2019 / volume 31 / number 3

# ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA

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# SCREENING FOR ORTHOPAEDICS

## Independent Study Course 29.3

## Description

This course discusses the principles of differential screening and the important role physical therapists play in primary care. The authors apply a systematic data collection process to screening using the VINDICATE methodology for organizing a structured examination. This approach is used for the upper and lower extremities in separate monographs. A total of 9 patient case scenarios help apply concepts for the reader and highlight critical decision-making.

## Topics and Authors

**Principles of Differential Screening**
**Screening the Upper Extremity**
**Screening the Lower Extremity**
John Heick, PT, DPT, PhD, OCS, NCS, SCS
Seth Peterson, PT, DPT, OCS, FAAOMPT
Tarang Jain, PT, DPT, PhD

## Continuing Education Credit

**15 contact hours** will be awarded to registrants who successfully complete the final examination. The Academy of Orthopaedic Physical Therapy pursues CEU approval from the following states: Nevada, Ohio, Oklahoma, California, and Texas. Registrants from other states must apply to their individual State Licensure Boards for approval of continuing education credit.

Course content is not intended for use by participants outside the scope of their license or regulation.

## Learning Objectives

1. Discuss the significance of direct access legislation and how this influences differential diagnosis content and understanding.
2. Identify the important factors to screen for in the review of systems.
3. Discuss the pros and cons of using red flags for identifying systemic conditions.
4. Explain the use of VINDICATE to facilitate a thorough history-taking during a patient examination.
5. Differentiate between the signs and symptoms underlying systemic causes of shoulder dysfunction and orthopaedic causes.
6. Differentiate between the signs and symptoms underlying systemic causes of elbow, forearm, and wrist dysfunction and orthopaedic causes.
7. Differentiate between the signs and symptoms underlying systemic causes of hip dysfunction and orthopaedic causes.
8. Differentiate between the signs and symptoms underlying systemic causes of knee, ankle, and foot dysfunction and orthopaedic causes.
9. Recognize clinical patterns associated with orthopaedic conditions in the upper and lower extremity and when to refer to another health care professional.
10. Recognize the usefulness of the mnemonic VINDICATE and how this applies to screening of the upper extremity and lower extremity.

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ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

APTA American Physical Therapy Association

# ORTHOPAEDIC
# PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA


## In this issue



## Regular features



## OPTP Mission

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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**President's Corner**

# Calling All Members!

**Joseph M Donnelly, PT, DHSc**

The Orthopaedic Section transitioned to its new name, Academy of Orthopaedic Physical Therapy (AOPT) effective May 29, 2018. For those of you concerned that the Orthopaedic Section went away, be assured we are still here, we just changed our name. AOPT is more reflective of what an Academy represents in professional associations. Our new name can be cumbersome to say when introducing yourself, whether it is as a member or a leader. I found this out first hand while attending the World Confederation of Physical Therapy (WCPT) Congress 2019 in Geneva, Switzerland, May 10-13. It was much easier to say Orthopaedic Academy, APTA, and most international physical therapy professionals seemed to understand. Within the Orthopaedic Academy, branding us as AOPT is gaining momentum. In communicating with the membership and external stakeholders, I have been saying Orthopaedic Academy, which is not far from Orthopaedic Section.

Did you know the AOPT (Orthopaedic Section) was the catalyst for the APTA outcomes registry, the initiation and support of clinical practice guidelines, the APTA manipulation and dry needling workgroup, and numerous other initiatives? It is vital that "we know the past, enjoy the present, and think of the future (WCPT 2019)" as we continue to transform orthopaedic physical therapy practice and the profession.

The AOPT is committed to Practice, Research, Education, and Advocacy for continued growth and progress. We rely on members such as you to help us continue to be a leader in the orthopaedic community and within the profession of physical therapy. As a valued member, I am extending a personal invitation for you to get involved in moving the Orthopaedic Academy forward. I want to remind each of our 19,365 members that the Academy is depending on your engagement to accomplish its strategic goals and to meet your needs in practice, education, research, and advocacy. This is being brought to your attention due to our inability to engage enough members to reach a quorum this past April on our proposed bylaw amendment vote to increase the number of Directors and voting members on the AOPT Board of Directors. In attempts to sort out why we were only able to obtain 365 votes from approximately 17,500 voting members, we found there were 1,800 attempts but the majority never made it to casting their vote. This represents only 2% of the total eligible voting membership who actually cast a vote, 7% who were interrupted in their attempt to vote, and 91% who chose not to vote or did not receive information from the AOPT regarding the referendum. I am asking for your help in improving member participation in our voting process by responding to email or Osteoblast requests for participation. We (AOPT) have to do better with our member engagement if we are going to continue to be transformational in orthopaedic practice, research, education, and advocacy.

Here is what we need you to do: change your password on orthopt.org to allow you to access the member only portions of the website. The step-by-step process is on page 127 in this issue of *OPTP*. Your participation is vitally important if we are to improve our ability to communicate and engage the membership. Let us know by sending an email (through our Contact Us form at https://www.orthopt.org/contact-us.php) what barriers exist on our web site with communication, and most importantly, with our voting process. The Board of Directors and executive staff are investigating an alternative voting procedure that is less cumbersome than our current voting process.

The AOPT vision is to be a world leader in advancing orthopaedic physical therapy to optimize movement and health. To stay in line with our vision, I attended the WCPT Congress 2019 in Geneva, Switzerland. There were 4,200 physical therapy professionals representing approximately 109 nations in attendance. The United States delegation was the second largest with nearly 340 delegates, second to 1,200 delegates from Switzerland. The APTA hosted a breakfast for the US delegates and other world leaders, which was very engaging. I had the opportunity to speak with Emma Stokes, President of the WCPT, and Fernando Ramos Gomez, President of the Spanish Physiotherapy Association, regarding opportunities for future collaborations with the AOPT. I also had the chance to talk to physical therapists from Kenya, the United Kingdom, the Netherlands, and the United States. My 35th anniversary as a physical therapist was spent attending the WCPT Congress 2019 and I could not think of a better way to celebrate this achievement. I was able to participate in several scientific presentations on pain science chaired by Peter O'Sullivan from Australia, another presentation on musculoskeletal physical therapy with an emphasis on the spine headed by Nathan Hutting from the Netherlands, and an amazing leadership session chaired by Emer McGowan from Ireland. The leadership session was very insightful regarding the importance of self-leadership and creating teams with mutual and individual accountability. In closing, I would like to thank the AOPT Board of Directors and membership for entrusting me to represent the AOPT on the world stage. This, indeed, was one of the highlights of my professional career.

*(Continued on page 126)*


**Joe Donnelly with Emma Stokes, WCPT President.**

# President's Corner

(Continued from page 125)

Joe Donnelly with Fernando Ramos Gonzalez, President of the Spanish Physiotherapy Association.

Joe Donnelly found the AOPT Past President and now Senior VP at APTA, Bill Boissonnault in attendance in Geneva.


Joe Donnelly expressed that attending WCPT 2019 was a highlight of his career.

THE ORTHOPAEDIC SECTION

*is now the*

ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

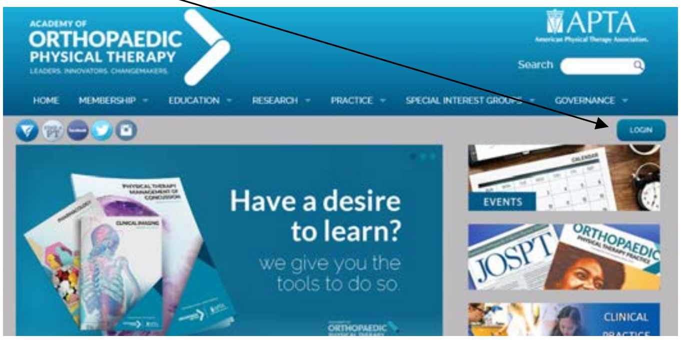
ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

## Congratulations Thomas McPoil, PT, PhD, FAPTA Mary McMillan Lecture Awardee

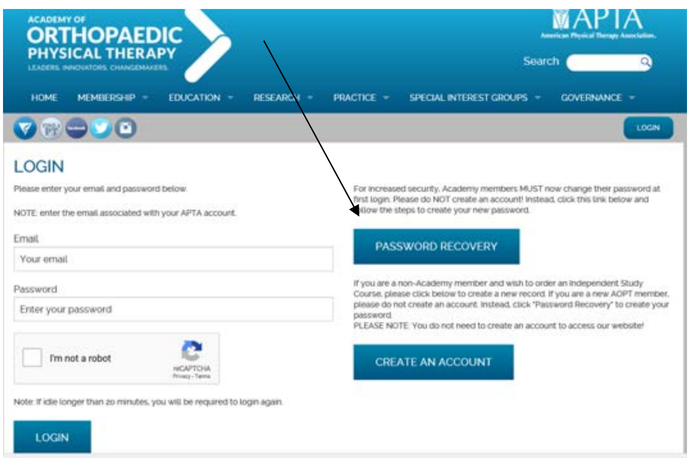
Tom presented the 50th Mary McMillan Lecture - Is Excellence in the Cards? on Thursday, June 13 at NEXT held in Chicago.

# Steps for Logging into the AOPT's Website

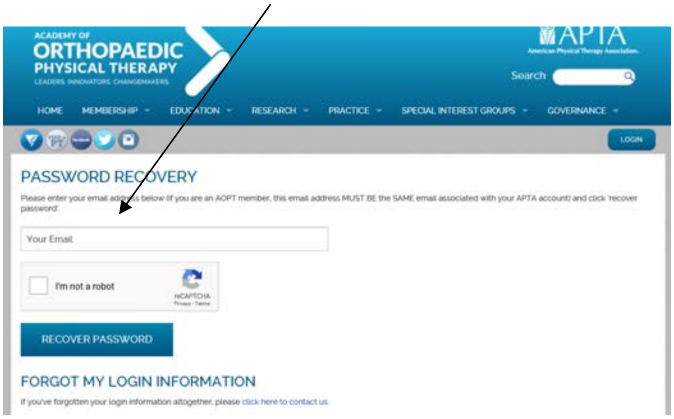
When logging into the AOPT's website **for the first time,** you will need to create a password.




The page that displays after clicking "**Login**" is shown below. Be sure to read the options carefully. If you are a current member, you will not "Create an Account". Instead, simply click "**Password Recovery**". Please keep in mind, **if you have just joined the AOPT**, it *may* take up to 1-2 days for your information to be imported into our system from APTA, and for you to gain access to the website.



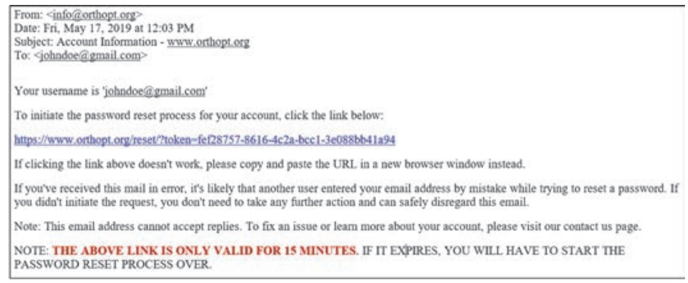

Be sure to enter the **SAME** email address that is associated with your APTA account, otherwise you will not receive the password recovery email! If you cannot recall your email address, please contact the AOPT office for assistance.




