°
Neck pain groups	≤ 3 months	Count	7	5
		% Within Neck Pain Groups	58.3%	41.7%
		% Within Forward Head Groups	17.1%	14.7%
	> 3 months	Count	22	11
		% Within Neck Pain Groups	66.7%	33.3%
		% Within Forward Head Groups	53.7%	32.4%
	No neck pain	Count	12	18
		% Within Neck Pain Groups	40.0%	60.0%
		% Within Forward Head Groups	29.3%	52.9%
	Total	Count	41	34
		% Within Neck Pain Groups	54.7%	45.3%
		% within Forward Head Groups	100.0%	100.0%

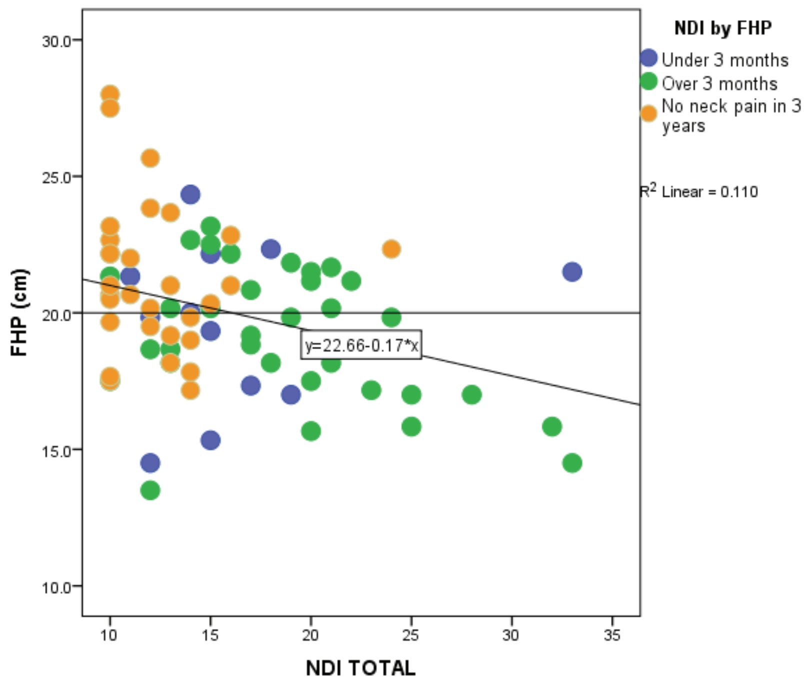
is also commonly reported that people with chronic neck pain have associated FHP but this was not supported in this study.[5,22]

Postural assessment of the cervical spine is often a key examination component of a physical therapist evaluation. Based on the evaluation, conclusions are drawn, and treatment interventions are recommended.[7,8] Effective treatment is dependent upon the reliability and accuracy of assessment measures. Unfortunately, few quantifiable measures exist for what constitutes FHP. The CROM is a device used to measure both range of motion of the cervical spine and FHP. However, there is no normative value associated with quantifying FHP. White et al attempted to identify what visually constitutes FHP and correlate it to the CROM device.[21] Based on study findings, FHP was defined as 20.5 cm or greater based upon clinician consensus when using the CROM device.[21] In the current study, the average FHP was 20±2.8 cm indicating that 55% of participants did not meet the cut-off defined by White et al as being representative of FHP.[21] This finding alone supports the need for having definitive and objective methods when recording this postural deficit versus singularly relying on visual observation.

When considering the relationship of neck pain and FHP depicted in the data from this study, the variability is important to consider. The broad variability in individual data represented (**Figure 2**) shows there may be limited conclusions to be drawn singularly from the objective measurement of FHP. Additionally, it is reported that neck pain increases with age[4] and may be associated with more FHP. In this study, age did not however appear to play a role consistent with older participants having more FHP and thus more pain. The average age of those with neck pain was younger at 43.64±3.27 years than those without neck pain at 55± .52 years, which was an unexpected finding.

Participants in this study were not blinded to the purpose or the types of postural measurement tools used. Additional limitations included participants being aware that their posture was being measured thus they may have attempted to correct

Figure 2. Relationship Between Forward Head Position (FHP; cm) and Neck Disability Index (NDI)[a]



[a]Relationship =-.331, p=.004. Line at 20 cm mark represents the cut-off between previously identified forward head versus no forward head.

their head positioning. Several participants required the researcher's aide to read the demographic and NDI forms due to visual impairments, which may have affected their answers. These limitations present a possible threat to construct validity and experimental bias based on interaction between the participant and researcher.

Additional research is needed in this area and potential future studies should continue to look at the relationship between neck pain and posture, as well as looking at other ways to objectively assess FHP.

CONCLUSION

In the current study, there was an unexpected inverse relationship between FHP and neck pain. The authors also found that NDI scores did not correlate with FHP. The authors believe that people with acute neck pain would not have FHP while those with chronic neck pain would have the presence of FHP. This however was not the case as no statistical difference in FHP angle whether symptoms of neck pain were acute or chronic were found. The authors found an inverse relationship in that those with acute symptoms had more FHP. Forward head posture alone is not a predictor of neck pain.

As physical therapists, the assessment of FHP is an important part of the objective examination; however, therapists need to account for other factors that contribute to neck pain other than posture alone.

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Physical Therapy Management of a Patient with Patellar Tendinopathy Recovering from Contralateral Anterior Cruciate Ligament Repair: A Case Report

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ABSTRACT

Background and Purpose: The literature on patellar tendinopathy treatment has largely focused on strengthening programs that have not provided detailed explanations of treatment for a full return to sport (RTS). Returning to a high level of sport following anterior cruciate ligament reconstruction (ACLR) can be challenging, with many athletes not able to return to the prior level of competition. The purpose of this case study is to demonstrate a treatment approach for a patient with patellar tendinopathy and inadequate recovery after ACLR on his contralateral knee. Intervention was geared toward full return to sport. **Methods:** The focus of treatment was a 4-stage progressive patellar tendon loading program and sport-specific training. **Clinical Findings:** The patient was discharged after 15 visits with full sport participation. Clinically significant improvements occurred on multiple functional outcome measures. **Clinical Relevance:** Limited evidence exists for the most effective RTS progression for patellar tendinopathy. This report describes how energy storage and sport-specific exercises can be effective for patellar tendinopathy and incomplete ACLR rehabilitation to RTS. **Conclusion:** Clinicians should consider using energy storage exercises for patients with patellar tendinopathy and ensure recovery after ACLR with objective and qualitative RTS criteria.

Key Words: isometrics, energy storage, loading

BACKGROUND

Patellar tendinopathy is a clinical diagnosis of pain and dysfunction of the patellar tendon. This condition most commonly affects male jumping athletes with the prevalence varying depending on the sport.[1] Estimated prevalence ranges from 14.2% in the general athletic population to 55% in elite basketball players.[2] In recreational athletes, the prevalence has a range greatest in volleyball players (14.5%) and least in soccer players (2.5%).[3] Knee pain and dysfunction can persist for years with as many as 53% of athletes with patellar tendinopathy stopping sport participation.[4]

In a recent systematic review, eccentric, heavy slow resistance (HSR), and isometric exercise were all effective in the management of patellar tendinopathy.[5] The eccentric protocol involved performing a 3 second eccentric phase unilateral decline squat on a 25º slant board for 3 sets of 15 repetitions. This program was performed twice daily for 12 weeks.[6-8] The HSR protocol starts at an intensity of 15 repetition maximum (RM) progressing over time to 6RM for 3-4 sets for bilateral squat, leg press, and hack squat exercises. The program is performed 3 times per week for 12 weeks.[8]

Time under tension is the total amount of time during exercise that a load is applied to muscle-tendon units. Heavy slow resistance, short duration isometrics, and long duration isometrics are equally effective for reducing patellar tendon pain when controlling for time under tension and total rest for the loaded knee extension exercise.[9,10] Long duration isometric protocols have involved 45 second holds at greater than 70% maximal volitional contraction (MVC) for 5 sets with 2 minutes rest between sets,[11] or 6 sets of 40 second holds at 85% MVC with 80 seconds rest between sets.[9] Short duration isometric protocols have involved 24 sets of 10 second contractions with 20 seconds rest between sets at 85% MVC.[9]

Malliaras et al[12] have proposed a 4-stage rehabilitation approach for treating patellar tendinopathy that involves isometric exercises in Stage 1 and isotonic exercise in Stage 2. Stages 3 and 4 involve energy storage exercises and sport-specific training, respectively.[12] Energy storage exercises involve greater tendon load exercises such as running, jumping, and cutting. Sport-specific training focuses on sport-specific movements that gradually build capacity of the tendon to tolerate the demands of the sport.[12] Cook et al[13] defined load capacity as "being able to perform functional movements at the volume and frequency required without exacerbating injury or causing tissue injury."

Building tissue capacity and sport-specific training are also essential for anterior cruciate ligament reconstruction (ACLR) rehabilitation. Return to sport rehabilitation after anterior cruciate ligament repair can be challenging. In non-elite athletes, up to 66% did not RTS at 12 months after ACLR.[14] In elite athletes, 17% did not RTS after ACLR, and athletes who did RTS did so at variable timelines ranging from 6-13 months.[15] Additionally, secondary injury rates after ACLR are significant with 29.5% of young athletes suffering a second ACL injury within 2 years,[16] and an overall second injury incidence of 15% for all athletes.[17] The potentially devastating effects on the athletes' sports participation highlights the importance of effective treatments and decision-making for RTS.

No consensus exists regarding objective RTS criteria for patients following ACLR rehabilitation,[18] but objective testing commonly involves passing a series of hop tests and dynamometry strength testing of the quadriceps and hamstrings muscles at greater than 90% limb symmetry index (LSI).[19] Limb symmetry index compares performance of the involved extremity against performance of the uninvolved extremity and is expressed as a percentage. In addition to objective RTS criteria, quality of sport-specific movements[20-21] and psychological readiness[18,22] are important factors to consider when returning an athlete to high levels of sport.

Many investigators have examined RTS criteria for ACLR,[18-19,22-24] but little evidence exists to guide patellar tendon loading in the latter stages of the loading program, including energy storage exercises and, eventually, a full return to the demands of sport. Studies on physical therapy intervention for patellar tendinopathy have largely focused on isometric and isotonic exercise. The purpose of this case study is to demonstrate a treatment approach for a patient who had patellar tendinopathy and inadequate recovery from a recent ACLR on his contralateral knee. The overall rehabilitation effort was geared toward full RTS.

CASE DESCRIPTION

Patient History

The patient was a 20-year-old male soccer player who aspired to compete professionally. The patient was referred to our clinic with a diagnosis of patella alta and patellar tendonitis of the left knee after his 9-month follow-up for right ACLR. He was cleared for full RTS participation by the orthopedic surgeon. The patient reported left anterior knee pain that was aggravated primarily with jumping, running, and playing soccer. The patient's symptoms started over 2 years ago after a period of increased volume of plyometrics, including unilateral jumping. The patient rated his pain at 0/10 in his left knee on the 11-point Numerical Pain Rating Scale (NPRS). However, he rated his pain at 6/10 on the NPRS after approximately 20 minutes of playing soccer. The pain during sport would cause the patient to stop sport participation and would persist throughout the following day. The patient also reported fatigue and reduced confidence in the stability of his right knee during soccer play.

The patient had received rehabilitation for his right ACLR with another therapist for 25 visits over a 19-week period and then was discharged from care. He was discharged based on passing the functional movement screen and a high score on the Lower Extremity Functional Scale, without any strength testing with a dynamometer or any hop testing. The highest level of RTS exercises he was performing at the time of discharge involved "light" plyometrics, jogging, and cutting drills.

The patient was working as a personal trainer at a local gym and trained regularly at this facility. The patient's lower body workouts at the time of the initial evaluation were barbell squats, deadlifts, front squats, and lunges. He could complete the lower body resistance training with low levels of pain. The patient reported completing multiple sets of 4-6 repetitions at a resistance greater than 75% 1RM. The radiographs of the patient's knee were normal, other than left patella alta. No red flag concerns or other relevant past medical history were present. The patient was not using any anti-inflammatory or analgesic medication. His main goal was to RTS at his pre-injury level.

The patient-reported outcome measures for this patient were the Knee Injury and Osteoarthritis Outcome Score (KOOS) Symptoms and Function in Sport and Recreation (Sport/Rec) subscales, the Patient Specific Functional Scale (PSFS), the NPRS during sport, and the Victorian Institute of Sport Assessment Questionnaire, Patellar Tendon (VISA-P). The scores for the initial evaluation and follow-up visits are in **Table 1**.

Examination

The patient had full knee range of motion (ROM) without pain with overpressure. Strength testing was globally 5/5 for both lower extremities. Ligamentous special testing for both knees was normal and pain-free. Joint mobility testing was normal, except hypermobile superior and inferior glides of the patellae bilaterally. Flexibility testing for the quadriceps and hamstrings muscles was normal. Palpation of the inferior pole of the left patella and unilateral jumping on his left lower extremity were the only tests that reproduced his pain. The results of the physical exam are in **Table 2**.

Return to sport testing was completed on the third visit. Limb symmetry index of greater than 90% was set as this patient's criterion for RTS.[18,19] Included in the LSI analyses were quadriceps and hamstrings dynamometry strength testing, the single hop, triple hop, cross-over hop, and 6-meter timed hop tests. Isometric belt-fixated dynamometry strength testing was performed for the quadriceps (**Figure 1**) and hamstring muscles using techniques that have been validated.[25-26] The results of the hop and strength testing are in **Table 2**. Limb symmetry index assessments were computed by comparing the right lower extremity performance data in the numerator to the left lower extremity performance data in the denominator. On the third visit, the patient passed all hop tests and isometric strength testing with greater than 90% LSI, except the triple hop test (86% LSI). Since the patient's left extremity had a chronic patellar tendinopathy, the LSI computations for the right lower extremity were likely overestimated early in treatment. Qualitatively, the patient demonstrated poor landing control with significant

Table 1. Patient-reported Outcome Measures, Hop Tests, and Dynamometry

Outcome Measure	Results							
	Initial Visit (Week 0)		Visit 3 (Week 3)		Visit 7 (Week 7)		Visit 12 (Week 13)	Visit 15 (Week 19)
KOOS Symptoms	33/35				34/35		34/35	34/35
KOOS Sport/Rec	18/20				20/20		20/20	20/20
PSFS	7.3				8.7		9.3	9.3
VISA-P	61/100				86/100		86/100	90/100

Outcome Measure	Visit 3 R	Visit 3 L	Visit 7 R	Visit 7 L	Visit 12 R	Visit 12 L	Visit 15 R	Visit 15 L
Single Leg Hop Test (in)	60	64	65	66	60	58	76	81
Triple Hop Test (in)	181	210	212	225	196	223	208	206
Cross-over Hop Test (in)	160	169	154	147	156	181	165	163
6-meter Timed Hop Test (sec)	1.85	1.85	1.82	1.84	1.84	1.85	1.78	1.87
Isometric Quadriceps Strength (lb of force)	70.6	75.0	80.8	92.4	82.1	106.6	100.7	109.1
Isometric Hamstrings Strength (lb of force)	71.4	73.9	80.9	82.8	83.3	89.9	102.6	103.7

Abbreviations: KOOS, Knee injury and Osteoarthritis Outcome Score; Sport/Rec, Function in Sport and Recreation; PFPS, Patient Specific Functional Scale; VISA-P, Victorian Institute of Sport Assessment, Patellar Tendon; in., inches; sec, seconds; lb, pounds

Table 2. Physical Examination Findings for the Patient in this Case Report

Visual Inspection	Left patella appeared more superior than normal
Strength	Gross strength testing of 5/5 globally and painless for bilateral lower extremities
Knee Range of Motion	(-) pain, 5-0-140° bilaterally
Muscle Length	Passive knee extension test – lacking 15° bilaterally Ely's test – heel to buttock bilaterally
Joint Mobility/Palpation	Tibiofemoral – within normal limits bilaterally Patellar: within normal limits for medial and lateral glides, hypermobile superior and inferior glides bilaterally (+) pain with palpation to inferior pole of the patella on the left
Special Tests (all bilaterally)	(-) pain and laxity for varus and valgus stress test at 0° and 30° knee flexion (-) Lachman's test (-) patellar apprehension test (-) pain with knee hyperextension with overpressure
Functional Tests	Bilateral squat – full depth without pain Single leg squat – depth of approximately 75° knee flexion without pain, dynamic valgus bilaterally Bilateral jump landing – decreased trunk/hip flexion, knee flexion and hip extension without pain Unilateral jump landing – decreased trunk/hip flexion, knee flexion and hip extension with infrapatellar pain on the left

Figure 1. Isometric Belt-fixated Dynamometry Testing for the Quadriceps Muscles

right dynamic knee valgus compared to his left knee. This matched his subjective reports of more difficulty and less confidence with his right knee during testing.

The primary subjective finding consistent with a working diagnosis of patellar tendinopathy was high tendon load dependent infrapatellar pain that started after an increase in volume of plyometrics. Pain also progressively worsened and continued throughout the following day after high tendon load activities. The primary objective findings corroborating patellar tendinopathy were tenderness to palpation of the inferior pole of the left patella, a stiff landing strategy with jumping, and pain provocation at the inferior pole of the patella during unilateral jumping. A cardinal feature of patellar tendinopathy is load dependent pain provocation.[12,28] Energy storage exercises develop the greatest rate of force through the patellar tendon. The transition from half of the patient's body weight with bilateral jumping to full body weight with unilateral jumping produced sufficient loading within the patellar tendon to provoke the patient's pain.

The primary findings consistent with an inadequate recovery from right ACLR rehabilitation were subjective reports of fatigue and decreased confidence compared to his left knee during sport, poor unilateral squat mechanics, and poor jump landing mechanics. The patient demonstrated increased dynamic knee valgus during unilateral squats with the right extremity compared to the left. He also reported significant fatigue of his right quadriceps muscles after 10 unilateral vertical hops in place with the same stiff landing pattern observed on the left extremity. These movement patterns clearly demonstrated deficits in strength, power, and jump landing mechanics that necessitated further treatment.

INTERVENTIONS

Based on the working diagnoses of patellar tendinopathy and incomplete ACLR rehabilitation, initial conservative management of physical therapy was appropriate. Most controlled trials of physical therapy management for patellar tendinopathy focus on a resistance training program of eccentrics, HSR, or isometrics.[5-11] A progressive loading program similar to the 4-stage rehabilitation program proposed by Malliaras et al was used for this patient.[12] Patellar tendon load tolerance was assessed using the pain monitoring model.[29] Thresholds for training were established with the following as guidelines: (1) pain 5/10 or less during the activity[29] and (2) pain returning to baseline within 24 hours after the activity during a single leg decline squat.[12,28] All interventions were performed on both extremities because of the patient's contralateral incomplete post ACLR recovery.

Based on subjective and objective examination findings, the patient was classified as being in the energy storage phase. This phase was chosen because he could perform his resistance training exercises with minimal pain (3/10 or less) and the pain returned to baseline within 24 hours following activity.[12] In this phase, several authors have recommended a loading cycle of low, medium, and high patellar tendon loading forces on consecutive days.[12,28] The loading cycle recommended for this patient is described in **Table 3**.

For medium load days, the patient was instructed to continue with the resistance training program he was currently performing with the addition of unilateral seated knee extension exercises for each lower extremity. Adding unilateral knee extension enabled isolated patellar tendon loading and quad-

Table 3. Patellar Tendon Loading Cycle Recommendation

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Week 1	Medium	Low	Medium	Low	High	Low	Off/low
Weeks 2-6	Medium	Low	Medium	Low	High	Low/off	High
Weeks 7-12	Medium	Low	High	Medium	High	Low/off	High
Weeks 13-19	Medium	High	Low/off*	Medium	High	High	Low/off*

Low: Isometrics, soccer drills at low intensity (eg, footwork)
Medium: Isotonics, heavy slow resistance, soccer drills at moderate intensity
High: Energy storage exercises, sport-specific training, soccer games
Off: Optional day rest of exercise
*Isometrics recommended as needed for pain relief

Figure 2. Spanish Squats

riceps strengthening. The patient performed his resistance training program twice weekly. The patient was not performing eccentric or HSR exercise for his resistance training program, but instead he was performing a slow (3 seconds or greater) eccentric and a relatively quick concentric (less than 3 seconds) phase type of exercise. A quicker concentric phase requires more power, and power is important for his sport. Instead of modifying his resistance training to include eccentrics or HSR, isometrics were added for additional time under tension. The patient performed unilateral resistance training exercises on both extremities, because strength is important for post ACLR recovery and is protective against reinjury.[23,24]

On low load training days, the patient was instructed to perform Spanish squats (**Figure 2**) for 45 second isometric holds at approximately 60° knee flexion for 5 repetitions with a 2-minute rest between sets. Spanish squats involve placing a non-elastic belt behind the knees and anchored to an immovable object. This exercise was chosen because it can be easily performed at the patient's home, unlike a loaded knee extension, and is a bilateral movement, that facilitates strengthening and loading for both knees simultaneously. On the initial visit, the patient was not able to complete the full 45 second set, indicating volitional failure. Cook et al recommend avoidance of maximal intensity exercise or muscle fasciculations during isometric exercises for tendon pain,[12,28] but the intensity was not altered because the goal of the isometrics was added time under tension and not pain relief. Although the main goal was not pain relief, the patient experienced relief of his pain immediately after performing the isometric exercises. The patient reported the isometric exercise consistently reduced his pain throughout the remainder of the rehabilitation effort.

Landing mechanics training was introduced at the beginning of the energy storage phase, with the goal of reducing the stiff landing of reduced trunk, hip, and knee flexion. This upright posture with landing is associated with greater knee extensor moments, reduced hip extensor moments, and increased patellar tendon forces. Landing with greater trunk and hip flexion angles results in reduced knee extensor moments and reduced patellar tendon forces.[30,31] Drop jumps are commonly used to train jump landing mechanics and were performed with cueing to promote increased trunk, hip, and knee flexion to decrease patellar tendon forces.[20,30,31] The greatest ACL shear force occurs during landing with knee flexion angles less than 30° with further increases in ACL shear force with greater anterior tibial translation[32,33] and decreased trunk flexion.[34] The same jump landing pattern of increased trunk, hip, and knee flexion reduces shear forces on the ACL[32,33] and was used for training the right extremity as well.

Energy storage exercises were performed in a progressive manner to build patellar tendon tissue capacity. Bilateral movements were performed before unilateral movements, and exercise volume was increased prior to increasing intensity. The number of sets varied from 2 to 3 depending on the exercise. Sport-specific activities were initiated in the clinic after week 7. Plyometrics were the main energy storage exercises performed in clinic after week 7, because they have the greatest rate of loading through the patellar tendon,[35,36] theoretically improving tissue capacity. The plyometrics are also important for improving neuromuscular performance and quality of movement.[20,37] A review of plyometrics and RTS training after ACLR is beyond the scope of this case report but has been extensively discussed in the literature.[21,38] A detailed list of interventions for each treatment session in this case are listed in **Table 4**.

During the seventh visit, the patient was provided a chart to monitor his patellar tendon loading activities each day. The chart consisted of the following rows: date, activity/exercise, intensity, duration, training surface material, pain during the activity, pain the next day with a single leg decline squat, and comments. The type of load performed in treatment sessions was dictated by the patient's loading patterns and tendon loading responses for that specific week. For example, during the week of visit 9, the patient played soccer on consecutive days before the treatment session and presented with pain at the time of the treatment session, indicating tendon overload. Instead of progressing energy storage exercises, HSR knee extensions were performed to avoid further overload and to decrease pain.[10]

OUTCOMES

The patient was treated for 15 visits over the course of 19 weeks. The patient's NPRS improved from 6/10 with 20 minutes of sport participation to 2/10 or less pain during two 90-minute soccer games that he played on consecutive days without pain on a single leg decline squat the following day after each game. The patient's KOOS Symptoms and Sport/Rec subscales improved from 33/35 to 34/35 and 18/20 to 20/20, respectively. The patient's VISA-P score improved from 61/100 to 90/100, exceeding the minimal clinically important difference (MCID) of 13 points.[39] The patient's PSFS average score improved from 7.3/10 to 9.3/10,

Table 4. Treatment During Each Physical Therapy Visit

Visit Number	Exercise	Dose	Other Interventions
1	Spanish squat isometrics	5 x 45 second hold	Education on activity modification – no activities that raise pain to 5/10 or greater, no soccer. HEP review that continued for the rest of treatment after every visit.
2	Bilateral drop jump Unilateral squats on stable and unstable surfaces Unilateral balance on unstable surface with soccer volleys Bilateral vertical static and horizontal jumps in sagittal and frontal plane over 4” hurdles	2 x 10 reps from 8 in. height 3x 10 reps each 3 x 20 volleys 2 x 10 reps each	Jump landing mechanics training Loading progression education
3	Hop tests Unilateral squats on unstable and stable surfaces	 3 x 10 reps	Reinforce previous education topics
4	Unilateral drop jumps Unilateral jumping/landing at submaximal height (8-10 in. boxes) vertical, horizontal, multi-directional	2 x 10 reps 2 x 10 reps each	Continued jump landing mechanics training
5	Bilateral jumping/landing to a height of 28 in. and 30 in. Unilateral jumping/landing to a height of 22 in. Unilateral knee extension (both legs)	10 jumps each height 2x 10 jumps 3 sets to volitional failure	
6	Bilateral bounding jumps Split squat bounding jumps Zig zag horizontal progressing to bounding jumps Unilateral jumps over hurdles: forward, lateral, multi-directional Unilateral knee extension (both legs)	2 x 10 reps 2 x 10 reps 2 x 10 reps 2 x 10 reps each 3 sets to volitional failure	
7	Hop tests. Combination of exercises from visits 5-6 Acceleration and deceleration drills for sprinting/cutting around cones	2x10 each exercise 5 minutes	Load management education with activity tracking log that continued each visit throughout the rest of the plan of care
8	Combination of exercises from visit 5-6 Sprinting and cutting drills	2x10 each exercise 5 minutes	Education of sprinting/cutting drills to perform on soccer field
9	HSR technique training without the heavy resistance for barbell back squats, and split squats HSR unilateral knee extension	15 each with 3 second eccentric and concentric phase 5 sets to volitional failure	Education to add HSR leg extensions, barbell back squats, and barbell split squats
10.	HSR barbell back squat HSR split squat HSR TRX unilateral squat HSR unilateral knee extension	3 x 6-8 reps each exercise	Added TRX unilateral squats to HSR program

11-14	Multiple bilateral and unilateral jumping/landing in succession over hurdles and onto boxes of various heights (12 in., 18 in., 24 in.) in multiple planes External perturbations added intermittently with physioball. Soccer passes and dribbling incorporated into drills after jump landings Sport-specific movements and drills, reactive change of direction Hop tests on visit 12	2 x 5 each sequence. Max sequence of 3 jumps in a row with or without a cutting activity.	Reinforce previous education topics
15	Hop tests		Activity tracking review
Abbreviations: reps, repetitions; HEP, home exercise program; HSR, heavy slow resistance; TRX, total body resistance, in., inches; sec, seconds; R, right; L, left			

exceeding the MCID of 1.5 points for knee dysfunction.[40] The patient passed all hop tests and isometric dynamometry testing at greater than 90% LSI. The patient's quadriceps strength improved from 70.6 to 100.7 and 75.0 to 109.1 pounds of force for his right and left lower extremities, respectively. A detailed description of the outcomes in this case are in **Table 1**.

DISCUSSION

This case study describes the examination, clinical reasoning, and conservative treatment approach for an individual who presented with a subjective history and objective findings consistent with patellar tendinopathy and incomplete recovery of contralateral ACLR. The intervention involved load management through activity modification, jump landing mechanics training, a progressive patellar tendon loading program, and sport-specific training.

Energy storage exercises can produce similar tendon forces but at a significantly greater rate of patellar loading than a heavy (3 times body weight) bilateral leg press. On average, the rate of loading from a vertical jump landing and a horizontal jump landing are approximately 19 times and 42 times greater than the heavy bilateral leg press, respectively.[35,36,41] Theoretically, this greater rate of loading explains the importance of including these exercises in physical therapy programs for building tendon load capacity. Based on the estimated patellar tendon forces and rate of loading, the patient performed a sequence of static vertical jumps before he performed bounding jumps.[35,36] Energy storage exercises were progressed gradually to avoid overloading the pathological tendon from the greater rate of loading associated with these exercises.

Energy storage exercises may not produce positive tendon adaptive changes that are similar to tendon changes produced by isometric, HSR, and eccentric exercise. This could be because energy storage exercises may not have adequate time under tension to facilitate adaptive changes.[42,43] Heavy patellar tendon loading with adequate time under tension is the main component of isometric, HSR, and eccentric loading programs.[5-11] Time under tension is an important mechanism for tendon adaptation and may explain why eccentric, HSR, and isometric exercise all are effective for patellar tendinopathy.[42,43] The optimal time under tension dose is unknown, but a recent study by Hasani et al has initiated an examination of this question.[44]

The outcomes for the patient in this case are promising, as the VISA-P and NPRS during sport for this patient were as good or better than the published outcomes from other studies.[5-11] The patient was treated in formal physical therapy for a longer duration than published trials, but this case was complicated by inadequate rehabilitation of ACLR of his contralateral knee. After week 7, the patient reported his right knee status was his main barrier to RTS, stating reasons of reduced confidence and performance with cutting/deceleration, acceleration, and jumping ability. Despite minimal improvements in standardized outcome measures after visit 7, the patient reported consistent improvements in his performance and confidence in sport-specific movements, which correlated well to qualitative observation in the clinic. The authors do not believe these improvements or patient satisfaction would have occurred without a longer duration of formal physical therapy.

In addition to patient-reported outcomes, strength improved throughout treatment with the greatest gains between weeks 7 and 12 for the left knee, consistent with the timing needed to build strength.[45] Prior to visit 12, the patient had right knee pain that was not present with previous testing, potentially causing the minimal improvement in right quadriceps muscle strength compared to his left knee, since pain can inhibit muscle strength.[46] The patient did not have pain with quadriceps strength testing on visit 15, which is likely the reason for the large increase in muscle force produced compared to prior testing.

The patient may have been judged ready for discharge following his initial post ACLR rehabilitation, however, he was not adequately assessed for RTS, thereby increasing his risk of reinjury. The patient's right knee function was likely overestimated with LSI computations early in treatment because of his chronic left patellar tendinopathy, increasing the percentage due to an impaired comparison extremity. Quadriceps strength deficits may be associated with increased risk of reinjury.[23,24] Grinden et al[24] reported a reinjury rate of 33% with less than 90% quadriceps LSI compared to 13% with greater than 90% quadriceps LSI. Additionally, for every 1% increase in quadriceps LSI, reinjury risk decreased by 3%.[24] The patient in this case improved his quadriceps strength measured by isometric dynamometry in both extremities by greater than 30 pounds of force, reducing his risk of reinjury. Although the specific RTS test battery has yet to be established,[18] objective testing, especially quadriceps strength, is essential before making RTS decisions after ACLR.[18,19,23,24]

Quality of movement[18,21,38] and psychological factors[18,22] should be considered prior to RTS in addition to the assessment of objective criteria. Restoring quality of movement is not a new consideration in ACLR treatment. Dynamic knee valgus and stiff landings may be a risk factor for ACL injury.[47] Adequate ACLR rehabilitation should involve elimination of these movement patterns during a unilateral squat, unilateral jump, and most sport-specific movements. Psychological factors play an important role in an athlete's RTS decision. Results from a systematic review indicate psychological reasons may account for 65% of athletes who do not RTS. Reduced confidence and fear of injury were two of the most commonly reported psychological reasons cited in the review for athletes not returning to sport.[48] The patient in our case consistently reported reduced confidence in his right extremity throughout treatment as a major reason he was not at his pre-injury level of performance and was an important consideration throughout treatment.

Several limitations exist for this case report. The possibility exists that isometric, isotonic, and HSR exercise alone were responsible for the positive outcomes. The authors do not know the additive effects energy storage and sport-specific exercises had on outcomes. The authors do believe, however, that these additional forms of exercise are necessary to prepare an athlete for the full demands of sport and to build tissue capacity. Controlled trials are needed to evaluate the additional benefit of energy storage exercises to traditional loading programs. The adherence to loading recommendations and tendon response to loading were not recorded until after week 7. The patient may not have been adherent and/or may have overloaded the patellar tendon during this 7-week period, but this is unlikely based on the patient's subjective reports of adherence and significant clinical progress. Lastly, the psychological readiness was not assessed with a standardized outcome measure.[18] The patient consistently reported increased confidence in his sport, but the true amount of progress in this domain is unknown.

CLINICAL APPLICATION

Limited evidence exists for the most effective RTS progression for patellar tendinopathy. This case describes in detail that the addition of energy storage exercises and sport-specific exercises to a heavy patellar tendon loading program with adequate time under tension can be effective for patellar tendinopathy rehabilitation. Additionally, it highlights that inadequate recovery of ACLR on the contralateral limb can complicate and prolong treatment when returning to a high level of sports performance. Clinicians should use a battery of validated objective tests, assessments of movement quality, and patient-reported psychological readiness before clearing a patient to RTS after ACLR. Clinicians should also consider adding energy storage exercises to loading programs for patients with patellar tendinopathy.

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THE FEMALE ATHLETE THROUGHOUT THE LIFESPAN

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2. Understand the physiological, musculoskeletal, and psychological changes that often occur during pregnancy and after childbirth.
3. Understand the age-related changes that occur in the master female athlete and how these changes affect performance.
4. Recognize common acute and overuse injuries sustained by the female athlete at various stages of life.
5. Understand the principles and key components of injury prevention training for female athletes throughout the lifespan.
6. Utilize clinical decision-making to select appropriate examinations and treatment strategies of the young female athlete, the female patient during pregnancy and postpartum, and the mature female athlete.
7. Understand important guidelines for effective exercise prescription to address specific needs of the young female athlete, the female patient during pregnancy and postpartum, and the mature female athlete.

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The Pregnant and Postpartum Athlete
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The Master Female Athlete
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ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

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Do PROMIS Fatigue and Self-Efficacy Measures Show Similar Responsiveness to Pain Interference and Physical Function in Musculoskeletal Physical Therapy Patients?

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ABSTRACT

Background and Purpose: Measuring patient-rated levels of pain and physical function is a standard in musculoskeletal practice. Objectively appraising change following intervention across a broader range of physical and psychosocial attributes might be possible in this population. This analysis was to determine if Patient-Reported Outcomes Measurement Information System (PROMIS) Pain Interference (PI), Physical Function (PF), Fatigue, and Self-Efficacy for Managing Symptoms (SE) measures are responsive in musculoskeletal physical therapy patients. **Methods:** This study comprised 105 consecutive patients (48.3±18.8 years; 60% female). All PROMIS measures were completed at evaluation and at discharge. Change scores and effect sizes were calculated for the total sample and subgroups. **Results:** All measures showed significant mean T-score improvement overall. Effect sizes were moderate for PI (0.66-0.68) and PF (0.60-0.68), smaller for Fatigue and SE (both 0.38-0.42). Initial T-scores worse than published cut-off scores showed large effect sizes (≥0.80) for all four measures. Fourteen percent of patients only showed meaningful improvement in Fatigue and/or SE measures. **Clinical Relevance:** All 4 PROMIS measures are responsive across musculoskeletal diagnoses. Tracking changes in Fatigue and SE measures may provide clinicians with additional insight into patient response to treatment, particularly when not seeing improvements in pain complaints and or physical functioning.

Key Words: effect size, patient-reported outcomes, psychosocial, musculoskeletal, PROMIS, physical therapy

INTRODUCTION

For many reasons, patient-reported outcome measures (PROMs) are becoming important in healthcare. Giving patients a voice in care, PROMs can focus the patient interview on pertinent health issues for prioritizing treatments.[1-3] In physical therapy, use of PROMs to assess pain and physical functioning is well known, and recent work suggests that administering PROMs throughout the episode of care is associated with improved functional activity outcomes.[4] It is less clear if measuring other physical, psychological, and social health domains might improve clinicians' decision making for musculoskeletal patients. Using multiple PROMs to assess broad health status may improve outcomes in physical therapy by elucidating health-related factors, otherwise undetected, that impact rehabilitation.[3,5] Of concern is whether such PROMs can capture change in symptoms and functioning over a course of treatment.

One PROM option spanning multiple health domains is the Patient-Reported Outcomes Measurement Information System® (PROMIS). Comprising over 300 self-report measures of perceived physical, mental, and social health status,[6] PROMIS measures can be administered regardless of diagnosis, discriminating health status for patients at many levels of functioning[7,8] and minimizing testing burden (44-65 seconds per measure).[7,9,10] This makes it feasible to measure many health domains, including domains that are atypical (eg, fatigue) or that impact recovery (eg, self-efficacy), at multiple points during rehabilitation. For example, a set of PROMIS measures comprising Pain Interference (PI), Physical Function (PF), Fatigue, and Self-Efficacy for Managing Symptoms (SE) might aid physical therapist decision making for musculoskeletal patients.[3,5] However, the added usefulness of this expanded set of outcomes is unclear.

Tracking fatigue and self-efficacy in musculoskeletal patients might enhance clinical decision making.[5] Higher fatigue is associated with lower physical activity post total hip replacement,[11] and orthopedic physical therapy patients have reported reduction in fatigue scores similar to that of their pain symptoms.[12] Meanwhile, there is substantive evidence of the role that self-efficacy (ie, confidence in one's ability to take on tasks despite obstacles[13,14]) plays in rehabilitation. For acute and chronic musculoskeletal pain, higher self-efficacy is linked to better home exercise follow-through,[15] decreased pain intensity/duration, increased physical functioning,[16-18] and decreased kinesiophobia and fear-avoidance behaviors.[19] While these studies support assessing fatigue and self-efficacy, no studies yet have investigated the clinical application of PROMIS Fatigue and SE measures in musculoskeletal patients. Factors such as validity, usefulness, and responsiveness are important when considering a new set of outcome measures for clinical practice.[20,21] Unexplored is the responsiveness for a set of PROMIS measures, including Fatigue and SE with more typical measures (PI and PF), across an episode of care for musculoskeletal patients.

Responsiveness of PROMIS PI, PF, and Fatigue measures has been investigated in other medical services. Responsiveness for PROMIS PI and PF has been demonstrated in orthopedic surgery populations[22-26] and conservative primary care pain management.[27,28] One study reported responsiveness for PROMIS PF over a 6-week exercise program for knee osteoarthritis.[29] PROMIS Fatigue responsiveness has been reported for spine surgery,[26,30] a rheumatoid arthritis specialty service,[27] and various cardiorespiratory and cancer treatments.[31-34] PROMIS SE responsiveness has not been reported; however, SE scores falling below a derived cut-off value have been shown to be 74-79% accurate in discriminating patients with unacceptable health status, equivalent to accuracies for PROMIS PI, PF, and Fatigue cut-offs.[20,35] It is possible that PROMIS responsiveness varies depending on severity of patient presentation. In patients undergoing foot and ankle, anterior cruciate ligament, and spine surgery, preoperative PROMIS PI and PF scores worse than derived cut-offs were more likely to attain clinically meaningful improvement, compared to higher initial scores.[36-38] Of interest would be if patients receiving physical therapy with initial PROMIS scores worse than defined cut-offs show comparatively more improvement.

A significant step forward in determining usefulness of a broader set of PROMIS measures for both clinical decisions and research would be to evaluate the responsiveness of such measures in outpatient physical therapy. The purpose of this study was to determine the responsiveness of PROMIS PI, PF, Fatigue, and SE measures for musculoskeletal patients across a physical therapy episode of care. This included appraising whether the addition of Fatigue and SE measures led to more patients exhibiting improvement and determining the comparative responsiveness for worse versus better initial PROMIS scores.

METHODS

This longitudinal cohort study of adult patients in a rural, academic physical therapy practice included university students, staff, and individuals from the community. Only patients with primary musculoskeletal complaints who completed testing were included. Chronic health conditions were not excluded if physical therapy focused on a musculoskeletal problem. George Fox University's Institutional Review Board approved this study with informed consent obtained and all participant rights protected.

Data Collection

All patient data were collected in the electronic medical record as part of routine care between January 2018 and May 2020. PROMIS measures were administered in-person at the initial evaluation via the HealthMeasures iPad app (Glinberg & Associates). Follow-up measurement was conducted in-person for 86 patients. Nineteen remaining patients seen only once were administered follow-up assessments via telephone one week following their visit. Reliability and validity of telephone administration of PROMIS has been demonstrated previously.[39]

PROMIS Measures

Computer adaptive testing versions of PROMIS PI, PF, Fatigue, and SE were used. Each measure yields a T-score for a health trait: PI measures the extent that pain affects daily life (lower T-scores reflect less pain interference);[40] PF measures mobility, use of arms, and daily activities (higher T-scores reflect better functioning);[41] Fatigue measures impact on daily life (lower T-scores reflect less fatigue);[42] and SE measures confidence managing symptoms in work, leisure, and relationships (higher T-scores reflect better self-efficacy).[43] For PI, PF, and Fatigue, normative data references the general United States population, with a T-score mean of 50 and standard deviation of 10.[40-42] For SE, the normative population is individuals with chronic health conditions, with the same mean and standard deviation values.[43] PROMIS algorithms select questions from an item bank based on the previous response on a 5-point scale of choices (eg, "Without any difficulty" to "Unable to do").[9,44,45] This particular set of PROMIS measures has been applied in research for musculoskeletal patients in physical therapy, primary care, and orthopedic surgery.[5,20,35,46]

Data Analysis

Analyses were conducted using SPSS v.26 (IBM Corporation) and Microsoft Excel for effect size calculations. T-score and patient age data were bimodal in distribution (**Appendix 1**) with acceptable skewness but higher kurtosis values (0.720-1.440), so nonparametric analyses were applied. Wilcoxon signed ranks tests were used for within-group change scores. Standard response mean (SRM) and Cohen's d were calculated, with effect sizes 0.20-0.49 interpreted as small, 0.50-0.79 as moderate, and ≥0.80 as large.[47] Published MCID estimates from orthopedic populations were applied as follows: PI T-score improvement ≥3.2, PF ≥3.3, and Fatigue ≥3.4.[25,30] No published estimate of MCID for SE was available. To appraise the addition of PROMIS Fatigue, and SE, percentage of patients improving ≥½ SD across the 4 measures was calculated.

To compare responsiveness for worse versus better initial T-scores, previously-published cut-off values based on a patient-acceptable symptom state (PASS) anchoring question were used to dichotomize the data.[35] The PASS is a validated yes/no question self-appraising current activities, pain level, and perceived functional impairment.[48] T-score cut-offs have been shown to be 70-77% accurate in discriminating when a person would answer "Yes" or "No" on the PASS.[35] Analyses comparing dichotomized subgroups were: Mann-Whitney U tests for T-scores; Pearson Chi-Square for rates of ≥MCID and ≥½ SD improvement; and McNemar tests for rates or PASS "Yes" at follow-up. Sensitivity analyses evaluated SRM, Cohen's d, and change scores for additional dichotomized variables including: age in years (18-40, >40), body region of primary complaint (spine, extremity), number of visits (1-3, >3), single visit (yes, no), and duration in days (1-30, >30). Age dichotomization was based on published work showing significantly better initial PROMIS PI and PF scores for healthy adults up to 40 years of age, versus those older than 40.[49]

RESULTS

The sample (n = 105) showed a wide age range of 43.8±18.8 years (18-78)], predominately female (60%), and BMI range of 26.9±6.4 (17.2-62.4) (**Table 1**). Roughly half were treated for spine complaints (51%). The average number of physical therapy visits was 3.8±2.8, with over half receiving 3 or less visits (56%). Average episode duration was 38.1±36.9 days. Overall, 65-81% scored better than PASS "Yes" cut-offs at follow-up.

Total sample responsiveness (**Table 2**) was small to moderate for the 4 PROMIS measures. Initial T-scores ranged from 5.3-11.2 points worse than the normative average (50). Average improvement scores approached 5 points (½ SD) for PI and PF, and over 3 points for Fatigue and SE. Effect sizes for PROMIS PI and PF were moderate (0.60-0.68), for Fatigue and SE smaller (0.38-0.42). For PI, PF, and Fatigue, average T-score improvement exceeded MCID thresholds, with half of the patients (49-53%) achieving at least MCID. Percentages of patients with T-scores improving ≥½ SD ranged from 31% for SE up to 48% for PI. Altogether, 70% of patients improved ≥½ SD on at least one of the four measures—25 patients on one measure, 16 on two, 19 on three, and 13 on all four measures. Of these 73 patients, 15 *only* improved ≥½ SD on Fatigue and/or SE (not on PI or PF). See **Figure 1** for comparison of initial versus follow-up T-score distributions relative to PASS cut-offs.

Responsiveness on all 4 PROMIS measures was high for scores initially worse than PASS cut-offs, revealing marked contrast between PASS-dichotomized subgroups (**Table 3**). For PI, T-scores ≥60 (Pass "No") changed significantly from initial to follow-up by 6.9 ± 7.0, with high effect size values of 0.99 and 1.13, and 62% of patients improving ≥½ SD. For PF, T-scores ≤40 changed by 6.7 ± 8.0, with high effect sizes of 0.84 and 1.00, and 51% improving ≥½ SD. For Fatigue, T-scores ≥55 changed by 7.0 ± 8.4, with high effect sizes of 0.83 and 0.90, and 58% improving ≥½ SD. For SE, T-scores ≤45 changed by 5.4 ± 8.2, with moderate to high effect sizes of 0.66 and 0.83, and 39% improving ≥½ SD. Only for PF did the PASS "Yes" subgroup demonstrate a significant improvement score (3.1±5.3), with moderate effect size (0.58). Change scores for PASS

"Yes" subgroups on the other measures were not significant, with effect sizes small for PI (0.24 and 0.34) and poor for Fatigue (≤0.08) and SE (0.00).