Below is an example of the password reset/recovery email that you'll receive. Please note, if you do not receive this recovery email, it is due to:

- You entered an email address that is different than the one associated with your APTA account
- Your firewall has halted the email
- It may be in your Junk folder
- You may need to add info@orthopt.org to your address book.

NOTE: This reset/recovery email will only stay valid for 15 minutes. If you are not able to click on the reset link within 15 minutes, you will need to start the reset/recovery process over.



From: <info@orthopt.org>
Date: Fri, May 17, 2019 at 12:03 PM
Subject: Account Information - www.orthopt.org
To: <johndoe@gmail.com>

Your username is 'johndoe@gmail.com'

To initiate the password reset process for your account, click the link below:

https://www.orthopt.org/reset/?token=fef28757-8616-4c2a-bcc1-3e088bb41a94

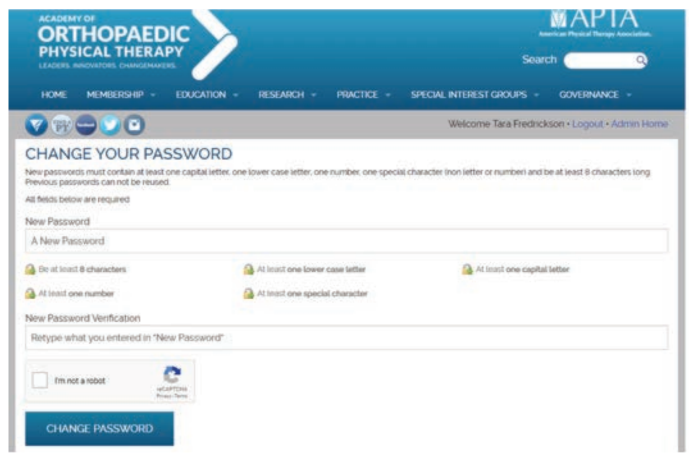
If clicking the link above doesn't work, please copy and paste the URL in a new browser window instead.

If you've received this mail in error, it's likely that another user entered your email address by mistake while trying to reset a password. If you didn't initiate the request, you don't need to take any further action and can safely disregard this email.

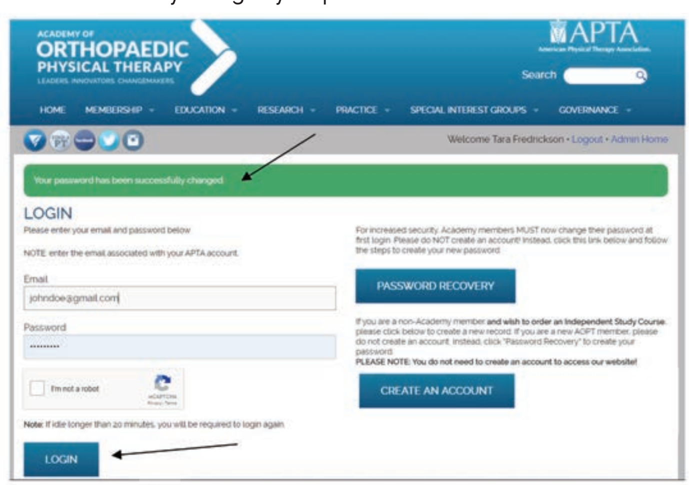
Note: This email address cannot accept replies. To fix an issue or learn more about your account, please visit our contact us page.

NOTE: THE ABOVE LINK IS ONLY VALID FOR 15 MINUTES. IF IT EXPIRES, YOU WILL HAVE TO START THE PASSWORD RESET PROCESS OVER.

Below is what the screen looks like when changing your password:




After entering your new password (according to the guidelines shown on the above form), and clicking "Change Password", you will be able to log into the AOPT's website. The following screen will appear when you have successfully changed your password:




**The AOPT office is here to help! Contact us at 800-444-3982 or online: https://www.orthopt.org/contact-us.php with any questions you may have.**

# Leaders, Innovators, and Change Makers In Action

## Join us next year at the CoHSTAR Implementation Science Institute.

**Dan White, PT, ScD, MSc, NCS**

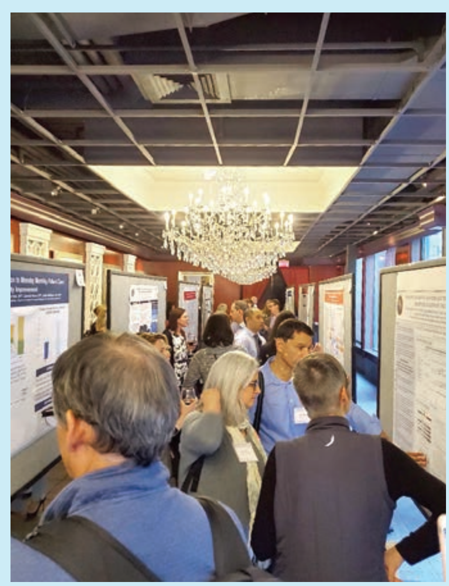
The AOPT has developed a strategic partnership with the Center on Health Services Training and Research (CoHSTAR) to promote and venture into the innovative and growing field of Health Service Research. Most recently, the AOPT was a major sponsor of the CoHSTAR Workshop and Implementation Science Institute, a two-day conference geared towards training the next cadre of clinical investigators in Implementation Science. The meeting was attended by over 90 individuals including APTA CEO, Justin Moore, PT, DPT, leading Implementation Scientists from around the country, and AOPT staff and Board members. There were 4 significant returns of investment to AOPT members by sponsoring the workshop.

1. The event fostered training of a new group of Health Service Researchers with an emphasis on implementation.
2. Relationships were fostered between seasoned scientists who are experts in implementation with clinicians and clinician scientists who want to conduct implementation studies, many were AOPT members.
3. The workshop provided practical hands-on feedback on implementation science proposals for a group of clinicians, which is vital for our profession.
4. The Institute provided a platform for dissemination of existing implementation related studies via platform presentations and scientific poster sessions, which generated excellent discussion.

**AOPT Members in action: Planning for Clinical Practice Guideline (CPG) Implementation and applying the frameworks learned from the 1.5 day Institute.**

We are excited to sponsor next year's Implementation Science Institute, which will build on the strides made from this year.


**CPG Author, David Logerstedt, PT, PhD, presenting his AOPT focus group findings and posing for a quick shot with Research Chair, Dan White, PT, ScD, MSc, NCS.**



**Lively discussions around the fantastic posters.**

# Editor's Note

Recently at a state association meeting, I overheard a conversation that I wanted to share as an example of how a portion of our profession feels about evidence-based practice (EBP). Here are several of the points that were made in the discussion:

- Clinical Practice Guidelines (CPGs) exist for limited topics in physical therapy, so should we only do what CPGs say we should do?
- The absence of evidence does not mean that an intervention is not any good, it just means that there is no evidence for the intervention.
- There are many research topics for which randomized controlled trials just cannot be done.

After my initial reaction, I reflected on these statements and have decided to write the next two editorial pages on this topic. There seems to be a disconnect between clinicians and researchers. This disconnect is often depicted as a waterfall to demonstrate that research flows down to the clinicians, to inform their practice. Many point out that this top-down system ignores the clinician's input, stating that water only flows down. Clinicians influence research through the propagation of new ideas that need investigation. What can be done about this misunderstanding?

As you may know, the APTA's House of Delegates in June is considering RC 3-2019 Amend Evidence Based Practice HOD P-06-06-12-08 to the following:

"The American Physical Therapy Association supports the development and utilization of evidence-based practice that includes the integration of best available research, clinical expertise, and patient and client values and circumstances related to patient and client management, practice management, and health policy decision making."

(note the underlined is the change for this motion)

Support for this states "Evidence-based practice is a well-established approach to patient and client management in physical therapy and in health services."

While many in our profession agree that EBP is a well-established approach to patient care, it is amazing to consider that part of our profession disagrees. A perfect example of our profession taking its time in accepting evidence is the use of Homans sign. Homans sign has been shown to be successful in indicating the presence of a deep vein thrombosis (DVT) in half of all patients with DVTs, and up to 30% of patients who test positive for a DVT actually have no DVT.[1,2] The sensitivity of Homans sign ranges between 8% and 56% and the specificity is less than 50%.[3] Continuing to use Homans sign to detect the presence of DVT then is equivalent to flipping a coin. The Wells Clinical Decision Rule (CDR), has a sensitivity of 96% to 100% and specificity of 30% to 70%.[4,5] The Wells CDR classifies patient characteristics into "likely" or "unlikely" to have a DVT so that those likely to have a DVT can be referred. The Wells CDR was developed in 1995 and many within our profession are still unaware of this evidence-based tool.

I am very much interested in readers' input on what can be done about improving communication between clinicians and researchers, completing the circle, if you will. I encourage readers to reflect on this and send your comments on this topic to the Academy of Orthopaedics' social media outlets. I am interested in action items, that is, what steps can we take to improve collaboration between clinicians and researchers? The Academy is the largest of all within the profession so perhaps if we come up with solutions, we can set the trend for our profession to follow.

*Professionally,*
*John Heick, PT, PhD, DPT*
*Board Certified in Orthopaedics, Sports, and Neurology*

## REFERENCES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2. Sohne M, Kamphuisen P, van Mierlo P, Buller H. Diagnostic strategy using a modified clinical decision rule and D-dimer test to rule out pulmonary embolism in elderly in- and outpatients *Thromb Haemost*. 2005;94(1):206-210.
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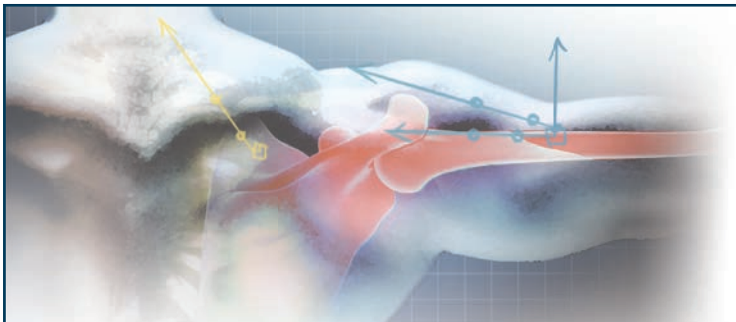

# THE SHOULDER

## Independent Study Course 28.2

### Learning Objectives

1. Understand shoulder biomechanics and pathomechanics.
2. Understand the components of a thorough physical examination in the diagnosis of rotator cuff tears.
3. Describe the evidence supporting a framework for prescribing therapeutic exercise for shoulder dysfunction.
4. Understand the specific etiology and pathology involved in rotator cuff tears.
5. Describe the rationale for nonoperative and operative treatment of rotator cuff tears.
6. Describe appropriate rehabilitation interventions in the early, middle, and late stages following rotator cuff repair surgery.
7. Describe the risk factors for development of shoulder stiffness and differential diagnosis.
8. Describe the current evidence for nonsurgical management of shoulder stiffness and specific physical therapy interventions.
9. Understand the natural history for adhesive capsulitis and key concepts in the prevention of postoperative stiffness.
10. Describe principles, goals, and quantitative measures of progression in the nonoperative rehabilitation for shoulder instability.
11. Understand advantages and indications for surgical methods to correct shoulder instability.
12. Identify criteria to return to desired activity following a postoperative rehabilitation program.
13. Discuss the structure and criteria for rehabilitation progression governing return to sport for the overhead athlete.
14. Identify appropriate return to play progression modifications to accommodate for workload variations and seasonal factors.
15. Compose a functional testing algorithm for return to activity based on patient expectations.

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Gordon Riddle, PT, DPT, ATC, OCS, SCS, CSCS—Associate Editor
Sharon Klinski—Managing Editor

### Description

This 6-monograph series addresses the biomechanical, pathological, and evaluative aspects of treating the shoulder. Specific emphasis is placed on the rotator cuff, shoulder instability, and special concerns for the overhead athlete. Therapeutic exercise and return to activity considerations are discussed in detail as well. Decision making and treatment plans for nonoperative and operative scenarios are highlighted. All authors have extensive experience in the evaluation and management of shoulder pathology.

**For Registration and Fees,** visit orthoptlearn.org
**Additional Questions—Call toll free 800/444-3982**

### Topics and Authors

**Clinical Kinesiology of the Shoulder Complex: Foundations for Therapeutic Exercise**—Phil Page, PhD, PT, ATC, CSCS, FACSM

**Evaluation and Treatment of the Rotator Cuff**—Craig Garrison, PT, PhD, ATC, SCS; Joseph Hannon, DPT, PhD, SCS, CSCS; Dean Papaliodis, MD

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ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

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# The Use of Electrical Dry Needling and Cervical Joint Mobilizations to Treat Cervicogenic Headaches: A Case Report

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## ABSTRACT

**Background and Purpose:** Limited research exists regarding the most efficacious conservative treatment for cervicogenic headache (CHA). The purpose of this case report is to describe the use of electrical dry needling with cervical joint mobilizations for the treatment of a patient diagnosed with CHA. **Methods:** A 36-year-old female was referred to physical therapy after an insidious onset of frequent (4-5 per week) headaches. The patient reported cervical stiffness, suboccipital pain, and right retro-ocular pressure. Cervical range of motion (ROM) (% normal): flexion, right rotation 75%; extension, bilateral side bending, left rotation 50%. Bilateral upper extremity strength was normal. Moderate hypomobility with comparable signs at C2-3, C3-4, and C4-5 levels. The Neck Disability Index (NDI) score was 8/50 (16%). The patient received physical therapy once a week for 6 weeks and the treatment focused on cervical spine joint mobilizations with electrical dry needling of the semispinalis cervicis and capitis muscles. Interventions also included exercises for cervical flexibility and postural muscle strengthening. **Findings:** At the discharge visit, the patient had full pain-free cervical ROM with no functional limitations. Cervicogenic headache frequency was noted by the patient as one CHA per week and the NDI was reduced to 3/50 (6%). **Clinical Relevance:** The combination of electrical dry needling and joint mobilizations resulted in successful conservative treatment of CHA in the patient. Conclusion: The combined use of electrical dry needling and cervical joint mobilizations may be an effective intervention for the treatment of CHA.

**Key Words:** cervicogenic headache, dry needling, joint mobilization

## INTRODUCTION

Headaches are a common condition affecting about 47% of the entire population, with cervicogenic headaches (CHA) accounting for between 15% and 20% of all chronic headaches with a prevalence between 0.4% and 15% of the headache population.[1-3] Women are 4 times more likely to suffer from CHA than men.[4] The International Classification of Headache Disorders currently describes CHA as a secondary headache caused by a disorder of the cervical spine and its component bony, disc and/or soft tissue elements, usually but not invariably accompanied by neck pain.[5] The International Headache Society has described CHA pain as either unilateral or bilateral, affecting the head or face but more commonly the occipital, frontal, and retro-orbital regions.[1] Additionally, the Cervicogenic Headache International Study Group has developed a list of clinically relevant diagnostic criteria that include pain with neck movement or sustained improper positioning, restricted cervical range of motion (ROM), and ipsilateral shoulder and arm pain.[5] Cervicogenic headaches are commonly associated with suboccipital neck pain and other symptoms such as dizziness, nausea, lightheadedness, inability to concentrate, retro-ocular pain, and visual disturbances.[1] Symptoms of CHA can ascend from anywhere in the cervical spine, including the vertebrae, discs, and soft tissue. Although symptoms of CHA can originate from any of the cervical spine components, recent studies have shown that CHA most commonly arises from the second and third cervical spine facet joints, followed by the fifth and sixth facet joints.[4]

There are many treatment techniques that physical therapists and other practitioners can use in the treatment of CHA, including steroid injections, dry needling, surgery, transcutaneous electrical nerve stimulation, massage, exercise, manipulation, or mobilization. Although many treatment techniques have been used, current research does not indicate the most effective conservative management of CHA.[1]

Garcia et al[4] reviewed 7 studies that investigated the possible effects of spinal manipulative therapy compared to a placebo, and found in 6 of the investigations, patients being treated by manual manipulation demonstrated statistically significant improvements when compared to a control group. They determined that short-term effectiveness of manipulation and mobilization to the cervical spine has shown moderate improvement with reducing headache pain or disability, intensity, frequency, and duration. This could be due to afferent input following manual therapy stimulates neural inhibitory pathways in the spinal cord and activates descending inhibitory pathways in the lateral periaqueductal gray area of the midbrain. Haas et al[6] found similar results in a small randomized control study, demonstrating spinal manipulative therapy to be more effective at reducing pain intensity and disability when compared to light massage. They found these effects were even greater when looking at long-term outcomes. Nilsson et al[7] found that subjects in the spinal manipulative therapy group had less pain, less analgesic use, a decrease in headache hours per day, and a decrease in intensity of the headache when compared to subjects undergoing low-level laser and deep friction cervicothoracic massage. Youssef and Shanb[8] also compared a mobilization and massage intervention for participants with CHA, and found that mobilization was more effective at reducing pain intensity, frequency, and duration when compared to soft tissue massage. These findings suggest that manipulation and/or mobilization are promising interventions in the treatment of CHA.

Dry needling is another commonly used intervention in the treatment of musculoskeletal and neuromuscular pain. Dry needling involves the use of the same thin monofilament needles as is employed in the administration of acupuncture. It is thought that needles placed into myofascial trigger points touch, tap, or prick tiny nerve endings or neural tissue for the purpose of pain reduction.[9] Liu et al[10] reported that myofascial trigger points in cervical and shoulder musculature can eventually lead to headache, pain, dizziness, limited ROM, abnormal sensation, autonomic dysfunction, and disability. They analyzed 20 randomized controlled trials comparing dry needling with a placebo or other treatment for myofascial trigger points, and found that compared to a control condition, dry needling led to significant symptom improvements in both the short and medium terms. Llamas-Ramos et al[11] described similar results in comparing dry needling to manual therapy for trigger point treatment. Dry needling was shown to equally improve pain, function, and cervical ROM. In the same study, dry needling even decreased pressure sensitivity to a greater degree than manual therapy for trigger points. Mejuto-Vazquez et al[12] determined that patients who had one treatment of trigger point dry needling experienced less neck pain, less tenderness, and improved cervical ROM when compared to the control group. The authors of these studies indicate that dry needling may improve cervical pain intensity, pressure pain sensitivity, and cervical ROM.

Although dry needling is used commonly for myofascial trigger points, it can also be used for a broad number of other pathologies. Research supports the insertion of dry needles throughout the body at non-trigger point sites for the purpose of reducing pain and disability in patients with neuromusculoskeletal conditions.[9] One author has reported that, "high-pressure stimulation by needling" or "mechanical irritation of the needle" to "multiple sensitive loci or nociceptors within the same myofascial trigger point likely elicits a local twitch response that subsequently provides a very strong neural impulse to the myofascial trigger point circuit to break the vicious cycle so that myofascial trigger point pain is relieved."[13(p348)]

Recent data supports the use of dry needling in the management of tendinopathy, as dry needling has been shown to positively influence tendon healing by increasing blood flow via local vasodilation and collagen proliferation. The biomechanical, chemical, and vascular effects of dry needling, in both superficial subcutaneous tissue and deep intramuscular tissue, have been found to improve microcirculation around the knee joint after dry needling into non-trigger point locations.[9] Lee et al[14] found similar results when using needle electrical intramuscular stimulation near myofascial trigger points in subjects with shoulder and cervical myofascial pain syndrome. Using laser Doppler flowmetry, they found that microcirculation above the area of the myofascial trigger points more than doubled when using needle electrical intramuscular stimulation. The results of their study also suggest a direct correlation between low blood flow and pain intensity. Endocrinological changes including increased beta-endorphins and decreased cortisol levels after electrical dry needling in patients with knee osteoarthritis has been shown in recent literature as well.

Overall there is a lack of scientific data regarding electrical dry needling, and although there is evidence of good outcomes with myofascial trigger points, there is little research on the effectiveness of dry needling to treat CHA. This prospective case report examined the therapeutic effects of combined electrical dry needling and cervical joint mobilization interventions in the physical therapy treatment of a 36-year-old Caucasian female suffering from frequent CHA.

## CASE DESCRIPTION

### Patient Information

The patient was a 36-year-old Caucasian female who began experiencing an insidious onset of frequent headaches and suboccipital pain. She reported performing long hours of desk work at her computer daily. The patient presented with complaints of cervical stiffness, suboccipital pain, and right retro-ocular pressure. Before physical therapy, she was attempting to manage her pain with muscle relaxant and nonsteroidal anti-inflammatory medications. An MRI was ordered prior to physical therapy with negative results for any degenerative changes or muscular abnormalities. She had an unremarkable past medical history and was independent with all activities prior to suboccipital pain and frequent headaches.

## EXAMINATION

The patient initially presented to physical therapy 3 months following the onset of frequent (4-5 per week) headaches. She complained of moderate difficulty tolerating prolonged sitting, working on the computer, sleeping, and driving, along with her average subjective rating of cervical pain at 3/10 at evaluation. She demonstrated classic forward head posture with rounded shoulders. Upon palpation, increased tenderness was noted over bilateral atlanto-occipital joints and suboccipital, splenius capitis, and upper trapezius musculature bilaterally. Passive accessory intervertebral motion was assessed and demonstrated moderate hypomobility with comparable signs at C2-3, C3-4, and C4-5. The patient's bilateral upper extremity strength was all within normal limits. Cervical ROM is displayed in Table 1. Neck Disability Index (NDI) was measured at 8/50 (16%).