Sensitivity analyses revealed no subgroup differences (**Appendix 2-6**), confirming that the 4 measures were equally responsive across age, body region, number of visits, and duration of care.

DISCUSSION

Novel findings here provide evidence of significant responsiveness for PROMIS PI, PF, Fatigue, and SE measures across an episode of care for musculoskeletal patients. Total sample effect sizes were moderate for PI and PF and smaller for Fatigue and SE, with improvement scores exceeding published MCIDs and 70% of patients improving ≥½ SD in at least 1 of the 4 PROMIS measures. This included 14.3% of patients who *only* showed such improvement in Fatigue and/or SE, demonstrating potential value including these measures with PI and PF to capture patient improvement. For initial T-scores worse than PASS cut-offs, high effect size values (≥0.80) were demonstrated for all 4 PROMIS measures. Findings support inclusion of Fatigue and SE in outcomes assessment while informing interpretation of change scores on these PROMs.

Patient and episode of care data reflected the rural, academic setting, which serves both university and community members. Average number of visits (3.8) was lower than typical in ambulatory physical therapy (9.6),[50] including patients with low back pain (4.6-15.0),[51] yet measures were responsive. This might be explained by the population of students and faculty who typically have little spare time and are regularly off-campus. Also, the rural setting might mean increased impediments in travelling to therapy (eg, distance, financial).

Table 1. Patient and Episode of Physical Therapy Care Characteristics (n = 105)

Variable	Statistic
Age, y	43.8 ± 18.8 (18 - 78)
Female Gender, n	63 (60%)
Height, cm	170.5 ± 10.2 (152.4 - 200.7)
Weight, kg	78.4 ± 20.4 (43.2 - 175.6)
BMI	26.9 ± 6.4 (17.2 - 62.4)
Body Region Primary Complaint, n	
Lower extremity	32 (31%)
Upper extremity	19 (18%)
Spine	54 (51%)
Total Visits, n	3.8 ± 2.8 (1 - 16)
1	19 (18%)
2 to 3	40 (38%)
4 to 6	31 (30%)
>6	15 (14%)
Duration Initial to Follow-up, d	38.1 ± 36.9 (5 - 215)
Total Days, n	
5 to 7	24 (23%)
8 to 30	34 (32%)
31 to 60	27 (26%)
61 to 90	9 (9%)

Abbreviations: SD, standard deviation; BMI, body mass index

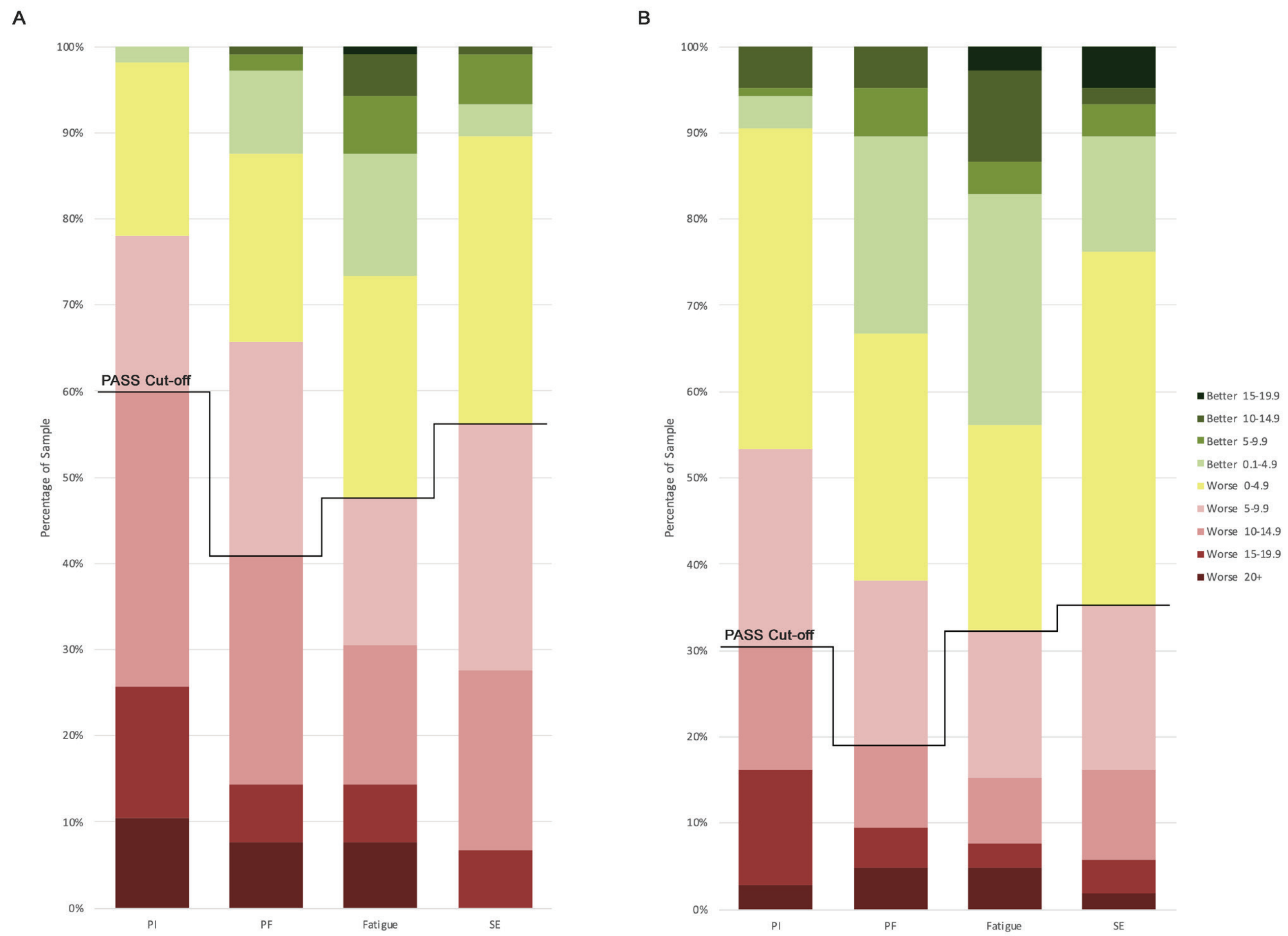
All 4 PROMIS measures demonstrated responsiveness across an average 38.1 days. Both PI and PF showed moderate effect sizes, Fatigue, and SE being comparatively smaller. In comparison, a 6-week physical therapy exercise program showed smaller PF effect size (0.43),[29] while two studies of patients 3-6 months post spine surgery demonstrated large effect sizes for PROMIS PI (0.84-1.00) but small-to-moderate effect

Table 2. Total Sample (n = 105) PROMIS T-score Mean Values for Initial, Follow-up, and Improvement Scores; Effect Size Values; and Prevalence of Favorable Outcomes *(Statistically significant comparative values in italics.)*

	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d	≥MCID improvement	≥½ SD improvement	PASS Yes Follow-up
Pain Interference	61.2 ± 6.3	56.4 ± 7.6	*4.8 ± 7.3**	0.66	0.68	56 (53%)	50 (48%)	73 (70%)
Physical Function	41.8 ± 7.5	46.4 ± 7.8	*4.6 ± 6.8**	0.68	0.60	53 (51%)	41 (39%)	85 (81%)
Fatigue	55.3 ± 9.6	51.7 ± 9.4	*3.6 ± 8.6**	0.42	0.38	51 (49%)	42 (40%)	71 (68%)

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean; MCID, minimum clinically important difference; SD, standard deviation; NA, not applicable
* p<.001
† No published MCID available for PROMIS Self-Efficacy for Symptom Management measure.

Figure 1. Comparison of initial A, versus follow-up B, PROMIS T-score distribution in 5-point ranges better or worse relative to the normative population mean of 50, including PASS cut-off line above which patients would likely report acceptable levels of symptoms and functioning.



Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; PASS, patient acceptable symptom state.

sizes for PF (0.31-0.60) and Fatigue (0.35-0.64).[26,30] That PI and PF showed higher responsiveness in a physical therapy setting might not be surprising, since pain and decreased functioning are common reasons to seek therapy. Additionally, PI and PF initial T-scores were more severe (11.2 and 8.2 points worse than average, respectively) than for Fatigue and SE (5.3 and 6.1 points worse than average; **Table 2**), allowing more potential for score improvement.[52] Nonetheless, average Fatigue score improvement was above MCID with 49% of patients exceeding that threshold.

Findings for PROMIS Fatigue and SE measures offer new responsiveness information with conservative treatment. Roughly half of initial T-scores were worse than PASS cut-offs for Fatigue (48%) and SE (56%)—higher percentages than PF (41%; Table 3). Over 30% of patients showed ≥½ SD improvement on 3 or all 4 PROMIS measures, and 15 patients *only* improved ≥½ SD on Fatigue and/or SE. It appears that limiting outcomes assessment to only pain and physical functioning might exclude identification of other relevant health factors pertinent to rehabilitation. Indeed, accuracies discriminating PASS status are equally as strong for PROMIS Fatigue (74-78%) and SE (74-78%) as for PI (74-76%) and PF (72-76%).[35] Inclusion of fatigue-related measures in healthcare minimal data sets are recommended for chronic low back pain,[52] as well as for determining health-related quality of life utility values.[53] For chronic pain patients, high importance is placed on improvement in fatigue, similar to pain and interference with daily activities.[54] Fatigue in mobility tasks is associated with pain severity and activity level in older adult primary care and total hip replacement patients,[12,55] while lower self-efficacy is associated with higher pain intensity/duration and less exercise follow-through for acute and chronic musculoskeletal populations.[15-18] Tracking whether fatigue and/or low self-efficacy overlie pain and physical limitation might guide clinicians toward more targeted intervention choices.[5,20,35] With roughly half of musculoskeletal patients presenting with Fatigue and/or SE worse than PASS cut-offs, there is support for weighting these equally with PI and PF in importance and for expecting similar improvement when scores are worse than PASS cut-offs.

Dichotomization using PASS offered new insight into PROMIS interpretation in this population. All improvement scores, effects sizes, and percentages of ≥MCID or ≥½ SD improvement were much higher for the PASS "No" subgroups (**Table 3**). For PI, PF and Fatigue, initial T-scores worse than PASS cut-offs averaged nearly 7 points improvement, with effect sizes from 0.83-1.13. This aligns with findings from other studies in post-surgical patients for PI (0.74-1.00) and PF (0.31-1.53), but larger than reported for Fatigue (0.35-0.64).[22-26,30,56] For SE, the

Table 3. Dichotomized Data Using PASS Thresholds—Worse than Threshold (PASS No) or Better (PASS Yes)—Including PROMIS T-score Mean Values for Initial, Follow-up, and Improvement Scores; Effect Size Values; and Prevalence of Favorable Outcomes *(Statistically significant comparative values in italics.)*

	PASS Status Initial	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d	≥MCID Improvement	≥½ SD Improvement	PASS Yes Follow-up
Pain Interference	PASS No (T-score ≥60)	63	65.6 ± 3.7	58.6 ± 7.8	*6.9 ± 7.0**	0.99	1.13	43 (68%)	39 (62%)	36 (57%)
	PASS Yes (T-score <60)	42	54.7 ± 2.8	53.1 ± 6.0	1.6 ± 6.4	0.24	0.34	13 (31%)	11 (26%)	37 (88%)
	Difference:		*11.1**	*5.5**	*5.3**			*30%**	*36%**	*31%**
Physical Function	PASS No (T-score ≤40)	43	35.0 ± 4.6	41.8 ± 8.4	*6.7 ± 8.0**	0.84	1.00	26 (61%)	22 (51%)	25 (58%)
	PASS Yes (T-score >40)	62	46.5 ± 5.1	49.6 ± 5.5	*3.1 ± 5.3**	0.58	0.58	27 (44%)	19 (31%)	60 (97%)
	Difference:		*11.5**	*7.8**	*3.6‡*			17%	*20%‡*	*39%**
Fatigue	PASS No (T-score ≥55)	50	63.5 ± 5.8	56.5 ± 9.5	*7.0 ± 8.4**	0.83	0.90	35 (70%)	29 (58%)	24 (48%)
	PASS Yes (T-score <55)	55	47.8 ± 5.2	47.3 ± 6.9	0.5 ± 7.5	0.07	0.08	16 (29%)	13 (24%)	47 (86%)
	Difference:		*15.7**	*9.3**	*6.5**			*41%**	*35%**	*38%†*
Self-Efficacy§	PASS No (T-score ≤45)	59	39.5 ± 4.0	44.9 ± 8.3	*5.4 ± 8.2**	0.66	0.83	NA	23 (39%)	30 (51%)
	PASS Yes (T-score >45)	46	49.5 ± 4.1	49.5 ± 7.4	0.0 ± 7.5	0.00	0.00	NA	10 (22%)	38 (83%)
	Difference:		*10.0**	*4.6**	*5.4†*			NA	17%	*32%**

Abbreviations: PASS, patient acceptable symptom state; PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean; MCID, minimum clinically important difference; SD, standard deviation; NA, not applicable.
* p<.001
† p<.01
‡ p<.05
§ No published MCID available for PROMIS Self-Efficacy for Symptom Management measure.

PASS "No" subgroup demonstrated 5.4 points improvement, with effect sizes from 0.66 to 0.83, supporting its inclusion as a responsive psychological measure to track from initial evaluation.

For PASS "Yes" subgroups, PROMIS measure responsiveness was minimal, with the exception of PF. Initial T-scores were 10.0-15.7 points higher than for PASS "No"; all falling within ½ SD of the United States average—interpretable as within normal limits.[57,58] Fatigue and SE showed essentially no change, and PI showed nonsignificant improvement. Unresponsiveness occurred despite the ability of each measure to differentiate distinct groups of individuals at higher-than-average T-scores values (>50),[40,42,43,49] suggesting the measures could have picked up change if it had occurred. Though 22-31% of these patients did show ≥MCID or ≥½ SD improvement, clinicians might not readily expect significant gains on these 3 measures in similar patient populations when initial T-scores fall around 50. Uniquely, the PF measure did show moderate responsiveness for PASS "Yes", exhibiting near-MCID T-score improvement. Clinicians might therefore still expect meaningful PF improvement with an initial T-score approaching 50. Regardless, across this set of PROMIS measures, 65-81% of the 105 patients achieved PASS "Yes" at follow-up in at least one health domain.

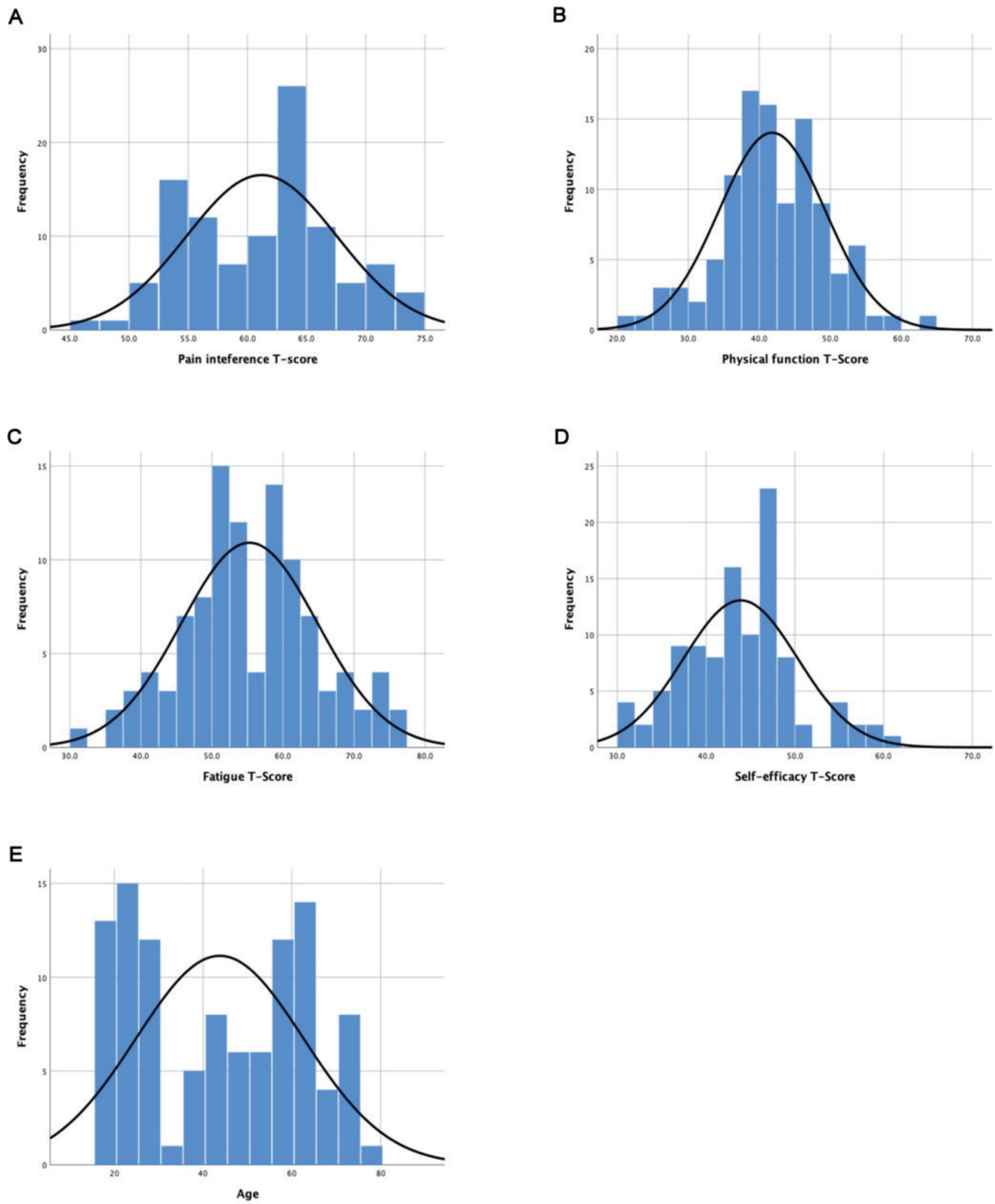
Study Limitations

These results are from a distinct academic, rural population. Responsiveness findings might not generalize to other clinical settings and may be sensitive to the practice patterns in this particular outpatient setting. However, the sensitivity analysis showed that potential confounders of age, body region, number of visits, and duration were not factors. Also, it is possible PROMIS PI and PF are interdependent in this population. A post-hoc analysis of correlations between initial T-scores revealed Spearman rho values from 0.38-0.71 (**Appendix 7**), with PI-PF being the highest. This suggests enough interdependence to expect improvement in PI and to be linked PF in certain patients. Previous work has suggested this linkage in other musculoskeletal populations.[22] However, patients continue to rank pain and physical function distinctly as both high in importance.[35,54]

CLINICAL APPLICATIONS

The findings of this study are important in supporting the adoption of the PROMIS measures for broader clinical assessment by demonstrating: (1) responsiveness across many diagnoses, (2) added detection of improvements in health domains beyond PI and PF, and (3) that these measures are more responsive in patients with more severe initial scores. Surprisingly, despite that these measures are known to distinguish symptoms and functioning in the score ranges above average,[40,42,43,49] PI, Fatigue, and SE were not responsive in patients with higher initial scores. Objectively tracking more global health domains like Fatigue and SE could enhance clinical decision making, particularly when not seeing improvements in pain complaints and/or physical functioning even despite patient report of positive life and health changes.