The patient was only able to attend clinic sessions once a week due to her living an hour away from the clinic. The plan of care consisted of manual therapy including electrical dry needling and cervical joint mobilizations, therapeutic exercise, patient education, and a home exercise program (HEP).

### Intervention

The patient was treated in physical therapy over a 6-week period to decrease her cervical pain and the CHA frequency. Electrical dry needling was the primary intervention used due to the substantial tightness and tenderness the patient had demonstrated at evaluation, as research demonstrates good results with dry needling in treating muscular pain and spasm.[9,10,12] The patient also demonstrated moderate hypomobility throughout her cervical spine. Therefore, joint mobilizations were performed by the treating therapist, as research by several authors including Garcia et al[4] showed significant improvement and reduction of headache related pain and frequency with joint mobilizations directed to the cervical spine. It is important to note that a therapeutic exercise program was also provided along with patient education and a HEP to improve postural strength and decrease cervical stiffness.

Electrical dry needling was administered each of the 6 treatment sessions using six 30 mm needles at a 10 mm depth into her bilateral semispinalis cervicis and four 15 mm needles at a 10 mm depth into the bilateral semispinalis capitis. Figure 1 shows the treatment configuration for electrical dry needling performed. These needles were left in for 10 minutes with electrical stimulation attached to the needles in the bilateral semispinalis capitis. Electrical stimulation was set at a pulse duration of 180 µs and a low frequency of 4 Hz. Grade 2 to 4 central and unilateral joint mobilizations were performed in a posterior-to-anterior direction over the atlanto-occipital joint and C1-4 spinous process each of the 6 patient visits. Because removal of the needles occasionally resulted in some very minor bleeding, joint mobilizations were typically performed prior to the dry needling treatment.

Table 2 summarizes the therapeutic and home exercises performed by the patient. The patient was educated on the proper execution of all exercises, and demonstrated the same in the clinic. The patient was instructed to

**Table 1. Range of Motion at Initial Evaluation Compared to at Discharge**

| Cervical Spine Range of Motion | Initial | Discharge |
|---|---|---|
| Active Flexion | 75% | Within Normal Limits |
| Active Extension | 50% Pain R suboccipital mm | Within Normal Limits |
| Active Right Lateral Flexion | 50% Stiff | Within Normal Limits |
| Active Left Lateral Flexion | 50% Stiff | Within Normal Limits |
| Active Right Rotation | 75% | Within Normal Limits |
| Active Left Rotation | 50% Stiff | Within Normal Limits |

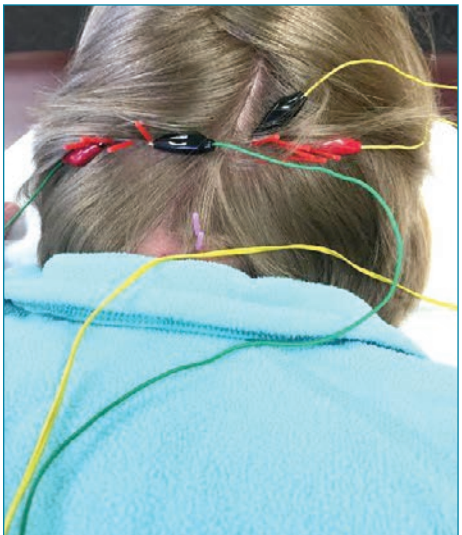

**Figure 1. Electrical dry needling configuration used for the patient.**

perform all exercises twice a day and was reportedly compliant with the stated treatment protocol.

## OUTCOMES

During her fourth treatment session, the patient demonstrated painfree full extension of her cervical spine, with a 50% deficit remaining in right sidebending and a 25% deficit with left sidebending. Left rotation also improved 25% and remained mildly limited. Her pain was reportedly 0/10 in the cervical region and the patient denied having any headaches in the previous 10 days. The patient demonstrated moderate hypomobility central posterior-anterior (CPA) at C2-5 and bilateral unilateral posterior-anterior (UPA) at C2.

Upon discharge at her sixth treatment session, the patient demonstrated full painfree ROM of the cervical spine. She remained tender to palpation over the left semispinalis cervicis with mild hypomobility CPA at C2. Her assessed NDI was 3/50 (6%), and she reported experiencing only two headaches in the last 14 days; left-sided in nature. She reported now being able to sit for prolonged periods of time including at her desk during work, without pain and being able to easily look over her shoulder during driving. The patient also could demonstrate good sitting posture, and reported she was more aware of her posture throughout the day.

The patient was contacted by phone 16 months post discharge to subjectively assess the long-term effects of her treatment. She reported that she was symptom-free for both cervical pain and headaches for 4 months following discharge. However, she currently experienced a headache frequency of approximately one per month, and rated her cervical pain at 3/10, which she treated with warm compresses. She reported continued compliance with her HEP. She expressed an interest in returning for dry needle treatment, as she believed that it had significantly helped to decrease her pain and headache frequency.

## DISCUSSION

The purpose of this case report was to describe the use of electrical dry needling and cervical joint mobilizations in the physical therapy treatment of a patient suffering from CHA. This case report demonstrated that electrical dry needling performed by a certified dry needling specialist in combination with appropriate cervical joint mobilizations can be used to improve cervical ROM, cervical pain, and related headaches in a 36-year-old female patient suffering 3 months of CHA and related symptoms. After 6 weeks of treatment including electrical dry needling and cervical joint mobilizations, the patient reported significant improvement in frequency of headaches, cervical pain, and demonstrated full cervical ROM. The patient also demonstrated a 10% reduction in the NDI, meeting the minimal detectable change for this functional tool.[15]

The outcomes of this case report may begin to fill a gap in the literature, which does not yet indicate a gold standard of treatment in the rehabilitation of CHA. Many authors have reported significant outcomes in the literature on both dry needling and cervical joint mobilizations.[4,6,8-12] However, there is still little research relating them to CHA and an overall lack of scientific data regarding electrical dry needling, which was used in this case report. With the positive outcomes in this case, the combination of electrical dry needling and cervical joint mobilizations could be considered effective for improving pain, ROM, and overall function in patients experiencing CHA. These findings are similar to studies that have separately assessed the treatment effects of cervical joint mobilization and standard dry needling. Both Garcia et al[4] and Haas et al[6] showed promising results with manipulative therapy in regards to improving pain and disability in their patients, though neither study focused on patients with CHA. Liu et al[10] and Llamas-Ramos et al[11] both demonstrated dry needling to have superior results when compared to other treatment methods regarding cervical disability, including improvement in pain, function, and cervical ROM. Again, neither of these studies looked specifically at dry needling in relation to CHA and, to our knowledge, this study is the first reported case examining a combined use of electrical dry needling and cervical joint mobilizations for the treatment of CHA.

There is limited research available on dry needling and even less evidence specifically focused on electrical dry needling. The outcomes of this case report warrant additional research that focuses on dry needling and manipulative therapy for the treatment of CHA. Additionally, it further suggests that research focusing on electrical dry needling may be beneficial in not only the treatment of CHA, but possibly anywhere with muscular tightness and trigger points that are leading to increased pain and decreased function. The research comparing dry needling with and without electrical stimulation may also be valuable given the results of this case report.

Limitations in this case report are that electrical dry needling and cervical joint mobilization were performed in tandem, the contribution of either method to the overall treatment outcomes cannot be determined. Also included were therapeutic and postural exercises as part of the patient's HEP, and the effects of these treatments can also not be quantified. Future investigations are recommended to focus on testing larger and more diverse populations in randomized controlled trials to better understand the

**Table 2. Therapeutic and Home Exercise Program Throughout the Six Sessions of Physical Therapy**

| Exercise | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 |
|---|---|---|---|---|---|---|
| Supine Cervical Retraction | 5”x20 | 5”x30 | 5”x35 | 5”x35 | 5”x35 | 5”x35 |
| Scapular Retraction | 3x10 | 3x10 | 3x12 | 3x12 | 3x12 | 3x12 |
| Pectoral Stretch | Next Visit | 3x20” | 3x20” | 3x20” | 3x20” | 3x20” |

effects of combined use of electrical dry needling and cervical joint mobilizations, as well as each treatment method in isolation, in the treatment of patients suffering from CHA.

## CLINICAL APPLICATIONS

Cervicogenic headaches are a commonly seen pathology in orthopaedic clinics in the United States. Understanding the various treatment options are therefore important to physical therapists. This case report demonstrates that electrical dry needling performed by a certified dry needling specialist in combination with appropriate cervical joint mobilizations may be successfully used to improve cervical ROM, cervical pain, and decrease CHA frequency in the orthopaedic population.

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# Use of Trigger Point Dry Needling as a Component of a Rehabilitation Program for a Patient with Nonspecific Chronic Low Back Pain and a History of a Lumbar Discectomy

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## ABSTRACT

**Background and Purpose:** Trigger point dry needling (TDN) is a technique that has shown to be very effective in patients with muscular dysfunction and myofascial pain. The background and purpose of this article is to describe the addition of TDN to a standard physical therapy approach following lumbar spine surgery to the myofascial tissues affected both directly and indirectly and from the trauma of the surgery. **Case Description:** The patient was a 38-year-old male with low back pain with radicular symptoms into both lower extremities going down into his feet. The patient stated he had the pain since June 2013.The patient had a history of L5-S1 microdiscectomy in 1997. He had been diagnosed with degenerative disc disease prior to his initial surgery. The patient had no treatment other than medication following surgery. **Outcome:** The patient was seen twice a week for 10 weeks in outpatient physical therapy. Upon discharge, the patient had met all of his goals for physical therapy. He was able to return to his prior level of function including working out and sitting for extended periods of time at work. The patient had improvements in range of motion and strength while having a decrease in pain. He had a 50% decrease in pain following his initial visit as measured by the Visual Analog Scale. As rehabilitation progressed, he was able to tolerate more activity including recreation and work, had improved quality of muscle recruitment with core stability, and was able to progress his home exercise program without pain. The patient was able to return to a level of function he had not experienced since prior to his initial injury and subsequent surgery. **Discussion:** The patient had multiple myofascial trigger points (MTrPs) throughout bilateral lumbar paraspinals, erector spinae, gluteal muscles, and piriformis following his surgery. The patient was limited with strength and range of motion (ROM) due to pain and muscular dysfunction. With the use of TDN along with other manual therapy, therapeutic exercise, and patient education immediate reduction was seen in subject perceived symptoms. Range of motion was improved with lumbar ROM using lumbar measurements from the floor with flexion, lateral knee joint line with sidebending, and inclinometer for extension. Manual muscle testing in relation to the initial evaluation was also improved. Research shows the influence of MTrPs on a multitude of musculoskeletal issues including lumbar musculature with a prevalence of low back pain prior to surgery;[1-4] further research is indicated for examining the effects of TDN to decrease pain following surgery.

**Key Words:** Failed Back Syndrome, manual therapy, multi-modal

## INTRODUCTION

Myofascial pain is defined as sensory, motor, and autonomic symptoms arising from myofascial trigger points (MTrPs). Prevalence of myofascial pain is very common in subjects with regional pain complaints.[5] Myofascial trigger points are associated with facet joint dysfunctions, disc herniation, osteoarthritis, tension type headache, etc.[6] A myofascial trigger point is a tender spot in a muscle often with a palpable taut band of tissue that elicits pain referral when pressure is applied. Specifically related to the spine, it has been found that individuals with nonspecific chronic low back pain (LBP) have a greater number of trigger points, associated with higher pain levels than the general population.[7] Myofascial trigger points can be caused by sustained muscle contractions at low levels, muscle overload and overuse, low load repetitive tasks, and sustained postures. The stimulation of nociceptors from active trigger points may cause peripheral and central sensitization through continued nociceptive signals to the dorsal horn. Therefore these trigger points are important to address in patients with chronic pain conditions.[8]

Pain following operative procedures of the lumbar spine is observed in a significant proportion of patients.[1-4,9-13] A specific diagnosis for LBP can be made with certainty in only 15% of individuals based off of examination alone.[14-19] This makes it more difficult in post lumbar surgery patients to identify pain-generating structures in patients presenting to physical therapy with a script of LBP. Additionally, surgery is trauma and this trauma to the low back may be a secondary pain generator. This suggests that treating the myofascial pain following the insult of surgery may be a good addition to postsurgical rehabilitation.

Trigger point dry needling (TDN) has been shown to be very effective in patients with muscular dysfunction and myofascial pain.[8] Trigger point dry needling is performed by inserting a small monofilament needle into a taut band eliciting a local twitch response to eliminate the MTrP. Trigger point dry needling has been shown to reduce pain, normalize the chemical environment of a MTrP, restore homeostasis, and restore range of motion (ROM) and muscle activation patterns.[8] Research has shown that TDN is a useful adjunct to other therapies for chronic LBP.[20]

Standard physical therapy approaches following lumbar spine surgery often include therapeutic exercise such as core stability, soft tissue mobilization, modalities for pain and symptoms, postural education, and body mechanic education. Often following surgeries, treatments are more focused on strengthening and treating symptoms than trying to decrease dysfunction. Adding TDN to a standard physical therapy approach following lumbar spine surgery to the myofascial tissues affected both directly and indirectly and from the trauma of the surgery itself could help postsurgical patient outcomes.

The purpose of this case report was to look at the effects of combining TDN with standard postsurgical treatment and describe how the use of TDN combined with standard physical therapy treatments may help decrease pain in a patient with chronic LBP and with a history of lumbar surgery.

## CASE DESCRIPTION

The patient signed a consent form for release of information, allowing the review of complete health records for the academic purposes of fulfilling this case report.

The patient was a very pleasant 38-year-old male with LBP with radicular symptoms into both lower extremities going down into his feet. The patient stated he had the pain since June 2013. He had a history of an L5-S1 microdiscectomy in 1997 and had been diagnosed with degenerative disc disease prior to surgery. The patient had imaging prior to his initial physical therapy evaluation at MD referral visit that showed mild degenerative disc disease (DDD) and prior surgery.

The patient had lost 70 pounds in the last year, now weighing 240 pounds. The patient had been active and working out and developed the pain following a rigorous workout in which he thought it was just muscle soreness. He developed pain across both hips around to the front and in his groin. The patient stated that his pain using a visual analog scale (VAS) was at worst 7/10, currently 6/10, and at best 5/10. This method of measuring pain has been widely used and has previously been found to be reliable and valid.[21] Sitting, standing, and sleeping all made his pain worse. Changing positions frequently helped ease his pain. He stated he had not been able to sleep all night painfree since before the surgery. The patient stated that he was really stiff and sore in the morning and when driving for greater than 5 minutes, the pain was almost unbearable. Pain was noted in the low back but his primary concern was the pain down his legs. He reported his pain was not the same as it was when he had the discectomy, stating that he was not having the electrical pain. He was worried he was going to need surgery again and unsure of the effect of physical therapy. There had been no change in bowel or bladder symptoms. The patient was limited with work, driving, and recreation due to pain. His work was demanding and kept him in the oil field for 10 to 20 hours per day; he was having a hard time sustaining the demand physically due to pain. The patient had been working out 5 times a week, twice a day for 45 minutes to an hour, trying to lose weight and had not been able to due to pain. The patient complained of tightness and achy pain versus the electrical pain he had experienced prior to his surgery in 1997. The patient's goals were to be able to work out twice a day painfree, sleep without pain for at least 6 hours, and be able to drive a vehicle painfree for work.

Initial clinical impression differential diagnosis included myofascial dysfunction with a lesser possibility of discogenic pain. Joint impairments in the lumbar facet joints and sacroiliac joints were ruled out. The patient had no apparent red flags, neurologic signs, and imaging was negative for significant findings other than previous surgery.

## EXAMINATION

On the initial visit, history, including a body chart (Figure 1), was taken and a physical examination was performed. The patient was also given a Focus On Therapy Outcomes (FOTO) questionnaire to set initial functional status, predict goal status, and determine a discharge functional status. The patient's level of function was rated at 47/100 with 0 indicating low function and 100 indicating normal function.

### Posture

The patient's standing posture was significant on observation for a decreased lumbar curve, decreased hip extension, and guarded spine posture.

### Gait

The patient ambulated into the clinic with a guarded spine lumbar posture including decreased trunk rotation, decreased hip extension, decreased lumbar curve, and wide base of support.

The patient's ROM was limited in lumbar flexion due to pain as he was able to reach to his patellae and upon over pressure, he had increased pain.[22] His movement was not smooth during the return to an upright position and he had to use his hands to assist to return demonstrating a positive Gower's sign. He was able to extend his lumbar spine to 5° measured with an inclinometer. Right and left spinal rotation were within normal limits. He showed equal sidebending and was able to reach to his lateral knee joint line but complained of increased pain going left. The patient had good lumbar and sacroiliac segmental movement throughout ROM.[23-25] The therapist noted he demonstrated abnormal muscle firing with lumbar motion primarily using quadratus lumborum (QL) and the erector spinae muscles for stabilization. The patient demonstrated lag time and weak contraction of the transverse abdominis and multifidi with active ROM testing.

### Strength

Core stability was "poor" due to pain and also demonstrated poor recruitment with multifidi and transverse abdominis muscles displaying a tendency to use larger muscles for stabilization.[26,27] Core stability was measured on a scale of poor to excellent as per Chmielewski et al.[27] Hip strength was 5/5 bilaterally throughout all motions with pain during abduction on both the right and left.[28,29]

### Palpation

The patient had significant pain, tenderness and MTrPs with palpation of the bilateral QL, erector spinae, multifidi from L2-5, gluteus minimus, gluteus maximus, gluteus

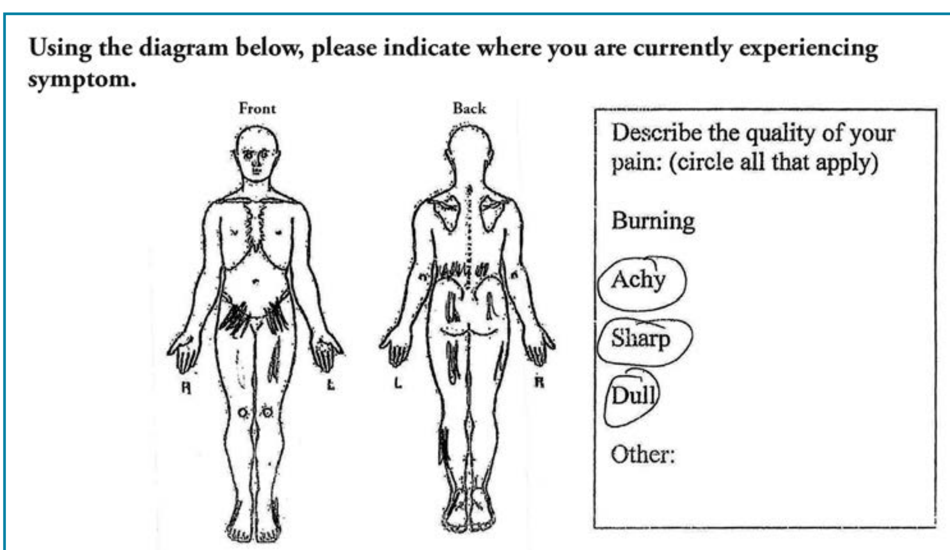


**Figure 1. Patient's body chart on initial evaluation.**

medius, and piriformis muscles. The patient had pain with contraction of both the right and left psoas major. The patient had a significant increase in muscle tone with palpation to the bilateral erector spinae muscles.

### Special Tests

Leg length was equal in long sitting and supine. The prone lumbar instability test was negative at L1-S1. The patient had no reproduction of symptoms with PA or unilateral lumbar springing to L1-S1. Further special testing is listed in Table 1.[30,31]

### Second Clinical Impression

The physical examination revealed a lumbar motor control dysfunction, tissue hypertonicity, and tenderness to palpation of bilateral lumbar paraspinals musculature and gluteal/hip musculature. All of these symptoms along with palpation indicated MTrPs to the therapist.[32] The patient also had a reduction of pain with passive segmental movement compared to active movements. His pain was made worse with forward flexion and left sidebending. He was cleared for red flag concerns as he denied any risk factors for cancer, night pain, fatigue, or a previous history of cancer. The patient was in good health overall.

## INTEREVENTION

The patient was seen for a total of 20 physical therapy visits. The patient was treated with core stability, soft tissue mobilization, postural education, and patient education. The patient's symptoms were inconclusive with discogenic origin due to his difficulty with sitting and having the radicular symptoms, but he did not demonstrate centralization of symptoms with McKenzie extension-based exercises. He did have a positive Lasegues's straight leg raise and seated dural stretch. He complained of tightness and achy pain, not the electrical pain he had experienced prior to his 1997 surgery. Based on these findings, McKenzie extension prone on elbows stretching was added to the home exercise program (HEP) to decrease neurotension. The patient's sacroiliac joint was cleared with special tests, movement tests, palpation, and alignment. Leg length discrepancy was negative. Prone instability test and lumbar springing tests were also negative.

The patient displayed a forward head, rounded shoulders, decreased lumbar lordosis, and posterior pelvic tilt with standing posture. Based on these findings, the patient was issued a HEP consisting of proper core stability exercises, with an emphasis on proper firing and timing of postural muscles, relaxation stretches/exercises, postural strengthening and retraining, and extension based neurotension stretches that progressed throughout the treatment duration. Therapeutic exercise was progressed as tolerated and added to the patient's HEP.