Appendix 1. Histograms for PROMIS t-score (A-D) and Patient Age (E) Distributions, Demonstrating Bimodality of Data with Acceptable Skewness but Excessive Kurtosis



Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System

Appendix 2. Dichotomized Data Using Age—18 to 40 years or >40 years—Including PROMIS T-score Mean Values for Initial, Follow-up, and Improvement Scores; and Effect Size Values ***(Statistically significant comparative values in italics)***

	Age	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d
Pain Interference	18 to 40 years	46	60.2 ± 5.6	55.4 ± 6.6	*4.8 ± 7.7**	0.62	0.79
	>40 years	59	62.0 ± 6.8	57.2 ± 8.3	*4.8 ± 7.0**	0.69	0.63
	Difference:		1.8	1.8	0.0		
Physical Function	18 to 40 years	46	44.1 ± 6.5	48.9 ± 5.7	*4.8 ± 7.7**	0.79	0.79
	>40 years	59	40.0 ± 7.8	44.5 ± 8.7	*4.4 ± 7.3**	0.60	0.53
	Difference:		*4.1*†	*4.4*†	0.4		
Fatigue	18 to 40 years	46	53.8 ± 8.6	50.1 ± 7.4	*3.7 ± 8.6*†	0.43	0.46
	>40 years	59	56.5 ± 10.3	52.9 ± 10.6	*3.6 ± 8.6*‡	0.41	0.34
	Difference:		2.7	1.8	0.1		
Self-Efficacy	18 to 40 years	46	44.5 ± 6.0	46.2 ± 7.6	1.7 ± 8.2	0.21	0.25
	>40 years	59	43.4 ± 6.7	47.7 ± 8.7	*4.2 ± 8.2**	0.52	0.55
	Difference:		1.1	1.5	2.5		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean
* p<.001
† p<.01
‡ p<.05

Appendix 3. Dichotomized Data Using Body Region Treated—Spine or Extremity—Including PROMIS T-score Mean Values for Initial, Follow-up, and Improvement Scores; and Effect Size Values ***(Statistically significant comparative values in italics)***

	Body Region	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d
Pain Interference	Spine	54	62.4 ± 6.4	57.9 ± 8.5	*4.5 ± 6.8**	0.66	0.60
	Extremity	51	59.9 ± 6.1	54.8 ± 6.2	*5.1 ± 7.8**	0.65	0.82
	Difference:		2.5	3.1	0.6		
Physical Function	Spine	54	41.0 ± 7.5	44.8 ± 8.1	*3.8 ± 6.1**	0.62	0.49
	Extremity	51	42.6 ± 7.5	48.0 ± 7.2	*5.4 ± 7.4**	0.74	0.74
	Difference:		1.6	*3.2*‡	1.6		
Fatigue	Spine	54	57.4 ± 8.9	54.8 ± 9.9	*2.6 ± 8.2*†	0.32	0.28
	Extremity	51	53.1 ± 9.9	48.4 ± 7.7	*4.7 ± 9.0*†	0.52	0.53
	Difference:		*4.3*†	*6.2*†	2.1		
Self-Efficacy	Spine	54	42.8 ± 6.4	46.3 ± 8.6	*3.5 ± 8.8*†	0.40	0.46
	Extremity	51	45.0 ± 6.3	47.7 ± 7.8	*2.7 ± 7.8*‡	0.35	0.38
	Difference:		2.2	1.4	0.8		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean
* p<.001
† p<.01
‡ p<.05

Appendix 4. Dichotomized Data Using Number of Visits Initial To Follow-up—1 to 3 Visits or >3 Visits—including PROMIS T-score Mean Values for Initial, Follow-up, and Improvement Scores; and Effect Size Values ***(Statistically significant comparative values in italics)***

	Number of Visits	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d
Pain Interference	1 to 3 visits	59	62.0 ± 6.7	57.7 ± 7.9	*4.4 ± 6.9**	0.63	0.59
	>3 visits	46	60.1 ± 5.7	54.8 ± 6.9	*5.3 ± 7.7**	0.69	0.85
	Difference:		1.9	2.9	0.9		
Physical Function	1 to 3 visits	59	41.5 ± 7.5	45.1 ± 7.9	*3.5 ± 5.9**	0.60	0.46
	>3 visits	46	42.1 ± 7.6	48.1 ± 7.5	*5.9 ± 7.6**	0.78	0.79
	Difference:		0.6	*3.0‡*	2.4		
Fatigue	1 to 3 visits	59	56.0 ± 9.3	51.9 ± 9.1	*4.1 ± 6.9**	0.60	0.44
	>3 visits	46	54.4 ± 10.0	51.4 ± 9.9	*3.0 ± 10.5‡*	0.30	0.29
	Difference:		1.6	0.5	1.1		
Self-Efficacy	1 to 3 visits	59	43.4 ± 6.7	45.8 ± 8.3	*2.4 ± 7.1**	0.34	0.31
	>3 visits	46	44.5 ± 6.0	48.6 ± 7.9	*4.1 ± 9.6†*	0.42	0.58
	Difference:		1.1	*2.8‡*	1.7		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean
* p<.001
† p<.01
‡ p<.05

Appendix 5. Dichotomized Data Using Number of Visits— Single Visit Versus >1 Visits—Including PROMIS T-Score Mean Values For Initial, Follow-Up, And Improvement Scores; And Effect Size Values. ***(Statistically significant comparative values in italics)***

	Number of Visits	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d
Pain Interference	Single visit	19	65.3 ± 6.0	59.0 ± 9.9	*6.3 ± 7.6†*	0.83	0.77
	>1 visits	86	60.3 ± 6.1	55.9 ± 6.9	*4.5 ± 7.2**	0.65	0.60
	Difference:		*5.0†*	13.1	1.8		
Physical Function	Single visit	19	37.3 ± 6.1	42.3 ± 7.8	*5.0 ± 6.1†*	0.81	0.71
	>1 visits	86	42.8 ± 7.4	47.3 ± 7.6	*4.5 ± 6.9**	0.65	0.65
	Difference:		*5.5†*	*5.0‡*	0.5		
Fatigue	Single visit	19	59.0 ± 8.5	54.4 ± 9.6	*4.6 ± 5.1**	0.91	0.51
	>1 visits	86	54.5 ± 9.7	51.1 ± 9.3	*3.4 ± 9.2†*	0.37	0.36
	Difference:		*4.5‡*	3.3	1.2		
Self-Efficacy	Single visit	19	41.5 ± 5.6	47.9 ± 8.6	*6.4 ± 8.3†*	0.77	0.87
	>1 visits	86	44.4 ± 6.5	46.8 ± 8.2	*2.4 ± 8.1†*	0.29	0.33
	Difference:		*2.9‡*	1.1	4.0		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean.
* p<.001
† p<.01
‡ p<.05

Appendix 6. Dichotomized Data Using Duration of Therapy Initial to Follow-Up—1 To 30 Days Or >30 Days—Including PROMIS T-Score Mean Values for Initial, Follow-up, and Improvement Scores; and Effect Size Values *(Statistically significant comparative values in italics)*

	Duration	n	Initial T-score	Follow-up T-score	Improvement Scores	SRM	Cohen's d
Pain Interference	1 to 30 days	58	62.3 ± 6.4	57.3 ± 7.5	*5.0 ± 6.9**	0.72	0.71
	>30 days	47	59.9 ± 6.0	55.4 ± 7.7	*4.5 ± 7.7**	0.69	0.85
	Difference:		*2.4*[‡]	1.9	0.5		
Physical Function	1 to 30 days	58	40.9 ± 7.0	45.2 ± 7.8	*4.4 ± 5.9**	0.74	0.59
	>30 days	47	42.9 ± 7.9	47.8 ± 7.7	*4.9 ± 7.8**	0.62	0.62
	Difference:		2.0	2.6	0.5		
Fatigue	1 to 30 days	58	56.0 ± 9.2	51.8 ± 8.8	*4.3 ± 9.1**	0.47	0.48
	>30 days	47	54.3 ± 10.1	51.5 ± 10.2	*2.8 ± 7.9*[‡]	0.35	0.28
	Difference:		1.7	0.3	1.5		
Self-Efficacy	1 to 30 days	58	43.1 ± 6.4	46.3 ± 7.9	*3.1 ± 8.6**	0.37	0.44
	>30 days	47	44.9 ± 6.4	47.9 ± 8.6	*3.0 ± 7.9*[†]	0.38	0.40
	Difference:		1.8	1.6	0.1		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SRM, standardized response mean.
* p<.001
[†] p<.01
[‡] p<.05

Appendix 7. Spearman's Rho Correlation Values Across All Four PROMIS Measures, Listed As Initial/Follow-Up/Change Scores[a]

	Self-Efficacy	Fatigue	Physical Function
Pain Interference	-.61 / -.64 / .62	.52 / .51 / .47	-.71 / -.65 / .64
Physical Function	.48 / .49 / .54	-.49 / -.50 / .47	-
Fatigue	-.38 / -.35 / .28	-	-

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System.
[a]All values statistically significant at p<.01.

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Effect of Three Relaxation Techniques on Hamstring Muscle Length

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ABSTRACT

Background and Purpose: Limited evidence exists on the significance of using diagonal over sagittal plane movement for enhancing relaxation for muscle lengthening with proprioceptive neuromuscular facilitation (PNF) techniques. The purpose of this study was to determine the effects on hamstring muscle length of PNF contract-relax agonist contraction (CRAC), isometric contraction followed by active resistive agonist repositioning (sagittal plane hold-relax active contraction [HRAC]), and isometric contraction followed by passive repositioning (sagittal plane HR) in 45 healthy female participants. **Methods:** Participants were randomly assigned into a group for one treatment session. Pretest and posttest measurements of hip flexion during straight leg raise determined hamstring length. **Findings:** A significant difference ($p<0.05$) in hamstring length was found between the 2 groups with isometric contractions and active resistive or passive repositioning performed within the sagittal plane. **Conclusion:** Performing exercises in the diagonal versus sagittal plane have no significant influence on muscle length. Active agonist repositioning significantly impacts the antagonist muscle's ability to relax and lengthen. **Clinical Relevance:** A replication of this study using patients with pathologically limited passive range of motion may help clarify its clinical applications.

Key Words: contract-relax agonist contraction, hold-relax agonist contraction, proprioceptive neuromuscular facilitation, range of motion, stretching

INTRODUCTION

A common impediment to a patient's progress and rehabilitation is decreased passive range of motion (PROM) or limited muscle flexibility. Significant therapeutic time and effort is devoted to improving or maintaining joint PROM because shortened muscles can create joint imbalances that lead to faulty postural alignment, joint dysfunction, and often injury.[1] For example, when the hamstring muscles are short, authors have shown that patients are at an increased risk of low back pain, as well as hip and knee joint impairments including hamstring injury, patellar tendinopathy, and patellofemoral pain syndrome.[1,2] Therefore, when joint or noncontractile structures are not at fault, physical therapists try to improve joint mobility by increasing the resting length of the muscle to prevent joint deformity and preserve function. Stretching increases soft tissue extensibility and elongates adaptively shortened structures.[1] Several techniques of stretching are reported in the literature; therefore, determining which technique is the most effective and efficient at improving muscle length and joint PROM is important.[3]

While static stretching is reported to be the most commonly performed muscle lengthening technique, several authors have reported that proprioceptive neuromuscular facilitation (PNF) is the most effective technique.[3,4] Developed in the 1940s, PNF introduced the concept of muscle relaxation or inhibition prior to muscle elongation.[1,5] This technique was initially used on patients who had endured a neurological injury and presented with significant spasticity. However, the technique has since been applied to other patient populations, including those with orthopedic conditions.[5] The theory of traditional PNF is based on functional movement patterns, in which muscles lengthen and shorten in spiral movements around a series of joints in multiple planes; therefore, traditional PNF is performed in specific diagonal patterns.[5,6] Modifications of the original diagonal patterns of PNF to those performed in a single plane have been made over the years, and most research on PNF stretching has focused on stretching done in a singular plane.[6] However, there continues to be limited and conflicting evidence on the critical significance of using diagonal over sagittal plane movement for enhancing relaxation. Furthermore, changes to the classic PNF application have generated confusion over both terminology and treatment effectiveness within a clinical setting.

Proprioceptive neuromuscular facilitation techniques were traditionally believed to make use of muscle proprioceptors including Golgi tendon organs (GTOs) and the muscle spindles to inhibit or relax the tight muscle, or antagonist, through autogenic or reciprocal inhibition, respectively.[6,7] Autogenic inhibition refers to the neurophysiological mechanism in which the GTOs in the antagonist are stimulated by contractile tension to inhibit the motor neurons of that muscle resulting in improved relaxation following the muscle contraction.[6] Reciprocal inhibition utilizes muscle spindles to inhibit the antagonist muscle and occurs when one isotonically contracts the agonist muscle, or the muscle opposing the tight muscle, allowing the antagonist muscle to further relax and elongate.[6] However, the actual influence of these underlying principles remains controversial, and more recently, authors suggest that autogenic inhibition is unlikely to explain the increases in PROM that are seen with PNF stretching techniques.[3,4] In fact, researchers questioning the influence of autogenic and reciprocal inhibition in PNF stretching found that the electromyography (EMG) activity in the hamstring muscle group following PNF stretching was similar to the activity shown following static stretching,[7] lessening the likelihood that PROM gains from PNF stretching can be attributed to these neurophysiological mechanisms. In the absence of a confirmed biomechanical explanation, the common belief is now that PNF stretching influences stretch perception, thereby increasing stretch tolerance of the patient.[6] Gate control theory, in which pressure receptor activation overrides pain signals generated, therefore delaying stretch perception, has been proposed as an alternate explanation for improved muscle elongation with PNF, but continues to have insufficient support as this neurophysiological process also characterizes several other stretching modalities.[4]

Although the underlying mechanism of PNF stretching remains ambiguous, literature associates it with greater PROM outcomes compared to other forms of stretching.[4,5] Proprioceptive neuromuscular facilitation (PNF) includes several specific techniques that have been studied and compared by numerous researchers.[1-7] These techniques include: hold-relax (HR), hold-relax with agonist contraction (HRAC), contract-relax (CR), and contract-relax with agonist contraction (CRAC).[7] Many clinicians have considered the hold-relax and contract-relax techniques to be the same; however, the classic application of contract-relax allows the rotators of the extremity to shorten while the other muscle groups perform an isometric contraction.[1,7] In the hold-relax technique, all muscle groups are contracting isometrically and then are passively taken through the newly available range once relaxed. This technique becomes HRAC when the person concentrically contracts the muscle group opposing the short muscle to go through the newly available range of motion to the next point of limitation.[7] Agonist contraction (AC) can also be performed in isolation, in which one contracts the opposing muscle group of the shortened muscles (the antagonist) to end-range and holds that position for a few seconds.[1,7]

Several studies have compared the differences between the proposed PNF techniques.[1,3,5-7] In 2019, Dafda[1] found that the HR technique was more effective in increasing hamstring muscle length than the isolated AC technique after 5 sessions of stretching over 5 days in healthy female participants. In addition, recommendations from Sharman et al state that techniques that incorporate an agonist contraction have greater gains on ROM than those that are passively moved to the next point of limitation.[6] However, a study performed by Youdas et al comparing HR and HRAC on hamstring muscle length did not find any significant difference between the two techniques.[7] Roopchand-Martin and Taylor looked at the influence of the diagonal plane PNF compared to single plane passive stretching of the hip adductor muscles,[5] as the single plane modified PNF has become increasingly popular. This single blind crossover design study of 64 university students found that there was no significant difference between passive stretching in the horizontal plane and the HR technique applied in the diagonal of extension, abduction, and internal rotation.[5] However, two systematic reviews reported the studies available on this topic to be of low quality,[2,3] with one reporting a median PEDro score of 4/10 ranging from 2 to 7.[2] Reasons cited for low scores were due to insufficient reporting of randomization or allocation to groups, lack of assessor masking, and lack of power analyses to establish sample sizes.[2,3]

Deciding on the best technique for increasing muscle length is important for therapists to support their choices for treatment procedures with sound statistical data. Despite the studies examining the PNF relaxation techniques of HR and CR, little or no experimental or clinical data exists on the effects of PNF CRAC, which was previously called slow reversal-hold-relax.[8,9] Questions remaining focus on 2 major issues: (1) Does an active resistive contraction of the agonist affect the antagonist's ability to relax? (2) Does the plane of movement in which the antagonist's contractions are performed affect that muscle's ability to relax? The purpose of this study was to determine the effects on hamstring muscle length of the PNF CRC, isometric contraction followed by active resistive agonist repositioning (sagittal plane HRAC), and isometric contraction followed by passive repositioning (sagittal plane HR) in 45 healthy female participants.

METHODS

The study was approved by the Institutional Review Board of Texas Woman's University. Participants were 45 female student and faculty volunteers, 20-35 years old, from the institutions within the Texas Medical Center in Houston, Texas. An a priori power analysis for the analysis of covariance (ANCOVA) was conducted using G*Power 3.1.9.2.[10] Assuming a moderate effect size of 0.5, alpha level of 0.05, power of 0.80, a total sample of 42 participants was needed. Inclusion criteria for this study were: no known previous right lower extremity or back pathology; 20° or less of hip flexor tightness as determined by the Thomas test,[11] and 75° or less of hip flexion obtained during a passive straight leg raise (SLR). Participants who met those criteria were randomly assigned into one of three treatment groups.

Participants laid supine on a plinth during their treatment sessions. A quadriceps board, one 13 cm wide belt, 5 cm wide straps, and a towel were used for pelvic and left lower extremity stabilization. Measurements of hip flexion were taken with an inclinometer during a passive SLR. A metronome was used to count the seconds of each contraction and rest period.

The degree of hip flexion during a passive SLR was used to determine hamstring tightness.[12,13] The SLR test was chosen over the 90/90 test for hamstring length measurement since the SLR test most closely matched the treatment protocol positions. Each participant laid supine on the plinth with the upper extremities folded over the abdomen and the pelvis tilted posteriorly to flatten the spine against the plinth. The left lower extremity rested on a quadriceps board in 20° of hip flexion, and the right lower extremity was extended, with straps securing the subject to the plinth. The inclinometer was strapped 7.5 cm proximal to the lateral femoral condyle of the right lower extremity (**Figure 1**).

An initial reading of the inclinometer was taken with the right lower extremity extended and relaxed. The lower extremity was passively raised to the point of hamstring tightness with the examiner supporting the heel and thigh. The criteria for determining hamstring tightness included sensation of tightness or pulling of the hamstring muscle bellies or tendons, noticeable contraction of the quadriceps, flexion of the knee, and the examiner's palpation of tightness in the hamstring muscle bellies. The participant was instructed to tell the examiner when any one or combination of these were felt to occur, and the examiner's palpation was used as a check to help prevent premature measurements of tightness from occurring and to help increase consistency between measurements.

A reading of the inclinometer was taken again at the point of determined hamstring tightness after the assigned intervention with the first reading being subtracted from the second to determine the degrees of hip flexion gained. Three consecutive readings within a range of 5° were required for each par-

Figure 1. Right Lower Extremity Position for Initial Inclinometer Readings with Stabilization Straps in Place

ticipant to be considered trained for accurate reporting of hamstring tightness. Following a one-minute rest period, one passive SLR to the point of hamstring tightness was performed for the pretest measurement of hip flexion PROM. If this was greater than 75°, the subject was ineligible for this study. These pretest measurements of eligible participants were used for statistical calculations.

The principal investigator conducted all measurements and interventions for each person. She had been trained, deemed to be reliable in the examination and competent in the intervention protocols by a skilled licensed physical therapist during unpublished pilot work occurring over several months in preparation for this study.

Procedure

Group I: PNF Contract-relax agonist contraction ([CRAC] previously called slow reversal-hold-relax).[8,9] Before initiating the actual treatment, each participant was trained in executing isotonic and isometric contractions in the PNF diagonals through passive demonstration and active practice below the level of hamstring tightness. In order to be considered trained, each participant was required to actively initiate and perform the diagonals as commands were given.

For the administration of the treatment, each participant performed 3 sequences of contractions for each PNF extension pattern. Each sequence included 8 seconds of hamstring antagonist contractions, 1 second rest period, and 4 seconds of hip flexor or agonist contraction to reposition the limb to the new point of hamstring tightness. The 8 second hamstring antagonist contraction and 1 second rest period are consistent with textbook instructions of 5 to 8 second antagonist contractions and "brief" relaxation period.[6,9] The agonist isotonic contraction was not specified and was determined through pilot work seeking a standardized protocol assuming that small ranges of motion would be achieved with each antagonist contraction.

Diagonal one (D1): Hip extension, abduction, and internal rotation. The participant was passively taken through the agonist pattern and positioned with the hip flexed, adducted, and externally rotated, the knee extended, and the ankle dorsiflexed and inverted at the end of the range. The examiner provided resistance at the posterolateral aspect of the thigh and at the heel. The participant was instructed to perform a 4 second maximal isotonic contraction of the hamstrings by pushing down and out while rotating the heel laterally. No motion was allowed except for the rotatory component that had been maximally resisted but allowed to occur. Immediately following, the participant held a 4 second maximum isometric contraction in which all components were maximally resisted and prevented from moving. Then, a 1 second relaxation period ensued, followed by a 4 second resisted isotonic contraction in the agonist pattern of hip flexion, adduction, and external rotation, to the new point of hamstring tightness. Verbal commands were provided to all participants as follows: "When I say, 'Ready? Now, push…,' push your leg down and out and turn your heel out as hard as you can. Ready? Now, push your leg down and out, push… and hold… relax. Now, pull your leg up and in towards me." At this time, the procedure was repeated for a total of three complete sequences. Following the third one, the limb was passively lowered to the plinth, and a 1-minute rest period ensued.

Diagonal two (D2): Hip extension, adduction, and external rotation. The examiner took the participant through the agonist pattern passively and positioned the limb with the hip flexed, abducted, and internally rotated, knee extended, ankle dorsiflexed and everted at the end of the range. Resistance was applied to the posteromedial thigh and heel. The participant was instructed to execute a 4 second maximum isotonic contraction of the hamstrings by pushing down and in while rotating the heel medially; only rotation was allowed to occur during this contraction. A maximum isometric contraction of 4 seconds followed during which no movement occurred. The relaxation period of 1 second followed, and then a 4 second resisted isotonic contraction of the hip flexors within the agonist pattern occurred. Verbal commands were the same as reported earlier, except they were instructed to push the leg down and in while turning the heel in, rather than out as with the first diagonal. After the third sequence of contractions, the subject was instructed to relax, and the limb was passively lowered to the plinth. The inclinometer was strapped on as before to remeasure hip flexion. The degrees of hip flexion PROM attained with a single post-treatment passive SLR was used as the posttest measurement.

Group II: Isometric contraction followed by active-resistive agonist repositioning (HRAC-sagittal). The technique was explained and passively demonstrated to each subject before treatment. Each participant performed a total of 6 sequences of contractions within the sagittal plane during the actual treatment. Each sequence included hamstring antagonist contraction of 8 seconds, a 1 second rest period, and a 4 second agonist contraction to the new point of hamstring tightness.

The examiner passively flexed the participant's right hip with the knee extended in the sagittal plane to the determined point of hamstring tightness. At this point, the participant's heel was placed on the examiner's right shoulder that had been padded with a towel. The participant was then instructed to maximally contract the hamstrings for 8 seconds by pushing down onto the examiner's shoulder. No movement was allowed during this contraction. Then the participant actively flexed the hip against resistance to the new point of hamstring tightness. This isotonic contraction lasted 4 seconds. Verbal commands were provided to all participants as follows: "When I say, 'Ready? Now, push…,' I want you to maximally contact your hamstrings by pushing your leg down against my shoulder as hard as you can. Ready? Now, push, push, … relax. Now, pull your leg straight up as far as you can." Two additional contraction sequences followed, and after the last one, the limb was passively lowered to the plinth for a 1-minute rest period. The participant then performed 3 additional contraction sequences as above. After the final one, the right lower extremity was passively lowered to the plinth, the inclinometer was re-strapped onto the thigh, and the posttest measurement of hip flexion was recorded during the passive SLR.

Group III: Isometric contraction followed by passive repositioning (HR-sagittal). The technique was explained and passively demonstrated to each subject, according to the format used with Group II. A significant exception, however, was that following isometric contraction into hip extension, no active repositioning occurred. Each participant performed a total of six 8-second contractions of the hamstrings, with each contraction being followed by a 5-second rest period. Starting with the participant relaxed, the right lower extremity was passively flexed through the sagittal plane to the point of hamstring tightness. The participant's heel was placed on the examiner's right shoulder that had been padded with a towel as in Group II. Three 8-second maximum isometric contractions were performed by pushing down against the shoulder of the examiner. These contractions were separated by a 5 second rest period. During each rest period, the limb was taken passively to the new point of hamstring tightness. Verbal commands were provided to all participants as follows: "When I say, 'Ready? Now push…,' I want you to maximally contract your hamstrings by pushing your leg down against my shoulder as hard as you can. Ready? Now, push, push, … and relax." As in the other two groups, a 1-minute rest period followed the third contraction. Three additional isometric contractions were performed as before, each with passive repositioning to the end of hip flexion PROM. Following the last contraction, the limb was passively lowered, inclinometer replaced, and the posttest measurement of hip flexion PROM attained during passive SLR was recorded.

Data Analysis

A multigroup pretest-posttest treatment design was used in the present study. A one-way ANCOVA was run on the data, using the pretest goniometric measurements as the covariate. The Newman-Keuls post hoc multiple comparison was performed to determine where the significant differences existed. This post hoc test was chosen for several reasons. The Newman-Keuls test is similar to, but more powerful than a Tukey test. However, it may over-inflate the alpha level when there are more than 3 comparisons. This test is particularly robust with equal sample sizes, which is the case in this study.[14,15]

RESULTS

Table 1 shows the mean pretest, mean posttest, and adjusted mean posttest scores for each group. The one-way ANCOVA, depicted in **Table 2**, showed that a significant difference at the $p<0.05$ level existed between the three treatment groups. A Newman-Keuls post hoc multiple comparison test revealed this significant difference to occur between Group II, HRAC-sagittal, and Group III, HR-sagittal. Group I, CRAC, was not significantly different from either Group II or Group III.