The patient received soft tissue mobilization to the lumbar paraspinals, QL, and gluteal musculature. In conjunction with those more common treatment options to address the patient's symptoms, TDN was used to treat the myofascial dysfunction, as it is an effective way to reduce muscle hypertonicity and MTrPs. Trigger point dry needling was applied to the muscles that have been shown to refer pain and cause dysfunction in the same referral patterns as the patient's symptoms. In this patient's instance bilateral QL, psoas major, L2-5 multifidi, gluteus minimus, gluteus maximus, gluteus medius, and piriformis all are capable of referring the patient's symptoms.[25,26]

A monofilament needle was used to treat the bilateral QL, psoas major, L2-5 multifidi, gluteus minimus, gluteus maximus, gluteus medius, and piriformis musculature at the areas of elicited pain with palpation of taut bands during 12 of the 20 scheduled therapy visits. As treatment continued, the last 5 treatment sessions did not contain TDN due to the treatments being more focused on strengthening to prevent recurrence of symptoms. These specific muscle groups were treated each visit, as per Table 2. The number of needles to each area depended on the session due to patient tolerance and the clinician's expertise. Trigger point dry needling treatment techniques were used as per education from Myopain Seminars and Kinetacore. Clean technique was used following universal precautions. The patient consented to TDN and educated on the potential risks to include pneumothorax, infection, and short-term muscle soreness, fatigue, and possible sympathetic response. He did not have any contraindications/precautions for TDN, such as a local infection, bleeding disorders, immune suppression, or fear of needles. Moist hot packs were used following TDN to aid in pain management and to increase blood flow to the area that was needled.

**Table 1. Special Tests on Initial Evaluation**

| Special Test | Left | Right |
|---|---|---|
| McKenzie Flexion Biased Centralization | Negative | Negative |
| McKenzie Extension Biased Centralization | Negative | Negative |
| Lasegues's Straight Leg Raise | Positive | Negative |
| Seated Dural Stretch | Positive | Negative |
| Sacroiliac Compression Test | Negative | Negative |
| Prone Sacoiliac Gapping | Negative | Negative |
| Stork Standing Test | Negative | Negative |
| Gillet Test | Negative | Negative |
| FABER | Negative | Negative |
| FADIR/Hip Impingement Test | Positive reproducing pain in gluteal muscles | Positive reproducing pain in gluteal muscles |
| Hip Labral Test | Negative | Negative |
| Hip Scour Test | Negative | Negative |

Abbreviations: FABER, flexion, abduction, external rotation; FADIR, flexion, adduction, internal rotation

## OUTCOME

The patient was seen regularly 2 times per week and was diligent with his HEP. Upon discharge, the patient stated his pain was 0/10 and at worst 1/10 according the VAS. The FOTO outcome measure score was 88 at midpoint and 99 on discharge.

### Posture

Upon discharge, the patient displayed an improved lumbar curve in standing.

### Gait

The patient ambulated with improved lumbar rotation and lumbar curve, improved hip extension and base of support, and the

**Table 2. Timeline for Interventions**

| Treatment Day | Pain | Intervention |
|---|---|---|
| Day 1 | 7/10 | Initial Evaluation<br>Therapeutic Exercise<br>Patient educated on HEP:<br>Hand and heel rocks x20. Hooklying lumbar rotations x20.<br>Manual Therapy<br>Patient educated on and consented to TDN of B QL, psoas majors, and L2-4 multifidi. STM to B lumbar paraspinals. |
| Day 2 | 3/10 | Therapeutic Exercise<br>Patient educated on HEP:<br>Hand and heel rocks x20. Hooklying lumbar rotations x20.<br>Manual Therapy<br>TDN of B QL, psoas majors, illiacus, and L2-4 multifidi. STM to B lumbar paraspinals. |
| Day 3 | 3/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Hooklying lumbar rotations x20.<br>Manual Therapy<br>TDN of B QL, psoas majors, illiacus, and L2-4 multifidi. STM to B lumbar paraspinals. |
| Day 4 | 3/10 | Hand and heel rocks x20. Hooklying lumbar rotations x20.<br>TA isometric contractions 3x15.<br>Core stabilization with hooklying marching and bridges 2x fatigue each.<br>Manual Therapy<br>TDN of B QL, psoas majors, illiacus, and L2-4 multifidi. STM to B lumbar paraspinals. |
| Day 5 | 4/10 | 90/90 hip lift 4x4 breaths. Diaphragmatic breathing with rib depression assist with emphasis on lumbar paraspinal inhibition. B gastrocnemius, quadriceps, and hamstring stretching x30 sec each. Emphasized importance of abdominal bracing during all stretches to prevent lumbar hyperextension.<br>Manual Therapy<br>STM to B lumbar paraspinals. |
| Day 6 | 1/10 | Core stabilization. TA isometric contractions 3x15, hooklying marching 3x15, bridges 3x15. Leg lowers 2x10. Elliptical x10 min.<br>Manual Therapy<br>TDN to B psoas major, iliacus, L1-3 multifidi. |
| Day 7 | 4/10 | Core stabilization. TA isometric contractions 3x15, hooklying marching 3x15, bridging 3x15. Quadruped leg extension, opposite arm/leg extension. Elliptical x 10 min.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. |
| Day 8 | 2/10 | Core stabilization. TA isometric contractions 3x15, hooklying marching 3x15, bridging 3x15. Quadruped leg extension, opposite arm/leg extension. Elliptical x10 min. Pigeon stretch 3x60s B hip flexor stretch 3x60s.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. |
| Day 9 | 1/10 | Therapeutic Exercise<br>Core stabilization. TA isometric contractions 3x15, ER B UE with BTB 3x20, rows with BTB 3x20, wall push-ups 3x20, scapular depression 3x10, caption with 4# 3x15.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. TDN to B psoas major, iliacus, and QL. |
| Day 10 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min. Patient is I with core stability for HEP.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. TDN to B psoas major, iliacus, and QL. |
| Day 11 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. TDN to R psoas major, iliacus, QL, gluteal medius/minimus/maximus, and piriformis.<br><br>*(Continued on page 140)* |

**Table 2. Timeline for Interventions** *(continued from page 139)*

| Treatment Day | Pain | Intervention |
|---|---|---|
| Day 12 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. TDN to B psoas major, iliacus, QL, and L2-5 multifidi. |
| Day 13 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. TDN to R gluteal medius/minimus/maximus and piriformis. |
| Day 14 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min.<br>Manual Therapy<br>TDN to B gluteal medius/minimus. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. |
| Day 15 | 2/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. TDN to L QL, psoas major, illiacus, L gluteals and piriformis. |
| Day 16 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min bridges 1x20. Side planks with hip abduction 1x10 B double leg lower with core stabilization.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. |
| Day 17 | 2/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min bridges 1x20. Side planks with hip abduction 1x10 B double leg lower with core stabilization.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. |
| Day 18 | 1/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x 10 min bridges 1x20. Side planks with hip abduction 1x10 B double leg lower with core stabilization.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. |
| Day 19 | 0/10 | Therapeutic Exercise<br>Hand and heel rocks x20. Elliptical x10 min bridges 1x20. Side planks with hip abduction 1x10 B double leg lower with core stabilization.<br>Manual Therapy<br>STM to B lumbar paraspinals and erector spinae and gluteals. STM to B lumbar paraspinals and R gluteals. R LE long axis traction. |
| Day 20 | 0/10 | Discharge visit. Patient had met all goals. |

Abbreviations: HEP, home exercise program; STM, soft tissue mobilization; B, bilateral; QL, quadratus lumborum; TA, transverse abdominus; TDN, trigger point dry needling

patient stated he felt like he was walking normal again.

## Range of Motion

The patient's ROM improved to within normal limits.[22] During lumbar flexion, the patient was able to reach the floor without complaints; all other lumbar ROM was within normal limits without complaints. The patient had no pain with over pressure to ROM and demonstrated good lumbar and sacroiliac mobility.[23-25]

## Strength

The patient demonstrated "excellent"[26,27] core strength. The patient demonstrated good recruitment and timing with multifidi and transverse abdominis muscles and was no longer using his primary mover muscles, QL, and erector spinae, to stabilize. The muscle recruitment was assessed with palpation and observation to multifidi and transverse abdominis during ROM and core stability therapeutic exercise. His bilateral hip strength remained 5/5 throughout and progressed to without pain with abduction bilaterally.[28,29]

### Palpation

The patient no longer had pain, tenderness and MTrPs with palpation of bilateral quadratus lumborum (QL), erector spinae, multifidi L2-5, gluteus minimus, gluteus maximus, and piriformis as he did on initial evaluation. The patient still had tightness and latent MTrP in his gluteus medius but it did not produce pain. He was able to contract his bilateral psoas major without complaints. The patient had normal muscle tone throughout bilateral lumbar erector spinae.

### Special Tests

Leg length remained equal in long sitting and supine. Prone lumbar instability test remained negative at L1-S1. The patient still had no reproduction of symptoms with PA or unilateral lumbar spring tests at L1-S1. Further special testing is listed in Table 3.[30,31]

**Table 3. Special Tests on Discharge**

| Special Test | Left | Right |
|---|---|---|
| McKenzie Flexion Biased Centralization | Negative | Negative |
| McKenzie Extension Biased Centralization | Negative | Negative |
| Lasegues's Straight Leg Raise | Negative | Negative |
| Seated Dural Stretch | Negative | Negative |
| Sacroiliac Compression Test | Negative | Negative |
| Prone Saroiliac Gapping | Negative | Negative |
| Stork Standing Test | Negative | Negative |
| Gillet Test | Negative | Negative |
| FABER | Negative | Negative |
| FADIR/Hip Impingement Test | Negative | Negative |
| Hip Labral Test | Negative | Negative |
| Hip Scour Test | Negative | Negative |

Abbreviations: FABER, flexion, abduction, external rotation; FADIR, flexion, adduction, internal rotation

The patient had returned to working out twice a day. In addition, he had been able to drive his vehicle for several hours without complaints and was also able to work without complaints. He stated he was still mildly stiff in the morning when getting out of bed but was able to manage the pain with his HEP. Physical examination demonstrated proper lumbar motor control, normal tone, and he no longer had tenderness to palpation of the lumbar paraspinal musculature and gluteal/hip musculature.

## DISCUSSION

The purpose of this case report was to describe the addition of TDN to physical therapy in a patient following lumbar spine surgery.

The patient demonstrated motor control dysfunctions and pain with muscle contraction, palpation, ROM, and change in position following previous back surgery. The use of TDN resulted in an immediate reduction in pain by 50% after the first treatment, painfree ROM, and total reduction in symptoms. Following the first visit, the patient was still limited with decreased strength, ROM, and had recurring pain which improved with therapy and TDN.

These results match the findings from two articles that found that dry needling of MTrPs was significantly better than sham treatment and usual care for pain.[33,34] Trigger point dry needling has been shown to inactivate MTrPs by eliciting local twitch responses (LTR)[35,36] that are modulated by the central nervous system.[37,38] Evidence suggests that MTrPs influence a multitude of musculoskeletal issues and lumbar spine pain following surgeries. Further research is needed for examining the effects of TDN for motor control and painful conditions occurring in the lumbar spine following specific surgeries.