Discussion

This study was designed to expand current knowledge in the area of active exercise techniques, especially with regards to the issues of straight versus diagonal plane exercise and active versus passive repositioning of the limb into increased PROM. In the current study, Group II (HRAC-sagittal) using active-resistive agonist repositioning following maximum hamstring (antagonist) contraction had a significantly higher group mean for hip flexion PROM changes than Group III (HR-sagittal) with passive repositioning. In both groups, the limb was moved into increased hip flexion to the new point of hamstring tightness after each hamstring contraction. The statistically significant difference between Groups II and III relative to increase in hamstring length would suggest that the type of repositioning used was the significant factor causing this difference since their initial positioning and type of antagonist contraction were the same. This finding is supported by the evidence-based recommendations proposed by Sharman et al[6] that includes contracting the opposing muscle group during PNF stretching elicits greater PROM gains. The PNF CRAC technique incorporates active repositioning through defined diagonals to the new point of muscle tightness after each antagonist contraction.

No significant differences were found between Group I, CRAC, and Group II, HRAC-sagittal, or Group III, HR-sagittal. These findings question the importance of diagonal positioning and movement that has been advocated strongly in the traditional PNF philosophy. A lingering question remains as to why Group I, CRAC, in the traditional PNF diagonals with its active agonist repositioning into the new position of hamstring tightness did not significantly differ from Group III, HR in the sagittal plane with passive repositioning. Group I was positioned within defined PNF diagonals, and Groups II and III were simply placed in the sagittal plane at the point of hamstring tightness. The starting position and direction of movement of the hamstrings, therefore, do not seem to have been the factors contributing to the lengthening of hamstrings following maximum contraction. This conclusion is supported by Roopchand-Martin and Taylor,[5] who found no significant difference between PNF stretching of the hip adductors performed in the traditional multi-plane diagonal compared to passive stretching performed in the single horizontal plane. However, because they did not examine diagonal PNF stretching compared to single plane PNF stretching, the question of optimal positioning for the application of PNF stretching remains.

An explanation for the ambiguity of these results could be that during the PNF diagonal stretching, only one component of the hamstrings muscle group is being addressed in either diagonal. For example, the optimal position for facilitation of the biceps femoris is seen in D1, hip extension, abduction, internal rotation, in which the limb is placed in hip flexion, adduction, and external rotation for the initiation of the contraction.[8] The limb being positioned according to these components at the point of hamstring tightness, as seen in the PNF techniques, would seem to be at a slight mechanical advantage over single component, sagittal plane, isometric contractions for the elicita-

Table 1. Pretest and Posttest Hip Flexion Passive Range of Motion Measurements for Comparison of the Current Study (N=45)

Treatment, Group	n	Pretest Means[a]	Posttest Means[a]	Adjusted Posttest Means[a]	Standard Error
CRAC, I	15	65.400	84.000	82.770	1.950
HRAC- sagittal, II	15	59.933	84.467	86.599	2.003
HR-sagittal plane, III	15	64.867	80.067	79.164	1.938

[a] Measured in degrees
Abbreviations: CRAC, contract-relax agonist contraction; HRAC, hold-relax agonist contraction; HR, hold-relax

Table 2. One-Way Analysis of Covariance for the Current Study

Source	Sum of Squares	Degrees of Freedom	Mean Square	F
Pretest[a]	597.103	1	597.103	10.763
Group	382.282	2	191.103	3.445[b]
Error	2274.526	41	55.476	

[a]Covariate
[b]Level of significance $p<0.05$

tion of maximum hamstring contractions. However, the emphasis being placed on the biceps femoris rather than the entire hamstring muscle group may account for no significant difference being found between diagonally and sagittally positioned exercises in this and in other studies.[5,16] Therefore, since maximum tension may have been elicited in approximately half of the muscle groups during one diagonal and half in the other, as D2 is the optimal position for semimembranosus and semitendinosus facilitation, less total hamstring tension may have been generated in Group I. Conversely, Groups II and III pushed straight down in the sagittal plane, and all the muscles of the hamstring group were probably equally active and capable of generating maximum tension.

In addition to the differences in positioning (diagonal versus sagittal planes), CRAC also employs the isotonic rotational contraction followed immediately by the isometric contraction into hip extension and either abduction (D1) or adduction (D2). Although the examiner attempted to prevent any movement into hip extension or abduction/adduction during the isotonic rotation contractions, minimal movement is possible, especially when resisting the hamstrings, a large muscle group, of young healthy females pushing down into gravity. If the hip was not prevented from extending during the isotonic part of the sequence, then the maximum isometric component may not have occurred at the point of hamstring tightness as in the other 2 groups.

There were several limitations in this study. The first limitation is the subjectivity involved in the determination of hamstring tightness. Each participant was required to detect tightness within a range of 5° in 3 consecutive measurements; however, each participant's perception of the sensation of tightness probably differed. As long as each participant was consistent in reporting hamstring tightness, though, the resulting data were meaningful.

A second limitation is lack of objective measurement of the participants' execution of maximum hamstring contraction. Each participant was told of the importance of contracting as hard as possible and was strongly verbally encouraged to do so during the treatment, but no method of quantifying the force exerted during each contraction was used. However, other investigators have found that significant ROM gains can occur with contractions at 20% to 100% of effort when held from 3-15 seconds.[5,6] So, while participants may not have executed maximum contractions, they held the contractions for 8 seconds, which is within the range stated above. Therefore, variations in effort are unlikely to have contributed to differences in ROM gains.

A third limitation of this study is that there was no follow-up to determine how long the changes in ROM lasted. For these ROM gains to be clinically useful, assessment of the long-term changes in hamstring flexibility that each technique engenders will be important. As this study only researched immediate gains in PROM with each technique, it may not be translated to lasting PROM improvement that is associated with promoting optimal musculoskeletal alignment.[3] Current literature recommends PNF stretching of CR or HR to be performed at least 1-2 times per week to achieve ROM gains that last or increase over 12 weeks.[3,6]

Another limitation is that the principal investigator was both the examiner and treatment provider and was therefore, not masked to group assignment during either measurements or treatments. She was aware of the potential risk for bias and carefully followed the measurement protocols with use of the inclinometer and standardized participant positioning, duration of contractions elicited, and consistent verbal instructions provided. However, the participants were unaware of their group assignment and simply told that they were participating in an exercise technique to potentially improve hamstring flexibility.

Finally, the study was conducted on young healthy females in a university setting. Although the HRAC technique performed in the sagittal plane appears to have caused at least immediate changes in hamstring length, these results cannot be generalized into other populations, particularly those with pathologic conditions.

CONCLUSIONS

Hamstring muscle length increased substantially in all the groups during treatment. The results of this study indicate that active-resistive contraction of the agonist significantly affects the antagonist's ability to passively lengthen. The authors recommend that this agonist repositioning should be used for more rapid increases in PROM, especially when the person has sufficient agonist motor control and/or strength to perform the contractions and the cognitive and/or language capability to understand the alternating directions of commands (ie, push down, relax, pull up, etc). The results also indicate that antagonist contractions within diagonal planes and sagittal planes of movement are equally effective in allowing that muscle to relax. However, the treatment of choice should be determined by the patient's specific condition, the therapist's confidence and ability in administering it, and the evidence supporting it. Proprioceptive neuromuscular facilitation techniques such as HR and HRAC in sagittal planes are simple for the therapist to perform, perhaps facilitating more confidence and ability to effectively administer.

Further investigation is warranted in all areas relating to active exercise techniques to induce muscle relaxation with a resulting increase in PROM, especially related to how long the changes last and dosage required. A replication of this study using patients with pathologically limited PROM may help clarify its clinical applications. Monitoring EMG activity of the hamstrings during contraction within PNF patterns may help clarify the level of muscle activity and relaxation that are occurring. Also, studying the neurophysiological mechanisms that underlie the perception or tolerance of stretch and if PNF stretching techniques can inhibit pain transmission during stretch may provide evidence to support its clinical use.

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Trial of the NewGait™ to Alter Running Mechanics in a High School Athlete: A Case Report

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ABSTRACT

Background/Purpose: Running is a complex skill requiring synchronization of neural centers, joints, and muscles. The athlete in this study presented with poor dynamic ankle function, running mechanics, and chronic pain. Physical therapy interventions had been successful but not sustainable since the age of 10. The purpose of this case report was to determine if the use of NewGait™ could improve running mechanics in a high school athlete. **Methods:** NewGait™ was used for 8 visits. Standardized tests and 2D videos were done on first and last visits. **Clinical Findings:** The athlete had no complaints of pain by last visit. All standardized test scores showed improvement, and 2D videos demonstrated significant changes in ankle and running mechanics. Improvements were sustained at one year follow-up appointment. **Conclusion:** NewGait™ was successful in altering running and jump mechanics. **Clinical Relevance:** NewGait™ may be a reasonably priced, easy to use clinical tool to alter ankle and running mechanics.

Key Words: altering running mechanics, dynamic ankle function, proprioception

BACKGROUND AND PURPOSE

Running is a complex skill requiring synchronization of various neural centers, joints, and muscles. Progress has been made in understanding the biomechanics of running.[1,2] Translating this knowledge to alter such a complex system in an individual is a major challenge for runners and therapists. The study of 2D videos to retrain runners is helpful but does not provide all the answers.[3] Research centers and major clinical centers have access to 3D videos, augmented feedback, biofeedback, robotics, and exoskeletons.[4-6] These systems are often too expensive for smaller centers. The purpose of this case report was to determine if the use of NewGait could improve running mechanics in a high school athlete.

CASE DESCRIPTION: PATIENT HISTORY AND SYSTEMS REVIEW

The athlete in this study was an 18-year-old female with a history of physical therapy interventions for treatment of low back pain, hip pain, and bilateral ankle and foot pain since the age of 10. The athlete had been involved in gymnastics, diving, and pole vaulting, with performance and injuries strongly influenced by poor ankle range of motion (ROM) and strength.

Past medical history included recurring sacral and lumbar mechanical dysfunction (left posterior innominate with associated L5-S1 flexion, rotation, and side-bending right), along with ankle joint ROM and strength restrictions. Range of motion measurements included plantar flexion 25°, dorsiflexion 5°, inversion 0°, and eversion 0°. The participant was able to dorsiflex her ankles against moderate resistance within limited range but was unable to perform more than one heel raise. The participant's chief complaint was interruption in sports participation due to pain in the feet, ankles, hips, and low back. Observational findings included minimal trunk rotation or reciprocal arm swing during gait, recurring failure of hip extensor and hip flexor activation, and the habitual pattern of maintaining ankles in neutral position during walking, running, leaping, and jumping. Descriptions of the athlete's preferred motor patterns were based on explanations found in *Muscle Testing and Function*.[7] The athlete used reverse action of the latissimus dorsi and quadratus lumborum to compensate for the lack of ankle function. Long toe flexors and extensors were hypertrophied and shortened secondary to overuse as a compensation pattern. Other examination findings included the following: deep muscle tension bilateral medial calves; severe restrictions in anterior/posterior glide at talocrural joint; poor talar rock and side tilt medially or laterally at subtalar joint; poor talar rock and side tilt medially or laterally at the subtalar joint.

CLINICAL IMPRESSION

Despite functional ankle motion and strength restrictions, the athlete had been motivated to excel in sports requiring single leg push off, such as gymnastics, diving, and pole vaulting. She had developed alternative movement patterns to allow for upward momentum in sport to compensate for lack of functional plantar flexion. These substitution patterns, although effective, may have created and perpetuated strain patterns in the athlete's pelvic, lumbar, and ankle, and foot regions. Without these compensatory mechanics, she would have been unable to enjoy or compete in sports. Positive outcomes of past interventions had not been maintained and potential for continued problems and further pain and injury persisted. She hoped to obtain a pole-vaulting college scholarship.

METHODS

Therapists were introduced to the NewGait™ system by developers at the APTA-Michigan Fall Conference in 2019. A trial of this system was started for this athlete having exhausted other treatment modalities. Therapists and the participant were hoping that the direct external proprioceptive feedback provided by the NewGait™ system would influence the neuro-motor system and promote sustainable change in run and jump mechanics. The athlete participated in 8 sessions with NewGait™ with no other interventions (**Tables 1-3**). The athlete was instructed in one drill using elastic bands to do at home after each session. Drills were designed to duplicate the influence of the device. The athlete reported that she did not practice drills at home. Sessions included review of past data, strength and ROM measurement, and review of 2D videos with the athlete. Configurations for all sessions included the use of a shoulder harness, waist belt, and limb straps on thighs and calves. Elastic assistance bands (AB) were used on her hip flexors, extensors, and abductors. Shoelaces were used for attachment of dorsiflexion assistance bands. Heel straps were made from bike tubes to provide anchors for plantar flexion AB (**Figure 1**). Multiple AB combinations, locations, and directions were

Table 1. Treatment Sessions 1, 2, 3 for the Participant in this Case Study

	Configuration	Session Plan	Results
1	 **Figure 2.** NewGait™ Configuration	**Goal:** Facilitate hip extension with hip abduction and to drive plantar flexion, facilitating dorsiflexion **Exercises:** • Warm up –quick pelvic rotation –Walk 30 feet x2 –quick pelvic rotation –Walk 30 feet x2. • Walk on treadmill 5 minutes • Descend and ascend 16 standard steps x2. Stairs **Notes:** Stairs required greater need for prolonged muscle activation as well as a need to lean forward on ascent and to use eccentric muscle control on descent.	• Extreme fatigue despite current competitive fitness level • Patient reported no perception of change • No change observed on video
2	• Added 2 green hip abduction AB to Session 1 configuration	**Goals:** To increase eccentric activation of hip abductors and develop ankle dorsi/ plantar flexion pattern **Exercises:** • Warm up • Dorsi/plantar flexion ankle drills on mini-trampoline	• Demonstrated active dorsi/ plantar flexion • Demonstrated ability to perform mini jumps with and without NewGait™ • Patient reported she could "feel her ankles pushing off"
3	• Decreased assistance for hip abduction from 2 green AB to 1 green and 1 red AB • Hip AB were secured diagonally to increase multiple muscle recruitment • Increased assistance for ankle dorsiflexion AB from yellow to red • Decreased assistance for plantar flexion AB from green to red	**Goals:** "Force" hip abduction throughout the gait cycle, replacing need for hip hiking and drive dorsi/plantar flexion **Exercises:** • Warm up • Descend and ascend 16 standard steps x2 • Mini trampoline drills **Notes:** Patient stated that during the previous week she was able to push off balls of her feet with conscious effort, push off was not automatic. She also felt like her knees were coming up higher when she took a step. New set up for session 3 dramatically increased difficulty on stairs.	• Patient felt more resistance to movement • Demonstrated increased ankle motion with and without NewGait™

used during each session (**Figures 2 and 3**). The most successful placements of AB were documented during each session (**Tables 1-3**).

CLINICAL OUTCOMES

The athlete denied complaints of back, hip, or ankle pain at the end of trial sessions. She reported minimal intermittent foot pain. She demonstrated trunk rotation with reciprocal arm swing during gait and running, and an enhanced ability to activate plantar flexors at the push off stage of gait and to initiate jumping. Her single leg stance time increased from 15 seconds to 45 seconds bilaterally and her double leg vertical jump increased from 6" to 17." Ankle ROM increased as follows: (1) ankle plantar flexion from 25° to 40°; (2) ankle dorsiflexion from 5° to 19°; (3) ankle inversion from 0° to 5°; (4) ankle eversion from 0° to 5°. She was able to perform 25 heel raises (**Tables 4 and 5**). The athlete's improved dynamic ankle function, hip, and pelvic control continued to improve between treatment sessions, as viewed on 2D video, by therapists and by coaching staff. Pole vault technique required modification secondary to increased running speed, forward propulsion, and jumping ability. Changes were maintained between treatments, and at 1-year follow-up appointment.

CLINICAL RELEVANCE

Retraining running technique is a challenge due to the complexity of the task, as well as the need to integrate neural, joint, and muscular control. Current strategies rely heavily on cognitive awareness and external

Table 2. Treatment Sessions 4, 5, 6 for the Participant in this Case Study

	Configuration	Session Plan	Results
4	 **Figure 3.** Modified NewGait™ Configuration **Notes:** Rationale is to provide more drive, encourage more external rotation and eccentric control of hip muscles, and encourage forward propulsion.	**Goals:** Overload system to gain more forward propulsion, and to facilitate more core muscle and eccentric control. **Exercises:** • Warm up • Monster walk to engage entire body in dynamic stretch and encourage forward lean and eccentric hamstring contraction • Stairs • Running in clinic with forward perturbation from therapist **Notes:** Patient stated that she noticed she has been walking heel/toe pattern and pushing off balls of feet while walking without thinking about it. Patient stated that she "felt like her body was being controlled like a puppet. She had no choice but to use her hips and ankles. She really enjoyed the feel."	• Increased trunk rotation and beginning of reciprocal arm swing • Patient was extremely tired and felt muscle ache in posterior calves, anterior and posterior thighs • Demonstrated dramatic improvement all skills, with and without NewGait™
5	Same as Session 4 configuration	**Goals:** Encourage more eccentric hip extension and to continue to drive forward propulsion **Exercises:** • Warm up • Monster walk • Stand to sit drills • Trial of sport specific drills: simulated running to foot plant • Repeated push off	• Improved technique all sport specific drills with and without NewGait™
6	• Increased assistance for hip extension from 1 green AB to 2 green AB on left and 3 green AB on right • Increased assistance for hip abduction on the right from 2 green AB to 3 green AB • Removed assistance for ankle dorsiflexion • Added sacral cinch belt  **Figure 4.** Sacral Cinch Belt	**Goals:** Alter muscle imbalance, increase pelvic stability and inhibit old pattern of hip hiking to gain push off and propulsion **Modalities:** • Manual therapy to address pain symptoms **Exercises:** Same as day 5 **Notes:** Patient observed walking into clinic with forward weight shift, heel/toe gait pattern with trunk rotation and reciprocal arm swing. She was not consciously aware that the gait pattern had altered. Patient reported the beginning of hip and foot pain. Pain was in area of SI joint and on the medial top of both feet.	• Pain pattern resolved • Previous drills handled with ease and minimal fatigue • Patient was instructed to continue to wear the sacral cinch belt for all activity

Table 3. Treatment Sessions 7, 8 for the Participant in This Case Study

	Configuration	Session Plan	Results
7	Same as Session 6 configuration	**Goals:** Alter sport specific skill mechanics **Exercises:** • Warm up • Monster walks • Repeated push off • Repeated drive and lifts • Pelvic rotation drills	• Improvement noted in areas addressed • Persisting over rotation of pelvis to the left • No complaints of pain. Patient brought video of pole vaulting and shared coaching techniques. Increased speed, forward propulsion, and increased jump height necessitated significant change in vaulting technique **Notes**: Video of pole vault reviewed with patient. Major issues included running beyond mark, over stepping with left leg, dropping pole arm back and rotating pelvis to the left.
8	Same as Session 6 configuration	**Goals:** Improve sport specific skills in pole vaulting **Exercises:** • Warm up • Monster walks • Pole vault drills with emphasis on altering faulty • Rotation pattern • Repeat of drills without NewGait™	• No complaints of pain • Minimal imbalance remaining • Rotation balanced right to left • Suggested use of sacral cinch belt for 2 more weeks at least during practice • This was determined to be last scheduled appointment secondary to vacations and sport schedule

Figure 1. Heel Strap for Plantar Flexion

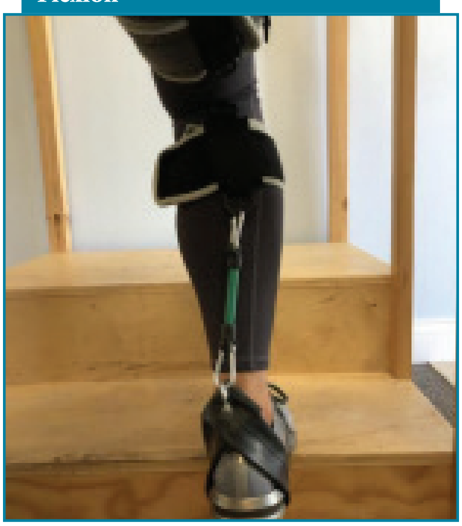

Figure 2. NewGait™ Configuration

Figure 3. Modified NewGait™ Configuration

Figure 4. Sacral Cinch Belt

feedback from a coach or therapist, when running is a complex neuro-motor skill, requiring internal feedback. The NewGait™ may provide the enhanced, simultaneous feedback to mechanoreceptors and proprioceptors of the core and limbs needed to initiate the change in neuro-motor sequencing and the development of new motor plans required to attain and sustain changes in running mechanics. The NewGait™ upper body harness appeared to assist with erect posture and support, while discouraging upper body motor control patterns. The AB from the waist down to the feet, particularly the AB on the hip abductors and plantar flexors, may have provided facilitation to lower extremity muscles, resulting in a gait pattern initiated by lower extremity muscles. The change in ankle function was difficult to explain. In a research paper, the authors

Table 4. Range of Motion and Gait Changes from First to Last Session with Device Off

	Plantar Flexion	Dorsi Flexion	Inversion	Eversion
Before	25°	5°	0°	0°
After	40°	19°	5°	5°
Norms	50°		35°	15°
	Foot Position @ Initial Contact	**Hip Angle @ Push Off**	**Tibia Inclination**	**Ankle Dorsiflexion Angle**
Before	Mid-Foot Striking Pattern	-15°	Mild Inclination	Decrease (Knee over midfoot)
After	Heel Striking Pattern	+10°	Appropriate (Within 5° of vertical)	Appropriate (Knees over toes)

Table 5. Functional Skills Test Changes from First to Last Session with Device Off

	Single Leg Stance Eyes Closed (secs)		Both Sides Used Balance Trainer (BOSU) Eyes Closed (secs)		Double Leg Vertical Jump
	Right	Left	Right	Left	
Before	15	15	15	15	6"
After	45	45	60	60	17"
Norms	44	44			15.6"

stated, "In the presence of a short GCM, tibialis anterior activity could be inhibited when ankle dorsiflexes." Later in the research they suggest that, "Through reciprocal innervation, the opposition of the GCM, that is, the tibialis anterior is facilitated."[8] The increased tension to the gastrocnemius muscles provided by the AB may have induced the changes needed to alter ankle ROM and strength as suggested in the article. Some authors suggest that ankle function, specifically the function of the gastrocnemius may be more related to the ability of an entire limb to load than to the specific control of ankle muscles.[9] Other authors suggest that ankle function may be as much a factor of neurology as mechanics,[10] or even that some malalignments or mechanics that we observe are compensations that athletes' develop to gain skill in their sport.[11] The NewGait™ may have provided enough constant feedback on a mechanical and neurologic level, to alter running mechanics.[12]

CONCLUSION

The current case report suggested that the NewGait™ may be an easy-to-use clinical tool to assist in retraining running and jumping mechanics in athletes. The NewGait™ company provides instructional material and guidelines to assist in clinical application of the device.[13] Future research might include a study comparing the speed and/or injury rates of runners with the same training schedules; one group using the device and the second group training without the device.