Limitations to this study are that this is a case report and therefore the results cannot be generalized to the population. Other limitations include that the treatment areas and techniques were therapist and patient directed based patient needs and not a set standard. In addition, the length of time following surgery until the patient was treated with physical therapy was long.

It appears that despite surgery correcting the perceived initial cause of the patient's LBP, surgery in this case may have exacerbated the cycle of chronic pain. This is unknown but speculated by the author as surgery may have disrupted the myofascial structures around the surgical site causing weakness and compensation from having the surgery, ie, lack of movement, guarded movement, compensatory strategies, etc. Following lumbar surgery, physical therapists may tend to treat the symptoms and potentially do not treat too close to the surgical site. Lumbar surgery may have removed the initial cause of pain and dysfunction but then disrupted the tissue around the surgical areas. If the dysfunction was treated appropriately, one may start to see improved outcomes following spine surgery. Adding TDN to physical therapy following lumbar spine surgery may improve postsurgical patient outcomes.

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# Rehabilitation after Manipulation Under Anesthesia in a Patient with Total Knee Arthroplasty: Case Report of a Recreational Rower

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## ABSTRACT

**Background:** Total knee arthroplasty (TKA) is one of the most successful surgeries to treat end stage degenerative pathologies involving the knee, however, complications may occur. Arthrofibrosis accounts for approximately 20% of failed surgical interventions, often resulting in manipulations under anesthesia (MUA). There is limited evidence detailing the rehabilitation of individuals who have undergone a MUA secondary to arthrofibrosis. **Case Description:** A 75-year-old male recreational rower underwent a TKA and subsequent MUA due to limited knee flexion from arthrofibrosis. This case report details the exercise progression and manual techniques used to meet functional milestones and assist the patient's return to daily and recreational activities, including rowing. **Outcomes:** The patient returned to rowing 5 months following the MUA. Objective measures were tracked throughout rehabilitation and correlated to progression through the proposed rehabilitation protocol. At discharge, the patient achieved an arc of motion of 0° to 134°, a Knee injury and Osteoarthritis Outcome Score (KOOS PS) score of 5/27, 4+/5 quadriceps strength, and was able to perform a single leg squat. **Discussion**: This case report details a recreational rower who returned to rowing following a failed TKA and subsequent MUA to restore knee range of motion. The use of multi-modal interventions within clearly defined phases may be beneficial in restoring range of motion, functional strength, and returning to pre-surgical activities, as demonstrated in this case.

**Key Words:** return to sport, joint arthroplasty, scar tissue management

## BACKGROUND

Total knee arthroplasty (TKA) is one of the most successful surgeries to treat end stage degenerative pathologies involving the knee.[1,2] As of 2014, more than 700,000 TKA surgeries are performed annually in the United States, with more than 90% of patients experiencing a dramatic reduction of pain and improvements in their ability to perform activities of daily living.[2-5] Complications including infection, blood clots, continued pain, and prosthetic problems can occur.[6-8] Up to 20% of these complications result from arthrofibrosis.[7,9]

Arthrofibrosis is characterized by the production of excessive fibrous scar tissue in the joint, with major consequences including loss of range of motion (ROM) and increased pain.[6,10] This complication can impede daily tasks such as stair climbing and normalized gait, often leaving patients feeling debilitated.[10] The mechanisms leading to arthrofibrosis are multifactorial, including preoperative, intraoperative, and postoperative factors.[11] Current consensus of objective ROM measurements to confirm the presence of arthrofibrosis does not exist, but the most common suggestions are knee flexion less than 90° and extension deficits greater than 10°.[10,12]

Recommendations for addressing arthrofibrosis include aggressive physical therapy (PT), manipulation under anesthesia (MUA), revision TKA, and arthroscopic or open debridement.[10,13] Among these interventions, MUA has been considered as the most effective and simple treatment.[13] To our knowledge, limited recommendations exist for guiding physical therapy interventions following MUA to optimize outcomes. The authors completed a literature review and were unable to find any clear guidelines to outline treatment of this patient population. The purpose of this case study is to describe the PT program and progression of a patient after MUA to propose a potential guideline for future treatment of arthrofibrosis.

## CASE DESCRIPTION

The patient was a 75-year-old male who presented to physical therapy at Hospital for Special Surgery for initial evaluation 3 weeks following left TKA and consented to his data being submitted for publication. He expressed concern at his evaluation with restoring full knee active ROM. The patient reported that he had full motion prior to surgery and was an avid recreational rower, rowing up until the time of surgery. Goals of therapy included restoring strength, normalizing gait, achieving full active ROM, and normalizing stair climbing, with the primary goal being a return to rowing. Upon evaluation, he presented with 10° to 70° active ROM and 7° to 74° passive ROM, quadriceps weakness, pain (Visual Analog Scale 4-9/10) and functional limitations (Knee injury and Osteoarthritis Outcome Score [KOOS PS)] Scale: 24/27) on evaluation. He underwent 5 visits of physical therapy over the course of 10 days, but did not demonstrate consistent progress in ROM, including the inability to flex beyond 90°. After a visit with his surgeon, the decision was made for him to undergo a MUA one month after the primary TKA.

In the operating room, the surgeon was able to achieve 0° to 125° of left knee passive ROM. The patient was discharged home with a continuous passive motion (CPM) machine and was instructed to use it 3 times per day for one to two hours at a time. The day after the MUA, the patient presented to PT with limited active ROM (10°-82°), and passive ROM (10°-85°). He also reported 6/10 pain, and poor quadriceps control and strength (3+/5) that resulted in intermittent buckling of the knee during the loading response of gait and an inability to reciprocally climb stairs.

The management of this case was divided into 3 phases: (1) addressing impairments, (2) restoration of function and strength, and (3) return to sport (Table 1). The proposed structure was formulated by the two treating physical therapists, after they were unable to find recommendations on treating patients following MUA during a literature review. The primary PT goals in this early stage of rehabilitation were regaining both flexion and extension active ROM and improving quadriceps strength and control. This was done through use of neuromuscular electrical stimulation (NMES)

**Table 1. Post Manipulation Under Anesthesia Treatment Phase Progression for a Patient Post Total Knee Arthroplasty**

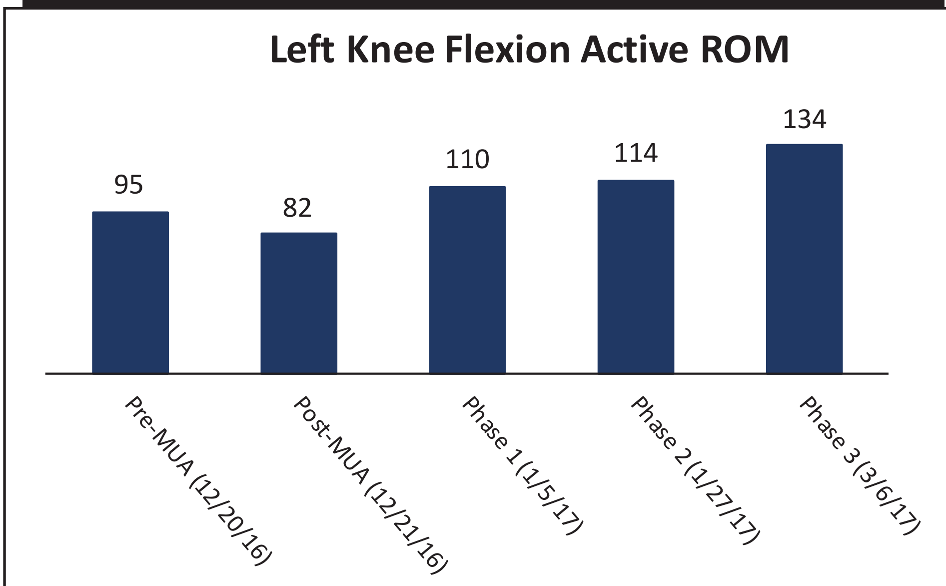
| | | |
|---|---|---|
| **Phase 1:**<br>**Addressing Impairments**<br>(4x/week for 2 weeks) | **Principles**<br>• Restore ROM<br>• Restore quadriceps activation | **Treatments**<br>• Low-load prolonged knee extension stretches with weight<br>• A/P tibiofemoral mobilizations<br>• Contract-relax stretching of quadriceps/hamstrings<br>• Patellar mobilizations<br>• Altering extension and flexion-based activities<br>• Quadriceps sets<br>• Short arc/long arc quadriceps strengthening<br>• Terminal knee extensions<br>• Nustep/upright bike<br>• Quadriceps NMES |
| **Phase 2:**<br>**Restoration of Strength & Function**<br>(2x/week for 4 weeks) | **Principles**<br>• Continue to restore ROM<br>• Progress quadriceps strengthening<br>• Address proximal/distal chain deficits<br>• Gait training<br>• Stair training<br>• Balance training | **Treatments**<br>• Progression to closed chain strengthening<br>*Sit to stand/squats/leg press<br>• Core hip, ankle strengthening<br>• Gait training with cues from TheraBand<br>• Step ups<br>• Step downs<br>• Double leg > single leg balance training |
| **Phase 3:**<br>**Return to Sport**<br>(1x/week for 4 weeks) | **Principles**<br>• Initiate when ROM, strength deficits are addressed<br>• Specific training to meet demands of the sport | **Treatments**<br>• Leg press with deep knee flexion<br>• Progressed to include TheraBand resistance<br>• Ergonomic training |

Abbreviations: ROM, range of motion; NMES, neuromuscular electrical stimulation; A/P, anterior to posterior

for quadriceps strengthening and low-load prolonged static stretching to address ROM limitations (see Table 1). The patient was seen 4 times per week for the first two weeks until consistent ROM carryover was seen. At the end of this phase, he achieved 110° of active flexion and was lacking approximately 5° of active extension (Table 2). Ambulation mechanics were improved, as he demonstrated greater stance time symmetry, improved cadence, and reduced buckling of the knee in loading response, however, lack of terminal knee extension remained due to restricted knee extension active ROM. The patient was able to perform a 4-inch step-up, which he was previously not able to perform due to quadriceps weakness and poor motor control.

At two weeks following MUA, the patient began the second phase of treatment, with frequency of PT decreased to two times per week for a total of 4 weeks. This was supplemented by a privately hired in-home PT, who provided similar ROM and strengthening interventions. At this point, greater emphasis was placed on strengthening, targeting proximal and distal structures, and progressing to closed chain activities. Gait, balance, and stair training were emphasized to help maintain ROM and strength gains through functional utilization (see Table 1). At the end of this second phase of rehabilitation, the patient's pain had reduced to a

**Table 2. The Patient's Left Knee Flexion Active Range of Motion Progression Timeline from Before Manipulation Under Anesthesia to Discharge from Physical Therapy**




Abbreviation: MUA, manipulation under anesthesia

2/10, active ROM was 2° to 114°, ambulation was normalizing with nearly equal stride length bilaterally and improved eccentric quadricep control in loading response, and stair mechanics improved. The patient was lacking quadriceps strength on the stair descent in this phase of rehabilitation (Tables 2 and 3).