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President's Message

Rick Wickstrom, PT, DPT, CPE, CME

The OHSIG is on the move! September 2022 marked the release of the second in a series of 3 virtual AOPT education courses to qualify physical and occupational therapists for an AOPT Occupational Health Practitioner (OHP) Certificate of Achievement. Our OHSIG has been resilient during the COVID-19 pandemic staying on schedule to implement our initiative to design and implement a certificate program to educate and position our OHSIG members as experts in occupational health. When COVID-19 struck in the Spring of 2020 and most physical therapy services were halted, OHSIG leaders accelerated our planning and were awarded an innovative grant by the Academy of Orthopaedic Physical Therapy to fuel this initiative.

ISC 32.5 Advanced Therapy Programs in Occupational Health builds on essential content covered in the first OHP prerequisite course titled, *32.4 Bridging the Gap between the Workplace and Therapy Clinic*. This second course is jam packed with best practice information and links to additional resources and clinical pearls from expert author teams for the following topics:

- Ergonomics for General Industry, Office, and Healthcare
- Work Rehabilitation: Managing Prolonged Episodes of Care
- Functional Capacity Evaluation and Disability Determination
- Collective Glossary of Occupational Health Terms

The OHSIG is on track to launch the final phase of our OHP initiative that consists of a live webinar titled, *Facilitating Therapy Services for Total Worker Health®*. This course will focus on assessing the *Total Worker Health®* needs of employers and developing Direct-to-Employer Services. *Total Worker Health®* is defined as policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness-prevention efforts to advance worker well-being. Direct to employer services emphasize entry-point of care services under direct contract with employers and employer groups to decrease costs, increase access, and improve quality of healthcare for employees. Direct-to-Employer Services include, but are not limited to, services meeting healthcare needs for prevention, wellness, fitness, health promotion, management and rehabilitation of disease and disability, safe work practices, safe return to work, leisure, and activities of daily living.

At CSM 2023 in San Diego, we intend to honor the first group of Physical Therapists and Occupational Therapists who complete the Occupational Health Practitioner Certificate of Achievement at the AOPT All-SIG Meet and Greet Reception. Any AOPT SIG member is welcome to attend this networking event. We would also like to invite all CSM participants to learn pearls of wisdom from the experiences and career track of several lead authors in our OHP Courses at the OHSIG-sponsored presentation titled, *Navigating a Rewarding Career Path in Occupational Health*.

At this checkpoint for OHP progress, Steve Allison and I would like to express our appreciation for the efforts of the first authors pictured below who set new bar for quality monographs that we hope will empower our members to excel in occupational health. We also want to thank Sharon Kinski (ISC & *OPTP* Managing Editor) and Guy Simoneau (ISC Editor) for their patience and wisdom in helping us complete the first 2 independent study courses. Stay tuned for more details about the OHP program and our final third interactive webinar course at https://www.orthopt.org/content/special-interest-groups/occupational-health. We are fortunate that our OHSIG Education Committee is benefiting from consultation with Karen Snowden, who is the program manager of a similar certificate program in the Pelvic Health Academy. Our OHP initiative is intended to inspire entry-point service opportunities for physical therapists and occupational therapists who are fed up with traditional health insurance.

32.4, Bridging the Gap Between the Workplace and Therapy Clinic

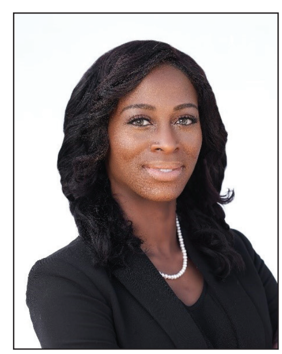
- **Total Worker Health® Protection and Promotion Programs**
  Joshua Prall, PT, DPT, EdD, MS, OCS; Rick Wickstrom, PT, DPT, CPE, CME; Shanna Dunbar, BSN, RN, COHN-S, BS; Todd E. Davenport, PT, DPT, MPH, OCS

- **Functional Job Analysis and Employment Exams**
  Moyo B. Tillery, PT, DPT, OCS, FAAOMPT; Roderick C. Stoneburner, MS, CRS (rtd); Rick Wickstrom, PT, DPT, CPE, CME

- **Entry Point Care for Workers with Job Participation Barriers**
  Jennifer Klose, PT, DPT; Alison Helmetsie, PT, DPT, OCS, Cert MDT; Michael Ross, PT, DHSc, OCS, FAAOMPT; Jennifer Gaul, PT, OCS, CSCS

- **Collective Glossary of Occupational Health Terminology**
  Rick Wickstrom, PT, DPT, CPE, CME; Steve Allison, PT, DPT, OCS, CME

Josh Prall



Moyo Tillery

Jennifer Klose

32.5, Advanced Therapy Programs in Occupational Health

- **Ergonomics for General Industry, Office, and Healthcare**
  Leslie Pickett, PT, DPT, CPE; Joanette Lima Nativo, PT, MS, CPE; Brian Lowe, PhD, CPE; Aresio Souza, PT, MS, CIE

- **Work Rehabilitation: Managing Prolonged Episodes of Care**
  Katie P. McBee, PT, DPT, MS, OCS; Colleen Medlin, PT, DPT; Brocha Z. Stern, PhD, OTR, CHT; Sarah Martin, OTR/L

Leslie Pickett

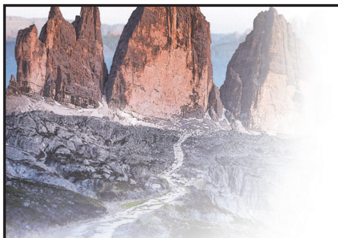
Katie McBee

- **Functional Capacity Evaluation and Disability Determination**
  Wayne MacMasters, PT, DPT; Steve Allison, PT, DPT, OCS, CME; Rick Wickstrom, PT, DPT, CPE, CME; Peter McMenamin, PT, DPT, MS

- **Collective Glossary of Occupational Health Terminology**
  Rick Wickstrom, PT, DPT, CPE, CME; Steve Allison, PT, DPT, OCS, CME

Wayne MacMasters

Rick Wickstrom



ADVANCED THERAPY PROGRAMS IN OCCUPATIONAL HEALTH

Independent Study Course 32.5

Learning Objectives

The intent of this monograph series is to prepare physical therapists and other health practitioners to:

1. Identify occupational and non-occupational risk factors for musculoskeletal disorders and understand how they impact the workplace.
2. Understand and describe types of ergonomics evaluations.
3. Recognize key elements of effective ergonomics programs including appropriate outcome measures resulting from effective interventions.
4. Identify appropriate candidates for comprehensive work rehabilitation programs beyond entry point care.
5. Describe the components of a comprehensive evaluation for a worker experiencing a prolonged episode of care.
6. Design an individualized comprehensive work rehabilitation program that aligns with worker needs and balances system demands.
7. Consider performance validity factors used in determining an individual's safe functional capacity and functional limitations.
8. Describe the process for differential diagnosis to assess the causal relationships between health conditions, physical impairments, and resulting functional limitations.
9. Compare the physical capacities of a worker to the physical demands of a job.

Topics and Authors

Ergonomics for General Industry, Office, and Healthcare—Leslie Pickett, PT, DPT, CPE; Joanette Lima Nativo, PT, MS, CPE; Brian Lowe, PhD, CPE; Aresio Souza, PT, MS, CIE

Work Rehabilitation: Managing Prolonged Episodes of Care—Katie P. McBee, PT, DPT, MS, OCS; Colleen Medlin, PT, DPT; Brocha Z. Stern, PhD, OTR, CHT; Sarah Martin, OTR/L

Functional Capacity Evaluation and Disability Determination—Wayne MacMasters, PT, DPT; Steve Allison, PT, DPT, OCS, CME; Rick Wickstrom, PT, DPT, CPE, CME; Peter McMenamin, PT, DPT, MS

Collective Glossary of Occupational Health Terminology—Rick Wickstrom, PT, DPT, CPE, CME; Steve Allison, PT, DPT, OCS, CME

For Registration Fees and Additional Questions, visit orthopt.org

Course Description

This is the 2nd in a series of 3 courses included in the Occupational Health Practitioner certificate program that is managed by the Occupational Health Special Interest Group (OHSIG) of the Academy of Orthopaedic Physical Therapy, APTA. It expands on essential content provided in the 1st course, *Bridging the Gap Between the Workplace and Clinic*, to address best practices in advanced therapy programs in occupational health.

The first monograph emphasizes the elements of a comprehensive ergonomics program and best practices for implementing job interventions to support injury prevention or worker accommodation. Ergonomics interventions are applied to 3 common areas of ergonomic practice: industrial ergonomics/manual material handling, healthcare ergonomics, and computer/office ergonomics. The second monograph emphasizes evidence-based, worker-centered, and clinically relevant strategies to implement advanced work rehabilitation programs for individuals experiencing prolonged episodes of care precluding return to work. Finally, the third monograph provides in-depth instruction on how to administer a functional capacity evaluation to establish cause and nature of an individual's injuries, symptoms, biopsychosocial factors, impairments, activity limitations, participation restrictions, return to work barriers, and facilitators. This includes recommendations for selection of functional performance tests, assessment of performance validity, and interpretation/reporting of information to promote greater fairness and objectivity in disability determination. Finally, each monograph concludes with 3 or 4 applied case scenarios to demonstrate delivery of advanced occupational health programs to prevent needless work disability or expedite functional recovery of injured workers.

Editorial Staff

Editor—Guy G. Simoneau, PT, PhD, FAPTA
Managing Editor—Sharon Klinski

ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

APTA American Physical Therapy Association

PRESIDENT'S MESSAGE

Laurel Daniels Abbruzzese, PT, EdD | labbruzzese@orthopt.org

THE NEW NORMAL

These past couple of years have posed numerous challenges to performing artists and to physical therapists that specialize in working with performing artists. Can we really say that we are "post-COVID" yet? Most performers are back on stages, in arenas and symphony halls, but the ways in which we practice have not rebounded to pre-COVID status. Infection control protocols have been updated. Telehealth, in some places, remains an adjunct to in-person care. Prevention and wellness services are a growing component in performing arts practices. These are good things! However, too many practitioners and educators are managing this new normal in silos. I urge you to share your insights and strategies with the PASIG community. Post your questions and share your ideas on our closed Facebook group: https://www.facebook.com/groups/1546315278934871/. If you are searching the literature to answer your own clinical questions, consider putting together a citation blast for the PASIG.

PASIG PROJECTS AND CONTACTS

[Please reach out if you are interested in getting involved]

- Monthly Citation Blasts [Michael Tsang | kinghontsang@hotmail.com]
- Quarterly Podcasts [Sara Edery-Altas & Isabella Scangamor | Sarah.Edery-Altas@nyulangone.org]
- Performing Arts Tests & Measures for Screening [Marissa Hentis | marisa.giangrasso@gmail.com]
- Performing Arts programming at CSM [Melissa Strzelinski | melissastrzel@gmail.com]
- Performing Arts PT Social Media Spotlights [Dawn Muci | Dawnd76@hotmail.com]
- Performing Arts Special Interest Group (PASIG) Apparel [Jessica Waters | jessicafultondpt@gmail.com]
- PASIG Video Project - "*Position members as experts in managing movement and functional performance impairments in performing artists*" [Danielle Farzanegan | dfarzanegan@gmail.com]
- Independent Study Course [Publication date projected for 2022] [Katrina Lee & Sara Edery-Altas]
  —Topic: **Clinical Management of Circus Artists**
    –Circus 101: Features and Feats of Circus Bodies
    –Aerial Athletes: Flying, Hanging, Wrapping, Catching
    –Equilibrium, Propulsion, Impact, and Control: Landing the Skills to Treat Ground Acrobats
  —Authors: Emily Scherb, Dawn Muci, Heather Heineman, and Stephanie Greenspan

PASIG ELECTIONS

Every year we elect new officers to the Performing Arts SIG. This year we will be electing a President (3-year term) and 1 Nominating Committee Member (3-year term). Please be sure to vote. Thank you to our Nominating Committee: Pam Mikkelsen (Chair), Kimberly Veirs, & Taylor Mravec.

CSM 2023 IN SAN DIEGO

We hope that you will join us in San Diego for CSM in February! The PASIG is pleased to announce the following program: "Evidence Based Lower Limb Updates in Dance- Risk Factors, Rehab, and Prevention" featuring Robyn Rice and Dawn Muci [Session ID:14476].

Also, please remember that if you are a student or performing arts fellow that had an abstract accepted to CSM, you are eligible for a PASIG student scholarship!

PASIG SCHOLARSHIPS

To recognize students for their contribution to performing arts physical therapy and to assist in defraying the cost of attending the Combined Sections Meeting (CSM), the Performing Arts Special Interest Group (PASIG) will support up to two $500 scholarships for one entry-level student and one post-professional student presenting research at CSM.

Eligibility:

1. Must be a student in an accredited pre-professional (DPT) or post-professional Performing Arts Fellowship Program when the research was conducted.
2. Must be a member of the PASIG.
3. Must be listed as an author on the poster/presentation.
4. Must have confirmation of acceptance as either a platform or poster presenter at the upcoming CSM meeting.
5. Topic of research must focus on performing arts physical therapy (and submitted under the Performing Arts subheading within the AOPT).
6. Must participate in presenting the poster/platform at CSM.

Questions? Contact Scholarship Chair, Anna Saunders | annarosemary@gmail.com

PERFORMING ARTS FELLOWSHIP TRAINING

Physical therapists with an OCS, SCS, or completion of an orthopedic residency may choose from 1 of 4 performing arts fellowship programs for advanced training and specialization in performing arts. If you have questions about starting a performing arts fellowship program, contact our chair, Tiffani Marruli, tiffany.marulli@osumc.edu. For specific program questions, contact the program directors.

- **Columbia University Irving Medical Center and West Side Dance Performing Arts Fellowship**
  —Program Director: Laurel Daniels Abbruzzese la110@cumc.columbia.edu
  —https://www.ps.columbia.edu/education/academic-programs/programs-physical-therapy/performing-arts-fellowship

- **NYU Langone-Harkness Center for Dance Injuries Performing Arts Fellowship**
  —Program Director: Angela Stolfi harkness@nyulangone.org

—https://med.nyu.edu/departments-institutes/orthopedic-surgery/specialty-programs/harkness-center-dance-injuries/education/professional-development-students-healthcare-practitioners/academic-observation-fellowship

- **The Johns Hopkins Hospital Performing Arts Fellowship**
  —Program Director: Andrea Lasner danceFIT@jhmi.edu
  —https://www.hopkinsmedicine.org/physical_medicine_rehabilitation/education_training/therapy-residency/physical-therapy/performing-arts-pt-fellowship.html

- **The Ohio State University Wexner Medical Center Performing Arts Fellowship**
  —Program Director: Tiffany Marulli tiffany.marulli@osumc.edu
  —https://hrs.osu.edu/academics/graduate-programs/clinical-doctorate-in-physical-therapy/residencies-and-fellowships/performing-arts

PASIG PRACTICE PEARLS PODCAST

Our fifth installment of PASIG Practice Pearls Podcast series is a 2-part series focused on Performing Arts Fellowship opportunities! All episodes are open to the public and are available on the PASIG website.

PERFORMING ARTS SIG FEATURED CONTENT

If you have a performing arts case study or research study that we can feature in an upcoming issue of *OPTP*, please bring it to my attention at labbruzzese@orthopt.org. We are eager to share the work of performing arts physical therapists and researchers with the broader orthopaedic physical therapy community.

BECOME A PASIG MEMBER!

Direct email-blasts go to registered PASIG members. If you would like to receive the monthly citation blast and PASIG news, be sure to become a member. [https://www.orthopt.org/login.php?forward_url=/content/special-interest-groups/performing-arts/become-a-pasig-member]

SCAN ME

DID YOU KNOW?

The Academy of Orthopaedics and the Performing Arts Special Interest Group are offering an independent study coursethis fall
Clinical Management of Circus Artists

Planned topics include:
- Circus 101: Features & Feats of Circus Bodies
- Aerial Athletes: Flying, Hanging, Wrapping, and Catching
- Equilibrium, Propulsion, Impact, and Control: Loading the Skills to Treat Ground Acrobats

Watch for future details to be announced.
All of our Current Courses can be accessed here:
https://www.orthopt.org/content/education/independent-study-courses/browse-available-courses

GREETINGS FASIG MEMBERS!

First, we were thrilled to see some of you at the September, American Orthopaedic Foot and Ankle (AOFAS) Annual Meeting in Montreal, QC. This year Chris Neville, PT, PhD, Jeff Houck, PT, PhD, and Stephanie Albin, DPT, PhD assisted with the excellent educational programming at the meeting. Dr. Houck presented an overview of rehabilitation approaches to Achilles tendinopathy. Dr. Albin presented evidence for dry needling as a key element of treatment for foot and ankle problems. Dr. Neville moderated a session on bracing and orthotics for use in rehabilitation. The FASIG and AOFAS remain committed to education for all health professionals treating patients with foot and ankle problems via webinars, on-line programming, and in-person meetings. Check out additional educational opportunities and consider joining the AOFAS at: https://www.aofas.org/education

Second, we have 2 new leadership changes and 2 more just around the corner. I am pleased to announce Ashley Waite, PT, DPT as the new FASIG Practice Chair. Dr. Waite is a Board-Certified Orthopaedic Clinical Specialist presently working in the Department of Orthopaedics and Physical Performance at the University of Rochester Medical Center (URMC) in Rochester, NY. She is actively involved in the foot/ankle and running teams as well as the orthopedic residency program within the Sports and Spine Rehabilitation Department at URMC. Ashley's post professional special interests and continuing education endeavors have been focused on clinical examination of runners, clinical gait analysis, and foot and ankle rehabilitation. Dr. Waite will be lending her expertise to a number of FASIG initiatives and leading the development of new infographics.

Jen Zellers, DPT, PhD is stepping down after years of service as Student Mentorship Chair. On behalf of all FASIG members, we thank Dr. Zellers for her service and leadership, and hope we still see her at FASIG events. Dr. Zellers also identified her successor, Hayley Powell, DPT, ATC.

Dr. Powell received her bachelor's degree in Exercise and Sports Science (concentration in Athletic Training) from the University of North Carolina. She earned her DPT degree from East Carolina University. After working as a clinician for several years in outpatient orthopedics, Dr. Powell is currently pursuing a Ph.D. at the University of Delaware researching Achilles tendinopathy. She will continue the excellent Quarterly Student Newsletters with a new group of students.

REGARDING FUTURE CHANGES.

Please cast your vote for the new FASIG Vice President and new Nominating Committee Member!

Third, we have continued to move additional FASIG initiatives forward. A big thank you to Jasmine Marcus, PT, DPT for authoring the new ChoosePT symptoms and conditions article on posterior tibial tendon dysfunction (PTTD). You can check out the article here: (https://www.choosept.com/guide/physical-therapy-guide-posterior-tibial-tendon-dysfunction-acquired-flat-foot-adults). ChoosePT is a growing resource for patients, and this current edition ties in well with our PTTD infographic. Please reach out to us if you have an idea, or if you would like to help create an infographic or ChoosePT article.

We have a new Author Spotlight Podcast! Thank you to our Research Chair, Abbis Jaffi, PT, MS, PhD, for his recent interview with Michael Mueller, PT, PhD, FAPTA discussing Dr. Mueller's work regarding the Physical Stress Theory and foot and ankle problems in people with diabetes mellitus. Check out all of the Podcasts here: https://www.orthopt.org/content/special-interest-groups/foot-ankle/fasig-author-spotlight

Lastly, keep a lookout for FASIG CSM programming and conference information - Hope to see you there!

Frank

PRESIDENT'S MESSAGE

With kind regards from Nancy Robnett Durban, PT, MS, DPT

Hello All…I hope this report finds you well, safe, and enjoying the fall. This report will feature our projects, our membership profile, and strategic plan highlights.

First, I am excited to introduce to you our newly appointed Membership Chair, Ryan Reed PT, DPT, Board-Certified Specialist in Orthopaedic Physical Therapy, Fellow of the American Academy of Orthopedic Manual Physical Therapists, and Assistant Professor at the University of St. Augustine Miami Campus. Please contact Dr. Reed at rreed@usa.edu if you are interested in helping with our membership efforts.

The Pain SIG continues to be busy. Here are the projects we are working on.

PainCast:

PainCast recordings are posted on our AOPT Pain SIG site and Facebook page. PainCast initiatives are developed and coordinated by Vice President, Eric Kruger, PT, DPT, PhD. Please contact Eric if you have future topic suggestions. (EKruger@salud.unm.edu)

Please click the following address for the most recent Conical Pearls https://www.orthopt.org/content/special-interest-groups/pain/webinar-series-podcasts

Clinical Pearls:

The Clinical Pearls team is organized by Research Chair, Adam Rufa, PT, DPT, PhD (RufaA@upstate.edu). The team is working on a series of pearls exploring pain mechanism classification. The first pearl in the series was published the end of July. https://www.orthopt.org/content/special-interest-groups/pain/clinical-pearls

Research Review:

The Research Reviews are organized by Research Chair, Adam Rufa, PT, DPT, PhD (RufaA@upstate.edu). Our last Research Review published June 2022, was titled, Opioid-Induced Hyperalgesia. It is published on our SIG website at Research: Abstracts, Articles, and Reviews - Academy of Orthopaedic Physical Therapy (AOPT) (orthopt.org).

Elections:

Dr. Max Jordan, PT, DPT, PhD (max.jordan@gmail.com), Nominating Committee Chair and committee have been busy preparing the slate of candidates for the office of President and Nominating Committee member. During the month of October, slated candidate materials will be posted to the AOPT website, and the SIG membership will be notified of this posted information. Voting for positions will occur November 1 – 30. The Academy will publish the election results in December.

It is not too early to be thinking of 2023. In2023, the SIG will be slating candidates for Vice President of Education and Nominating Committee member. For your information, each year we slate candidates for the Nominating Committee. The term is 3 years. The last year of their term they serve as the Committee Chair.

Pain Specialization:

If you treat pain, research pain, or educate about patients with pain, we are asking for your help. We are in the process of determining the need for *Board Certification in Pain Management* by developing a comprehensive description of specialty practice in Pain Management.

Our conceptual description of a Pain Management Clinical Specialist is a physical therapist who uses a person-centered approach to provide care within the biopsychosocial model and who can manage diverse populations presenting with various pain classifications and etiologies. If this description sounds like your practice, we do hope that you will be able to help us by completing an important survey.

We anticipate that this survey may take up to 75 minutes of your time to complete. Time is likely your most valuable commodity, so we realize we are asking a lot. The good news is that you do not have to complete the survey all in one session. The survey will save your responses, so you can return to where you left off. However, your responses are saved using "cookies" so you will need to return to the survey using the same the same computer and the same browser. We recommend that you use your computer to complete the survey instead of a phone or tablet. Your anonymity as a survey respondent is protected in that survey data will only be reported in the aggregate, and your individual responses will never be linked to you.

If you have questions or concerns that something is missing, you can contact Derrick Sueki, Project Coordinator at dsueki@apu.edu, or Jean Bryan Coe, Project Consultant at jbryancoe@mindspring.com.

Here is the link to the survey: https://www.surveymonkey.com/r/CRHJRXB

MEMBER STATISTICS

This is who we are. See next page for statistical graph.

STRATEGIC PLAN 2022

The complete 2022-23 strategic plan is posted on our website for your review https://www.orthopt.org/content/special-interest-groups/pain. The goals and objectives of the Pain SIG are aligned with the AOPT strategic framework. The AOPT strategies and goals are in black print and the SIG goals and initiatives are highlighted yellow. Here are some SIG highlights.

STRATEGY 1: Increase the diversity of members and leaders and engage in efforts to make AOPT a more inclusive organization

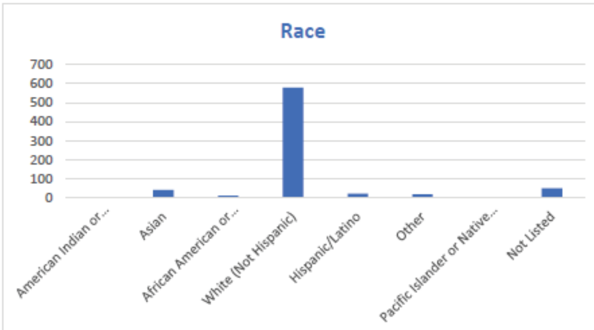
PAIN SIG MEMBER STATS
8/5/2022

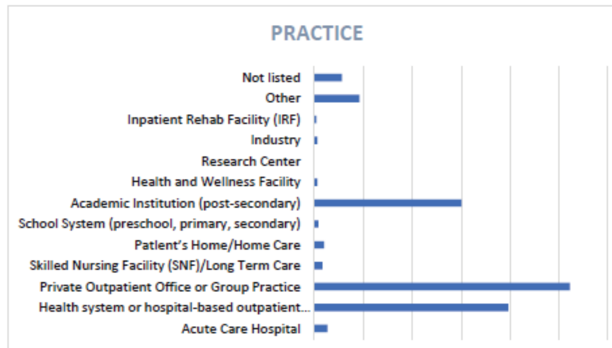
TYPE	
PT	712
PTA	6
STU	8
TOTAL	726

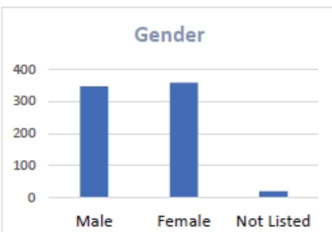
GENDER	
Male	347
Female	358
Not Listed	21

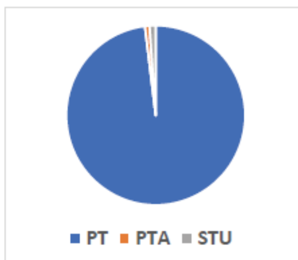
RACE	
American Indian or Alaskan Native	2
Asian	41
African American or Black (Not Hispanic)	11
White (Not Hispanic)	579
Hispanic/Latino	22
Other	18
Pacific Islander or Native Hawaiian	3
Not Listed	50

PRACTICE	
Acute Care Hospital	13
Health system or hospital-based outpatient facility or clinic	198
Private Outpatient Office or Group Practice	261
Skilled Nursing Facility (SNF)/Long Term Care	8
Patient's Home/Home Care	10
School System (preschool, primary, secondary)	4
Academic Institution (post-secondary)	150
Health and Wellness Facility	3
Research Center	0
Industry	3
Inpatient Rehab Facility (IRF)	2
Other	46
Not listed	28









1. Goal: Increase DEI in volunteer pool by 5-8% by December 2023.
2. Goal: Slate defined AOPT-DEI candidates that are representative of APTA membership for the 2021 AOPT election cycle.
3. Goal: Increase diverse membership to reflect APTA DEI's membership.
   a. Objectives:
      I. Creation of DEI Leadership Position (eg, DEI Chair) this would be the rep from our SIG to the AOPT (Max Jordan, Nominating, Ryan Reed, Membership, and Nancy Durban, President)
      II. Creation of CSM DEI Student Scholarship (DEI Chair, Ryan Reed, Membership and committee; Nancy Durban, President)

STRATEGY 2: Grow payment for services by demonstrating the value of physical therapy

1. Goal: Author and ensure new and consistent messaging that articulates the value-add proposition of AOPT's varied services.

STRATEGY 3: Position members as experts in managing movement and functional performance impairments

1. Goal: Develop and disseminate 3-5 resources to educate the public about orthopaedic physical therapy.
2. Goal: Develop and disseminate resources to educate members on how to position themselves as experts in their fields.
   a. Objectives:
      I. Pain certification (Derrick Sueki)
      II. Pain education manual rollout (Mark Shepard)
      III. Facebook page (Katie McBee and committee)
      IV. Pain SIG Website (Katie McBee and committee)

STRATEGY 4: Promote the development and implementation of evidence to best practice

1. Goal: Develop 7-10 innovative and varied learning products (webinar, podcast, etc).
2. Goal: Implementation of:
   a. Pain Education/Research Retreat (Derrick Sueki) 2023
      I. Work task force assigned (Nancy Durban) June 2022
   b. Pain Education Manual Educational Workshops (Mark Shephard)
3. Goal: CSM programming (Eric Kruger).

PRESIDENT'S MESSAGE CLOSING...

The Pain SIG would like to thank the AOPT office personnel, President**,** Bob Rowe, PT, DPT, DMT, MHS and Director/Board Liaison, Beth Collier, PT, DPT, OCS for their continued support and guidance.

We presently have multiple opportunities for SIG involvement on the membership, research, practice, and public relations committees. Please contact me (ndurban@orthopt.org) or any other Pain SIG leader to volunteer to help our initiatives and to set our future. https://www.orthopt.org/content/special-interest-groups/pain

SCUTTLE, OPINION, AND RUMINATIONS

from the Desk of the Imaging SIG President, Bruno Steiner, PT, DPT, LMT, RMSK; Bruno.steiner@wacbd.org

Cherished members of the mighty AOPT I-SIG,

I hope you have all enjoyed a great summer of fun, family, friendship, and professional fulfilment… and above all, spreading the importance of physical therapy imaging referral to anyone you know! It is time for some physical therapy imaging referral and MSKUS talk.

More Physical Therapists achieving the RMSK Credential – and More are Needed!

Let's start with some cause for celebration in MSKUS, shall we… I want to welcome our latest group of Physical Therapists who have passed the challenging RMSK exam. In a modest showing, we have added 5 more Physical Therapists who have been awarded the physician's RMSK distinction to administer MSKUS. Once again, this is the same board exam physicians take with the same questions focusing on intervention and pathology. It is not an easy exam and requires considerable preparation. Just ask our AOPT CPG task force liaison, Dr. James Dauber, DPT, DSc, RMSK, who just passed it. We are so pleased to welcome Jim to the RMSK fold along with our other successful examinees. James has been and continues to be a staunch advocate and collaborator for MSKUS and the AOPT's Physical Therapist imaging-referral initiative. I will reiterate to our dear readership that if you wish to commit the most impactful act to drive home physical therapist competence in imaging, then please start learning MSKUS, practice it in the clinic, build your caseload, study, and sit the RMSK exam. Join us as we integrate MSKUS into our practice to the point no stakeholder will be able to pry it away from our ever-evolving profession. The entry point into this technology has never been easier. There is no jurisdiction that prevents us from using it as an evaluative tool to extend our physical examination. Diagnostic ultrasound devices are getting less pricey, with outstanding high-definition handheld devices priced between 4-5K, so I say why wait? That's what I told a serious, bright, and forward-thinking physical therapy student, Borna Khavari, who reached me through the I-SIG. He wanted to know when and how to start learning. Along with some recommendations, I mainly implored him to start as soon as possible. I realize that students are cash-strapped and debt-burdened and may not want to hear this, but I say that there is no better time than NOW to join the quest. The sooner you commit to the initial awkwardness of learning this technology, the sooner you will master it. There is no magic formula to mastering MSKUS but to image, image, image. Borna has since reported to me that he has helped teach Anatomy to first-year students using ultrasound to identify and study structures, and it has proved to be a rewarding and enjoyable experience. Bravo, Borna!

Diagnostic Ultrasound Sales to Physical Therapists

As promised, a position letter has been approved and is now available to all Physical Therapists interested in buying a diagnostic ultrasound device. I have included the statement in this newsletter in its entirety. The usable copy will have both my and AOPT President, Bob Rowe's signatures on it. It provides the reader and vendor/manufacturer a crucial primer about the Physical Therapy doctoral profession and MSKUS. The document provides talking points ranging from our use of MSKUS in research to the major institutional recognition supporting our use of this high-definition modality. Please remember that the context of this persuasive letter was to address the resistance of ultrasound device vendors from selling us this crucial technology based on a misinterpretation of FDA guidelines. Please do give it a read-through:

Dear (Vendor/Manufacturer),

The American Physical Therapy Association's Academy of Orthopaedic Physical Therapy, in collaboration with the Academy's Imaging Special Interest Group, support the ability of physical therapists to purchase diagnostic ultrasound devices for the continued purpose of research, point-of-care evaluation of patients, physical therapist rehabilitative interventions and procedures, in accordance with their scope of practice. Physical therapists are licensed health care practitioners who are taught at the doctoral level to evaluate, treat, and manage patients with orthopaedic and neuromusculoskeletal conditions. Patients may consult with physical therapists without the requirement of an initial physician consultation. Their graduate curriculum includes background in imaging, radiology, and in differential screening.

Physical therapists are recognized providers of musculoskeletal ultrasonography by the American Institute of Ultrasound in Medicine and the Inteleos Foundation family of certification alliances: the Alliance for Physician Certification and Accreditation, the American Registry of Diagnostic Medical Sonographers, and the Point-of-Care Ultrasound Certification Academy. Pertinently, physical therapists are eligible for the physician's board certification of the APCA-conferred RMSK distinction, which many physical therapists have achieved. Moreover, the AIUM recognizes physical therapists as licensed medical providers of MSK ultrasound. The first published accounts of physical therapist-administered use of diagnostic ultrasound began in the 1980s. Physical therapists have continued to add high-quality peer-reviewed publications to the body of scientific literature, including submissions to the American Journal of Ultrasound in Medicine, Haemophilia, JOSPT, British Journal of Sports Medicine, Research Practice in Thrombosis and Haemostasis, and Blood, to name a few.

There is no federal regulatory basis to preclude physical therapists from purchasing ultrasound imaging devices, which are defined as Class II devices. Other Class II devices traditionally administered by physical therapists include electric stimulation, therapeutic ultrasound, and paraffin baths. Physical therapists have been administering therapeutic ultrasound for its thermal and nonthermal therapeutic effects since the 1950s and have routinely purchased these Class II devices for their practices without restrictions.

Relevantly, under the labeled use delineated in the "Title 21—Food and Drugs Chapter I-—Food and Drug Administration Department of Health and Human Services; Subchapter H — Medical Devices; Part 801 — Labeling, Subpart D - Exemptions from Adequate Directions for Use, Sec. 801.109 Prescription devices" is the following:

The labeled use of this Class II device stipulates that the device is:

1. *(i) in the possession of a person, or his agents or employees, regularly and lawfully engaged in the manufacture, transportation storage, or wholesale or retail distribution of such device; or*
   (ii) in the possession of ***a practitioner*** *[emphasis added], such as physicians, dentists, and veterinarians, licensed by law to use or order the use of such device*
2. *Is to be sold only to or on the prescription or other order of such practitioner for use in the course of his professional practice.*

The Labelling 1. (ii) simply refers to "a practitioner" and provides examples of practitioners without the exclusion of others. Section 2 follows with specific language concerning sales to "such practitioner for the use in the course of his professional practice."

It is clear and consistent with FDA stipulations that graduate-trained and licensed physical therapists are eligible for the purchase of diagnostic ultrasound devices, given our long-established precedent of routine purchases of Class II devices and as providers of POC-MSKUS recognized by the AIUM and APCA.

The physical therapy community looks to the continued engagement and collaboration with the vendors and manufacturers of diagnostic ultrasound devices. We anticipate increased demand for ultrasound devices and are excited to continue our integration of this crucial, high-definition, and, above all, safe, non-ionizing evaluative tool into our specialized orthopedic and neuromusculoskeletal practice of physical therapy.

Sincerely,

Dr. Bruno U.K. Steiner, PT, DPT LMT, RMSK
President, APTA Imaging Special Interest Group
APTA Academy of Orthopaedic Physical Therapy

Dr. Robert H. Rowe, PT, DPT, DMT, MHS
President, APTA Academy of Orthopaedic Physical Therapy

Minding our MSKUS language

Now then, I am certain that some of us reflexively cringed when the words 'Diagnostic Ultrasound' were pronounced - An unease of which rivals the very mentioning of 'Voldemort.' All kidding aside, though, I understand that we physical therapists from certain jurisdictions continue to deal with state board members who wither in fear from using the word 'diagnosis,' and thus, we continue to perform linguistic contortions, meritorious of Cirque-du-Soleil praise, to somehow defang the diagnostic implications of MSKUS. To accommodate and appease our profession's 'diagnostophobic' tendencies, we have teased and parsed out distinctions of Diagnostic US, Rehabilitative US, Interventional US, and Research US.[1] We further categorize the first 3 under the rubric of Point of Care US Imaging. Not to be outdone, my literary offering to this fecund lexical territory is 'Evaluative US' for those who absolutely must avoid the use of the 'Word-which-must-not-be-named', or… "you know *WHAT."*

But it does not stop there, my well-intentioned lexical ninjas. Here is how notables such as J. Jacobson MD and L.N. Nazarian MD define MSKUS in a very recent AIUM's *Journal of Ultrasound in Medicine* entry '*Recommended Musculoskeletal and Sports Ultrasound Terminology*'.[2] By and large, it is a good article with some sound (pun intended) nomenclature use for diagnostic and interpretational language. Regarding the definition of 'MSKUS,' the collaborating authors, who did not include physical therapist consultation, described MSKUS as:

"The use of ultrasound to diagnose and/or guide treatment of conditions involving bones, joints, tendons, muscles, bursae, ligaments, cartilage, nerves, fascia, and related soft tissue structures." Whereas 'Sports ultrasound' was described as "The use of ultrasound by a qualified medical professional to diagnose and/or guide treatment for injuries and medical conditions associated with sport and exercise…the authors continue, "This may involve both clinical and in-the-field applications. Sports ultrasound evaluations are most often performed to answer a specific clinical question, and the need for further imaging or involvement of other medical imaging experts should be considered." This rebranding of MSKUS should sound familiar as it is the very embodiment of POC-MSKUS.

Fortunately, Physical Therapists, as was mentioned in our position statement, are recognized by the AIUM as 'licensed medical providers' of MSKUS. My ultimate preference is to call it MSKUS or POC-MSKUS. Luckily for us Washingtonians, our state board recognizes that physical therapists provide a 'diagnosis.' At any rate, my fellow PT-image buffs, don't sweat the language, the words, and enjoy learning MSKUS, and see for yourself what lies beneath the surface… and answer the questions about the tissues you have been and will continue to treat. If you are concerned and uneasy about challenges from Physical Therapists or non-physical therapist stakeholders, simply explain that you are using MSKUS adjunctively as an evaluative tool to extend and inform your physical examination, and that you are not using MSKUS in lieu of a physical exam.

Noteworthy Educational Offerings in Imaging Advocacy and Ordering

The more informed we are as advocates, the better prepared we are as negotiators and effective communicators. I would urge you to check out the following webinar offering from the APTA Federal Academy. Dr. Aaron Keil, PT, DPT, will guide us through the image ordering with 'Diagnostic Imaging: What to Order and When?' at https://aptafederal.org/events/webinars/?recID=89D24287-B793-BD90-5A1A6E37D-8DCE5DC

And I would also strongly encourage you to get boned up on Aaron Keil's overview on the state of PT Imaging referral from the APTA learning center. It is as relevant now as ever. Please check out 'Direct Ordering of Diagnostic Imaging by Physical Therapists: Updates from the Field' at https://learningcenter.apta.org/Student/MyCourse.aspx?id=4fa88dbf-0272-457d-a344-c8118360dea2&ProgramID=dcca7f06-4cd9-4530-b9d3-4ef7d-2717b5d

Getting Ready Already for CSM 2023 in San Diego, CA

Keep a watchful eye for the Imaging Special Interest Group's one-day pre-conference course at CSM 2023 in San Diego on Wednesday, February 22nd. The course titled, "Getting a Clear View of Imaging Content in Physical Therapist Educational Curricula" is focused on providing guidance to educators teaching imaging content in DPT programs and in residencies. This accompanies the publication of the revised Imaging Education Manual, scheduled for release later this year. The course presenters consist of Michael Ross, Lynn McKinnis, Dale Gerke, Aimee Klein, and former I-SIG president, Chuck Hazle, who collectively have an extensive background in imaging education in multiple dimensions. Included are various strategies and multiple models of incorporating imaging content for students and residents. Discussions of barriers and opportunities for imaging content in curricula in preparation for evolving practice will also be featured.

Educators in long established and developing programs will benefit from attending this course. Please register early and inform your colleagues of the availability of this opportunity to enhance your curricular design and delivery.

Our Research Chair, George Beneck PT, PhD also reminds us that the AOPT SIG Research Committee will be presenting an educational session titled, "Integration MSK-US Integration into Physical Therapist Clinical Practice: Directions Exemplified by Case Reports" at CSM 2023.

From the desk of the I-SIG VP for Education – Brian Young, PT, DSc, OCS, FAAOMPT (brian_a_young@baylor.edu)

I want to highlight some recent work by members of the Imaging SIG in regard to research and physical therapist referral for imaging. First of all, Lance Mabry and colleagues have recently completed a paper titled, *Physical Therapists Are Routinely Practicing the Requisite Skills to Directly Refer for Musculoskeletal Imaging: An Observational Study*."[3] The study should expand the groundwork for obtaining imaging referral rights within the United States. The authors explore how residency/fellowship training, board certification, entry-level degree, experience, and APTA membership status influence the routine practice of imaging skills. The study is currently in press with the *Journal of Manual and Manipulative Therapy* and is anticipated to be available online in the immediate future.

This study follows a 2021 paper by Rundell et al titled, *Survey of Physical Therapists' Attitudes, Knowledge, and Behaviors Regarding Diagnostic Imaging*.[4] One of the key conclusions from this paper is that although physical therapists may recommend imaging, there is inexperience with writing referrals for imaging.

This brings us full circle to an educational point: algorithms to use for the writing of diagnostic imaging referrals. This topic was, to my knowledge, first published in Keil et al's *Referral for Imaging in Physical Therapist Practice: Key Recommendations for Successful Implementation*.[5] As part of the roles and responsibilities, the authors covered how to write a referral, considerations for urgent referrals, and an algorithm to use when determining if the physical therapist is the right clinician to write a referral for imaging. Make sure to check out these articles to advance your physical therapy and imaging endeavors.

The Imaging SIG has significant resources to assist you, your clinic, or your educational programs in using diagnostic imaging and performing referral for imaging in physical therapist practice. Reach out – we are here to help!

State Legislative Round-Up: Daniel Markels, State Affairs Manager, APTA

More States Moving Forward on Imaging

Another state so far in 2022, Arizona, expressly recognizes the ability of physical therapists to order x-rays. Arizona Senate Bill 1312 passed both chambers of the legislature unanimously and was signed by the Governor on June 13, 2022. Unfortunately, another imaging bill, Georgia Senate Bill 1514, which would have expressly allowed physical therapists to order imaging and diagnostic ultrasound, was not acted upon by the legislature before it adjourned for the year.

On another front, the AOPT Imaging SIG has been working with the APTA State Affairs Department in proposing legislative language to the Federation of State Boards of Physical Therapy (FSBPT) for the next edition of the Model Practice Act for Physical Therapy that is currently in the process of being updated. The APTA and the SIG provided language to FSBPT that proposes to expressly include language within the definition of physical therapy that would state that "consulting with other health care providers and referring for indicated services and testing." Such referrals would certainly include referral for imaging. The FSBPT Board of Directors is expected to finalize the updated Model Practice Act at the beginning of 2023. It will then be available for state licensure boards and APTA state chapters, who can use the model as they consider changes to their state practice acts.

Although most states' legislative sessions have ended for 2022, some APTA state chapters are already exploring pursuing imaging legislation in the 2023 state legislative session. APTA State Affairs will continue to work with the AOPT Imaging SIG to support APTA state chapters in pursuing such efforts.

Final Notes from the Trenches in Washington State – Bruno Steiner, President, AOPT I-SIG

I will leave you with the knowledge that I have been pursuing direct referral for advanced imaging here in the state of Washington and am eager to share our continued travails, tribulations, perspectives, and challenges in the next newsletter, so please stay tuned.

In the meantime, keep up the good fight, and keep your eyes on the noble vision of the Primary Care Physical Therapist. We can and need to do this for our patients, our profession, and for good, sound health policy change.

Yours collegially,
Bruno

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3. Mabry LM, Severin R, Gisselman AS, et al. Physical therapists are routinely practicing the requisite skills to directly refer for musculoskeletal imaging: an observational study. J Man Manip Ther. 2022 Aug 13;1-12. doi:10.1080/10669817.2022.2106729
4. Rundell SD, Maitland ME, Manske RC, Beneck GJ. Survey of physical therapists' attitudes, knowledge, and behaviors regarding diagnostic imaging. *Phys Ther*. 2021;101(1):pzaa187. doi:10.1093/ptj/pzaa187
5. Keil AP, Hazle C, Maurer A, et al. Referral for imaging in physical therapist practice: key recommendations for successful implementation. *Phys Ther*. 2021;101(3):pzab013. doi:10.1093/ptj/pzab013

IMAGING

ORF-SIG Dashboard:

Total Members: 405 (+14)
- **Facebook Group: 156 (+1)**

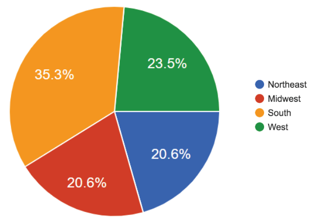
ABPTRFE ACCREDITED PROGRAMS:
- Residencies:
  - **Orthopaedic: 132 (+9)**
- Fellowships:
  - Hand: 0
  - Movement: 1 (-1)
  - OMPT: 25 (+1)
  - Performing Arts: 3
  - Spine: 2 (-1)
  - Upper Extremity: 3

ACOMPTE ACCREDITED PROGRAMS
- OMPT: 38 (+ 2)

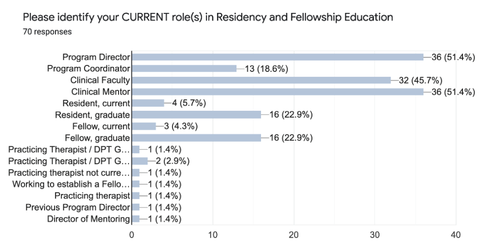
(+/- in members/programs since last quarter)

Current Member make up:

Demographic Regions:



Who We Are?



Please Scan the QR Code or go to: bit.ly/orfsig-membersurvey and complete the survey if you have not already:

PRESIDENT'S MESSAGE

ORF-SIG Members,

We have a lot of exciting projects going on within the ORF-SIG. We currently have 2 main areas of focus: (1) Sustainability of residency and fellowship programs and (2) Using alternative teaching tools to ease the burden on post-graduate educators by mentoring and educating smarter not harder.

To tackle sustainability, we have developed a task force to look at the rationale for the decreased volume of applicants across the country. Some of the universal challenges include:

- high cost of living in certain regions,
- competing programs and losing applicants to other programs with earlier acceptance dates,
- student debt,
- cost of marketing and not gaining applicants from current marketing strategies, and/or
- ability to uniformly show value to employers for residency/fellowship trained clinicians.

Our action plan items to assist all of you with these issues, to open the dialogue and to tackle these challenges as a group include:

a. **CSM programing for San Diego 2023 (register early to save your spot):**
   i. **1 day Pre-conference:** Creating and Maintaining Competitive Residency/Fellowship Programs: Innovations for Curriculum Design, Mentoring, and Inter-Program Collaboration Session ID Number: 13940
   ii. **Education Session:** Mentoring Smarter Not Harder Session ID Number: 14033

b. **Universal post-graduate survey:** We are finalizing a post-graduate survey combining many of our current surveys. The goal of having one consistent survey of our programs is that it will allow us to analyze the value of post-graduate training. We need to look beyond the OCS pass rate to show value to employers for other areas including leadership roles, patient outcomes, patient satisfaction, productivity, etc. Historically there has not been a way to track this information across all programs within the ORF-SIG. We hope a universal survey will help all programs to identify value. We will send this out to members once completed this fall.

c. **Marketing Strategies Webinar:** We are creating a webinar to share some strategies with program directors addressing marketing, gaining applicants, and to address the decline in applications – stay tuned, hoping to have this available by November 2022.

As we all know many hands make for light work so get involved with the ORF-SIG to continue to move this tradition forward. I can honestly say this group of directors/residents and fellows inspire me daily. If you would like to Get Involved within the SIG, make sure to reach out to malloyma@arcadia.edu. Thank you for all of the work you are each doing every day for your residents, fellows and our profession!

Molly Malloy
President, ORF-SIG

ADDITIONAL RESOURCES

Orthopaedic Residency and Fellowship SIG Infographic Development

Tyrees Marcy

The Orthopaedic Residency and Fellowship (ORF) SIG is developing a series of 4 infographics with the focus on residency and fellowship education using the main themes listed below with supportive research.

- What is Residency Education?
- What is Fellowship Education?
- How does Residency and Fellowship Education bring expert care close to home?
- What are the Barriers to Residency and Fellowship Education?

Please consider a creative contribution for visual appeal and impact using supportive research. The creators of the infographic selected or contributing the most to the final product will receive a $250 cash prize and recognition from the ORF-SIG. All AOPT members, including student and post-professional members, are included in this invitation. Individuals or groups of individuals are encouraged to submit more than one type of infographic.

Details for submission

Target date for submission: October 6, 2022 to Tyrees Marcy at shatzert@yahoo.com

APPLICANT REGISTRY

Steve Kareha, Molly Malloy, Kirk Bentzen, Carrie Schwoerer

One big problem facing programs over the years is the ability to sustain consistent applicant bases despite using or not using RF-PTCAS. Our team had been working hard to collect interested applicants to attempt to steer them to open positions. We are brainstorming to revise this system to tackle the problem from the front end focusing on the following:

1. Raise awareness for our programs,
2. Steer qualified applicants to our programs, and
3. Address the problems of open positions throughout the country.

In the meantime, you can continue to use this link for an excess of applicants who you are open to sharing of their information. Specifically for those qualified applicants who are excellent candidates and have already been vetted but applied to a program that does not have any available spots. The program denying admission may then provide the applicant with a flyer explaining the database and providing them the option to participate. Member programs may access these qualified, vetted applicants as needed by contacting Steve Kareha (stephen.kareha@sluhn.org). Updates on the numbers of candidates in this list will be provided quarterly to the membership.

a. Currently, everyone who was on this list has been admitted into a program.

Residency & Fellowship
Qualified Applicants

http://bit.ly/3u0JR0s

PROGRAM RESIDENT/FELLOW/FACULTY SPOTLIGHT

Caitlyn Lang, Kristine Neelon, Bob Schroedter

What is the Program Spotlight?

It is an ORF-SIG, member-only feature that allows one or more orthopaedic residency/fellowship programs to be Spotlighted within a given month to market themselves to prospective candidates and those seeking more information on post professional education in orthopaedics. Additionally, programs will also be spotlighting individual faculty and/or residents/fellows-in-training as good-will ambassadors of their respective programs.

What are the benefits of being Spotlighted?

Programs that are Spotlighted advance the exposure and interest in post professional orthopaedic physical therapy programs across the country, thus bolstering their program's sustainability. Furthermore, by providing important, decision-making details about their program a prospective candidate can make a better-informed decision about what program may be a good fit for them.

Who is eligible to apply?

Program coordinators or program directors may apply for their program as long as they meet the following pre-application criteria:

- The program must be ABPTRFE or ACOMPTE accredited or in Candidate status.
- The Program Director or Coordinator must be a member of the AOPT and ORF-SIG.
- The Program Director or Coordinator must be certified as a specialization in Orthopaedics.

Please visit: https://www.orthopt.org/content/special-interest-groups/residency-fellowship/orf-sig-program-spotlight/spotlight-program-faqs

ABPTRFE FREQUENTLY ASKED QUESTIONS DOCUMENTS

Recently, the American Board of Physical Therapy Residency and Fellowship Education (ABTPRFE) released updates to their Policies and Procedures including some changes to the Primary Health conditions and Covid-19 accreditation recommendations. The ORF-SIG was able to work with the Chair of ABPTRFE, Mark Weber, and the Lead Accreditation Specialist, Linda Csiza. Together, they provided some further elaboration on several Frequently Asked Questions. Check out these documents here:

- Policy 13.5 Addition of Practice Sites FAQ
- Primary Health Conditions / Medical Conditions List FAQ
- CoVid-19 Temporary Guidance FAQ
- Program Sustainability: Applicant Sharing and Recruitment FAQ

RF-PTCAS

Kirk Bentzen, Steve Kareha, Megan Frazee, Carrie Schwoerer, Christina Gomez

If you are a newer program or need a refresher on some of the nuances of the processes and timelines, please review the following podcast: *Navigating RFPTCAS,* which can be found at: https://musc.hosted.panopto.com/Panopto/Pages/Embed.aspx?id=0841c14e-a3f7-4196-b654-acd90169c9e2. Presenters of this podcast included Ryan Bannister, Director-Centralized Application Services and Student Recruitment and Orthopaedic Residency and Fellowship SIG leadership, including Kirk Bentzen, Christina Gomez, and Steve Kareha.

Please contact Carrie Schwoerer (cschwoerer@uwhealth.org) with questions.

OTHER KEY RESOURCES

ABPTRFE Updates: Community HUB

Don't miss out on the latest ABPTRFE Updates from Kendra Harrington:

- Updates to ABPTRFE Processes and Procedures
- What Sites Should, and Should Not, Be Included on the Participant Practice Sites?
- ABPTRFE Recent Actions
- July 1 Policy Reminder

ACOMPTE Website and Resources

Orthopaedic Manual Physical Therapy Fellowship programs find ACOMPTE Information here:

APTE RF-SIG Resources

Christina Gomez

aptaeducation.org/special-interest-group/RFESIG/

You can also find more great information from the Academy of Education's Residency and Fellowship SIG (RFESIG). Here you will find a variety of Podcasts they have completed for Residency and Program Directors. Please make sure to check these out as well as the Think Tank resources.

- Virtual Site Visit
- RF-PTCAS Reminders

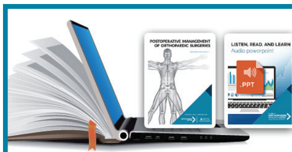
Take advantage of our member-only communication forums to share and develop ideas.

ORF-SIG Facebook group

bit.ly/orfsig-fbgroup

AOPT ORF-SIG Communities HUB

bit.ly/orsig-communityhub



RESIDENCY

AOPT Residency Curriculum

The Academy of Orthopaedic Physical Therapy offers a didactic curriculum package including regularly-updated and expanded learning modules with learning objectives.

The residency/fellowship curriculum package and individual courses are available to resident's fellows and directors currently in accredited, candidacy or developing residency or fellowship programs in orthopaedic physical therapy and/or a related fellowship field.

Learn how the program works here: https://www.orthopt.org/content/education/residency-curriculum/full-curriculum-package

The curriculum was designed to create or supplement the foundation for your residency program, and is available in two different options:

Full curriculum package:
https://www.orthopt.org/content/education/residency-curriculum/full-curriculum-package

Individual course package:
https://www.orthopt.org/content/education/residency-curriculum/individual-course-option

PRESIDENT'S MESSAGE

It is officially fall and just like that the year is almost over. For me 2022 has certainly flown by as I have been keeping myself busy at work with my clinic and consulting business, and at home as my daughter is now turning 1 year old! People told me that my life would change once she was born, and I knew it would, but I didn't expect to change it as much as it did in terms of me needing to fine tune my time-management skills. It has certainly given me a whole new appreciation for those of us who started a new business, especially for anyone who does so while raising little ones at home. With that being said, in this issue's article we wanted to highlight some folks who have branched out of the traditional clinical role that we have as physical therapists and ventured out into opening their own business in this field while still using their knowledge and skills as canine physical therapists.

I also wanted to take the chance to remind you all of some of the benefits you have as members of the Animal PT SIG. Earlier this year we started hosting quarterly educational webinars, and you also have access to those replays on your membership section of our website at https://www.orthopt.org. Last March, Lisa Bedenbaugh gave us a presentation on *Rehabilitation and Management of Dogs with Hip Dysplasia,* and in June we had Jenny Moe and Jill Kuhl present on *Dysfunction of the Lumbo-Pelvic-Hip Complex in Human vs Canine Clients.* Furthermore, Jenny Moe and I also hosted a Q&A last February focused on answering questions from physical therapists and students who wanted to learn more about the field of animal physical therapy. Topics covered included certification process, state legislation, job outlook, etc. All of those webinars, and more, are accessible to you as members of the Animal PT SIG, and if you have any questions, I am always just an email away.

Thank you,
Francisco Maia, PT, DPT, CCRT
Animal PT SIG President
fmaia@orthopt.org

BRANCHING OUT IN ANIMAL REHABILITATION: PHYSICAL THERAPISTS TAKE ON DIFFERENT ROLES IN THE PROFESSION

Lisa Bedenbaugh, PT, CCRP
Jenny Moe, PT, MS, DPT, CCRT, APT (NV)

The field of animal rehabilitation is a rapidly growing niche in the area of veterinary medicine. The pioneers in the field began treating in the early 1990s, and the first conference focusing on rehabilitation of animals was held in Corvallis, OR in 1999. Certification programs were developed, with Northeast Seminars/ University of Tennessee awarding their first graduates in 2002, and Canine Rehabilitation Institute following in 2003. Early on, working in this field meant direct hands-on patient care, but as animal rehabilitation has grown and matured, physical therapists are finding business opportunities in areas other than clinical practice. This article will introduce you to some of these entrepreneurs, and show you how your knowledge and talents can be used to help both clients and others practicing in the field.

PRODUCT DEVELOPMENT

In the early years of animal rehabilitation, almost all equipment used was either adapted from human physical therapy/fitness items or hand-built. Physical therapists are uniquely qualified to create new products, as we are constantly working on how to solve mobility and environmental issues for our patients. Often, there is no pre-made solution available, so we fabricate adaptive equipment to help the client to function more easily or independently. Similarly, many of the pre-made therapeutic equipment for humans did not conform to the needs of the animal rehabilitation practitioner, so a couple of physical therapists figured out how to develop and manufacture equipment more suited to the needs and challenges of those working in the animal realm.

Lisa Bedenbaugh is a physical therapist who spent the first 15 years of her career working in traditional physical therapy clinics and hospitals before finding out about animal rehabilitation. She started looking into this newly emerging field and was instantly hooked, receiving her certification in canine rehabilitation (CCRP) in 2003, and beginning to work part-time in the veterinary field. Over the next several years, she gradually transitioned over fully to animal rehabilitation. She was finding times where she was struggling to both support and be able to gait train a weak dog, or be able to complete certain therapeutic exercises because she didn't have equipment that was compatible to her needs. She enlisted the help of her husband, Scott, and together they began designing and building prototypes of support systems and therapeutic exercise equipment to fit her clinical needs. As the field continued to grow, she realized other therapy practitioners were having similar struggles in their daily practice, so she and her husband founded Canine Rehab Systems, which manufactures and sells support systems, durable medical equipment for small animal rehabilitation centers, and other therapeutic/fitness equipment. She is also a co-founder of K9 Align, which developed a wearable therapeutic garment for dogs with hip dysplasia and other similar issues. This came about from her frustration with kinesiotape not always sticking well to the dogs' fur, and her awareness that there was a gap between very light Ace wrap-type solutions and rigid bracing for the hip, so she helped design a full body garment for dogs with mild to moderate hip dysplasia that wouldn't interfere with normal movement patterns. Lisa receives satisfaction from seeing other practitioners being able to perform their jobs more safely and efficiently, as well as seeing pet owners notice their mobility impaired dogs living a better quality of life using products she helped develop. Lisa has helped support the APTA's Animal PT SIG as the newsletter editor for almost 10 years.

Jenny Moe, PT, MS, DPT, CCRT, APT (Nevada) began her career in physical therapy specializing in pediatrics, and specifically in the use of adaptive equipment such as the TheraSuit, TheraTogs, and custom bracing to help her patients. There was often a need for adapting existing equipment, or making her own, to suit the needs of her growing and complex patients. When Jenny transitioned into animal physical therapy in 2009, she saw the need for innovation and carryover of ideas for her canine and feline patients. Jenny continued to make many of her own devices, such as dorsiflex assist straps, support and proprioception garments, and adaptations to wheelchairs, or carts, as she prefers to call them. There was little instruction provided at the time of earning her certification in canine rehabilitation (CCRT) about bracing, assistive devices, or carts. Thankfully, Jenny was able to draw from her extensive experience in pediatrics to help her expansive population of patients, working at a busy specialty animal practice in the San Francisco Bay Area, and began to share her knowledge with fellow therapists.

At the end of 2020, Jenny had the opportunity to purchase and take over one of the longest operating animal wheelchair businesses, Doggon' Wheels. She and her husband, Ron Moe, moved the company to San Francisco in January 2021 after training with the original owners/founders, Lori and Chad Holbein. Jenny and Ron have made small improvements to the existing designs, and hope to continue to evolve the carts to meet the needs of all of their clients, from 2-pound rabbits to 200-pound Mastiffs. Jenny's knowledge as a physical therapist combined with Ron's engineering/drafting background provided the perfect pairing to save the company and help it grow. Doggon' Wheels was always Jenny's preference for most cases, and she is now honored to be able to help animals all over the world. She is also able to consult with owners and professionals to progress the rehab provided, and teach new ideas. She did dip her toe into clinical mentoring, but prefers to keep that on a more individual basis. Jenny is proud to see other clinicians expand their knowledge and skills through her guidance and products provided from Doggon' Wheels. She is also the current Vice President of the APT SIG.

BUSINESS COACHING

Francisco Maia, PT, DPT, CCRT is not only our APTA Animal Physical Therapy SIG President, but also the founder of a successful business coaching enterprise, The K9PT Academy. Francisco started his career in animal physical therapy in Chicago, IL working for a veterinary practice. He was paid the same wages as an entry level veterinary assistant, despite his credentials as a certified canine rehabilitation therapist (CCRT) and doctor of physical therapy. Francisco was able to take the experience he gained at the practice and go out on his own, founding his mobile practice, The K9PT. In 2021, Francisco opened his brick and mortar practice, which is thriving in Chicago with multiple physical therapists and staff.

In 2019, Francisco launched his pilot program, The K9PT Academy. Combining an online platform with live calls weekly, Francisco shared his knowledge to help expand the number of physical therapists working in canine rehabilitation, so that they could also be successful in their own endeavors and open/expand their own businesses. Francisco has had multiple rounds of the Academy with many success stories around the country of his mentees thriving in solo practice. Together with the program, a busy Facebook group helps to engage a wide audience of physical therapists both certified and interested, in discussion about popular topics and advocacy for the field. In August 2022, The K9PT Academy Podcast was added to Francisco's offerings in order to reach a wider audience. He realized over the last few years that veterinary rehabilitation professionals struggled with knowing how to adjust their rates to reflect their true value, run their businesses efficiently, and that this was not isolated to the United States. His audience has grown internationally, and the need for the podcast was realized.

Francisco is passionate about promoting physical therapists in the field of veterinary rehabilitation, our value and expertise, and helping more physical therapists make the transition into animal practice. He strives to make it easier for therapists to learn about the field and transition with ease, and to earn what they deserve to be paid for their knowledge.

Dr. Jenny Moe, fitting a Doggon' Wheels client in San Francisco, CA.

Lisa Bedenbaugh, PT, CCRP, demonstrating the K9 Align.

CLINICAL MENTORING

Amie Hesbach, PT, DPT, CCRP, CCRT is one of the first dozen or so physical therapists treating animals in the United States. She has a wealth of practical and clinical knowledge from years of working in large veterinary specialty practices, as well as having completed a residency in Proprioceptive Neuromuscular Facilitation (PNF), a national certification in Pilates, and a certification in KinesioTaping. When Amie first started out in the animal rehabilitation field, the numbers of practitioners in this field were very small, and most therapists were spread out across the country, which made learning from each other difficult. This was before video calls and other technology were in place to make collaboration relatively easy. She explains that she felt rather isolated, and longed for the ability of colleagues to "lend a second set of eyes or hands in helping to problem-solve those most challenging cases." More recently, she founded EmpowerPhysio and provided in-home rehabilitation services to pet owners in the Boston, Massachusetts area. Having her own solo practice taught her business and administration skills, as well as being more aware of how her pet clients have to function in their own home environments.

Amie Hesbach, teaching a cohort.

Dr. Francisco Maia with the first round of The K9PT Academy mentees in Chicago, IL

In 2019, she and her family moved to The Netherlands for 3 years due to her husband's work. Being several hundred miles away from her clients in Massachusetts, as well as most of her animal rehabilitation colleagues, required her to shift her business model to more of an educational realm, and embrace the technology to connect with others around the globe. She developed EmpowerPhysio Educate, which is a clinical mentoring program made up of on-demand video training, in-person workshops/lectures and group and one-on-one coaching sessions, to help other animal rehabilitation professionals improve their knowledge and skill base. She has enjoyed getting to know clinicians from all over the world and see how the education programs in various countries have both similarities and differences. She has also been able to have a better appreciation for the challenges that clinicians face in their practices around the globe. Amie has also served as a past president of the APT SIG.

As the field of animal rehabilitation has grown and matured, several physical therapists in the field have also branched out from full time direct patient care into other niches within the field. Their contributions have helped to support those practitioners working directly with patients and clients, through fostering better clinical and business skills and providing more options for assistive devices for their patients in need. We hope to see other clinicians with special skill sets also continue to branch out and further the profession even more in the future.

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Concussion Fact Sheet:

Optimize your Recovery from Concussion

What is a concussion?

A concussion is a brain injury caused by a bump, blow, or jolt to the head or body that causes the head, neck and brain to move quickly back and forth. This trauma affects thinking (confusion, feeling "off", or in some cases a brief loss of consciousness) and may also affect the neck and the balance system. Physicians may describe a concussion as a "mild" traumatic brain injury because often no structural injury to the brain is seen.

When should I see a doctor?

If you've seen a physician to diagnose your concussion, that is good. If you haven't and are having symptoms that are bothering you, see a physician as soon as you can. If you have symptoms that persist beyond the first few weeks after injury, rehabilitation treatment may be helpful to treat those issues.

How long does recovery take?

80-90% of people with concussion will be symptom free within a few weeks. A gradual return to usual activities after a short period of rest often helps people recover. If you follow these recommendations, you will maximize your body's ability to heal. If you have physical complaints that are slow to improve, recovery may be aided by physical therapy.

Recommendations to Speed Recovery

Activity

Rest for the first 24-48 hours. Avoid any activities that could put you at risk of additional injury. Talk with your healthcare provider about whether your occupation involves activities that present a risk for another injury. *You may not return to risky occupations until cleared by physician.*

After the first 24-48 hours, try to resume basic usual activities, including your daily routine and if you tolerate that well, school or work. There may be some rehabilitation strategies to assist in re-integration.

After 48 hours, it is okay to start light exercise again. Slowly increase intensity as your symptoms allow.

Consistent Sleep

Maintain scheduled bedtimes and awake times with no naps. Sleeping at night is the time your brain heals and napping inhibits night sleep. 7 to 9 hours of sleep at night is recommended.

Manage Stress

Perform some type of relaxation activity daily (ex. Yoga, Mindfulness, Nature walk)

Screen time - Use of computer, phone, or TV for a long time may not be good for you. You can use screen time to minimize stress if symptoms do not worsen. If symptoms worsen, take a break and resume once symptoms improve.

Eat and Hydrate

Eat a normal diet on a regular schedule. Food is fuel for the brain and is needed during this time to help repair itself.

Drink water throughout the day, 2-3 (16-24oz) bottles of water/day.

Do not drink alcohol. This may delay your brain's healing & cause a resurgence of symptoms.

Occasionally, people may experience more severe symptoms. If you experience any of the below symptoms, call your physician or go directly to the emergency room: *Headaches that worsen significantly, slurred speech, seizures or loss of consciousness, increasing confusion, inability to awaken, severe neck pain, weakness/numbness in arms/legs, repeated vomiting, &/or unusual behavior changes.*

For more information:

Evidence Based Clinical Practice Guideline: Physical Therapy Evaluation and Treatment After Concussion/ Mild Traumatic Brain Injury

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