Phase 3 of rehabilitation began at 6 weeks post MUA, with PT visits decreased to once per week for an additional 4 weeks as active ROM, quadriceps control, and daily func-

**Table 3. Depiction of Quadriceps Contraction Quality, Pain (Visual Analog Scale), and the Patient's Ability to Perform Stairs Reciprocally During the 3 Rehabilitation Phases**

| | Pre-MUA (12/20/16) | Post-MUA (12/22/16) | Phase 1 (1/5/17) | Phase 2 (1/27/17) | Phase 3 (3/6/17) |
|---|---|---|---|---|---|
| Quadriceps contraction | Poor | Poor | Fair | Good | Good |
| Pain VAS (0-10) | 7/10 | 6/10 | 2/10 | 2/10 | 0/10 |
| Reciprocal stair performance | No | No | No | Yes | Yes |

Abbreviations: MUA, manipulation under anesthesia; VAS, visual analog scale

tioning were improving and the patient demonstrated excellent adherence to his home exercise program (HEP). Physical therapy was now targeted to returning the patient to rowing. The HEP was altered to include rowing ergometer training and in-clinic therapy interventions included a combination of power and endurance training to mimic the demands of rowing (see Table 1).

**Figure 1. The patient 5 months following manipulation under anesthesia reaching his goal of a return to rowing.**

## OUTCOMES

At discharge 10 weeks following MUA, the patient presented with 0/10 pain, an arc of motion of 0° to 134°, KOOS PS) score of 5/27, 4+/5 quadriceps strength, and was able to perform a single leg squat (see Table 3). At follow-up 5 months after MUA, the patient reported that he had successfully returned to recreational rowing (Figure 1).

## DISCUSSION

Rehabilitation of the patient who has undergone MUA after TKA does not have a well-defined treatment protocol. To our knowledge, PT treatment guidelines for patients who have undergone MUA have not been proposed in the literature. Patient presentation can create a difficult decision-making process for the clinician, as the patient is likely to present with many impairments, such as lack of knee flexion and extension, impaired quadriceps strength, and pain, yielding decreased function in gait, transfers, and stair negotiation. The importance of this case lies in the systematic decision-making for identifying patient impairments and treating these impairments in order of functional importance and rehabilitative potential. However, the mechanisms that contribute to the success of these patients remain unclear.

The management of this case was divided into 3 phases: (1) addressing impairments, (2) restoration of function and strength, and (3) return to sport. Phase 1 of this treatment plan was based on addressing the specific impairments of the patient, particularly mitigating the effects of edema while restoring knee active ROM and quadriceps control. The presence of swelling limits ROM and quadriceps strength, and a successful rehabilitation plan is likely to require edema management at its early stages. Edema was managed through the use of effleurage, ice, and compression with elevation of the operative limb. Restoration of active ROM focused on active and active-assisted exercises, low-load prolonged stretching, and therapist-guided manual techniques, specifically patellar mobilizations, tibiofemoral mobilizations, and joint passive range of motion (see Table 1). Patellar mobilizations and low load prolonged duration stretching have been encouraged in the rehabilitation of patients status-post TKA, but the utility of tibiofemoral joint mobilization is unclear, as the prosthesis may not mimic the natural knee anatomy.[14] The authors feel that low-grade mobilizations helped the patient to feel confident in progressing his ROM and facilitated further improvement through patient-directed exercise.

A common difficulty for the clinician after ROM improvement is having the patient achieve active control of this range. Achieving active control may be hindered by pain and edema, possibly causing avoidance of the quadriceps and hamstring muscles activation, resulting in decreased motor drive from the central nervous system due to reflex inhibition. Patients with knee osteoarthritis pre-TKA demonstrate an approximate 20% quadriceps strength deficit compared to healthy age and sex-matched counterparts.[15] This weakness is compounded by surgical incision through the extensor mechanism and postoperative pain and swelling. Impairments in quadriceps strength have been associated with an increased risk of falls, decreased gait speed, and impaired stair climbing ability, and have been postulated to be due to deficits in voluntary activation and muscle atrophy.[15-17] Patients with a large activation deficit may experience negligible strength improvements despite intensive rehabilitation, as this inhibition may preclude the necessary stimulus to maintain muscle mass.[15,16] The use of NMES in conjunction with an appropriate exercise program has been suggested to mitigate this inhibition by overriding voluntary mechanisms of muscle contraction.[18] The implementation of NMES within one month post-TKA has been encouraged, as its effects have been shown to be most pronounced and meaningful.[18,19] This patient appeared to respond well to NMES, as his quadriceps strength and isometric endurance improved notably within the first several visits with the use of NMES.

Phase II of this treatment plan continued with restoration of active ROM and functional quadriceps strengthening (see Table 1). Historically, TKA is a successful surgery for pain reduction and improvement of active ROM, but walking and stair negotiation speeds have been reported to be as much as 50% below healthy age-matched controls one year after surgery.[16] Quadriceps weakness may propagate functional limitations, which is why improving quadriceps strength and control was a crucial part of this treatment plan. In progressing from nonweight-bearing quadriceps strengthening to weight-bearing functional quadriceps strengthening, the authors feel the patient experienced a beneficial effect of graded overload without notable setback due to excessive pain, edema, or soreness. Furthermore, once the patient demonstrated good concentric strength, the transition to eccentric strength training yielded a significant carryover to gait and stair negotiation.

The importance of quadriceps strengthening and patient-specific training lies in its achievement of a symmetrical, non-antalgic gait pattern. Functional strengthening and gait training are unlikely to be successful without prerequisite active ROM and sufficient strength to carry bodyweight over a single limb. Rowe et al[23] found that ambulation, sit-to-stand transfers from a standard chair, and stair negotiation require knee excursion of 110°. Following the evidence in this patient case, once sufficient range was achieved and maintained, balance and proprioception training was initiated to facilitate independence of ambulation on all surfaces and to negotiate stairs of multiple heights.

This patient's long-term goal was to return to recreational rowing. Rowing requires full knee flexion ROM and muscular power and endurance. To prepare the patient to return to rowing in Phase III, task-specific training was implemented (see Table 1). The patient was placed on the leg press close to the resistance platform to train concentric quadriceps strength from a deep knee flexed position. When the patient became comfortable in this position, the movement was progressed to the patient holding an elastic band secured by the therapist, and was instructed to perform a row while on the leg press. The authors feel that the implementation of task-specific training both encouraged the patient to progress with the plan of care and prepared him for the demands of his sport (Figure 2). The patient remained motivated throughout Phase III and eventually returned to competitive rowing.

When the patient was discharged at 10 weeks following MUA, he was painfree and demonstrated full ROM and functional strength. Further, he was able to ambulate and negotiate stairs with minimal restrictions and was practicing sport-specific activities at home including the use of an erg machine in preparation for his return to rowing.

One characteristic feature of this case was the motivation of the patient to return to competitive rowing. It has been suggested that patient motivation plays a significant role in functional improvement and pain relief, and that coping style has an influence on the rehabilitation process of TKA.[21,24] Furthermore, it has been suggested that depression and anxiety have a strong correlation with functional impairment.[23] The patient's motivation and coping played a significant role in the success of this case due to the prolonged recovery from his original TKA and associated pain.

Persistent pain can cause physical changes in the central nervous system, namely the activation of the "pain matrix", made up of the frontal cortex, cingulate cortex, and the insular cortex.[24] These central nervous system changes can potentially lead to central or peripheral sensitization and the subsequent perception of little hope in one's own recovery.[25] The chronic nature of arthrofibrosis and external locus of control can influence outcomes. Patient motivation and concomitant psychosocial factors may confound the rehabilitation processes, and identification of these factors may assist in the implementation of a proper, patient-specific rehabilitation program.

It is unclear if the post-MUA use of CPM contributed in increased ROM in the early phase of recovery. Additionally, the patient had a two-week hiatus in his program due to the winter holidays. Direction for future research should include exploring whether treating certain impairments in a hierarchy can yield the most optimal functional improvements, which interventions can improve multiple impairments simultaneously, the optimal timing and dosage of therapeutic exercise, and the frequency of PT visits required in different phases of rehabilitation.

## CONCLUSION

The rehabilitation of a patient status-post MUA of a TKA does not have a well-defined treatment progression. The use of multimodal interventions within clearly defined phases appeared to facilitate this patient's recovery to return to sport participation. Progressing from ROM restoration to muscular control of the newly acquired range builds a solid base from which to progress functional rehabilitation. Addressing isolated strengthening and then moving to functional training allows the clinician to tailor the patient's rehabilitation program to his or her specific functional deficits. Finally, for a patient who wants to return to sport, addressing sport-specific kinetic chain deficits and training the necessary endurance, strength, and power may empower the patient to transition independently to a HEP and sport. The definition of a successful MUA is subjective based on the patient's goals, and achievement of these goals is the paramount objective of a rehabilitation program.

**Figure 2. The patient performing the home exercise program to mimic demands of rowing.**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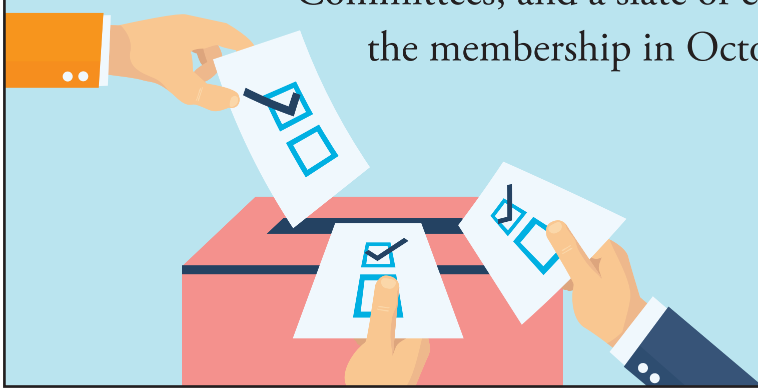

ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

# A Novel Biomechanical Approach for a Runner With Plantar Heel Pain Using Regional Interdependence: A Case Report

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## ABSTRACT

**Background:** Plantar heel pain (PHP) is a common condition affecting a large percentage of the population and frequently becomes chronic. Often PHP is a primary limiting factor for runners. While several biomechanical anomalies have been reported to contribute to PHP, local treatment is not always effective. This may be because the condition is often treated as an overuse condition due to the stresses of gait. **Methods:** This case report highlights the evaluation and treatment of a runner with primary complaints of PHP that are limiting his training and sport. A regional interdependence approach that uses both local and regional treatments to lessen the compression of the origin of the plantar fascia between the calcaneus and the ground was used. **Findings:** This case report shows the importance of using a regional interdependence approach on a runner with PHP. **Conclusion:** Using this model may allow for better treatment of PHP and a quicker return to sport.

**Key Words:** overuse injuries, plantar fasciitis, running injuries

## INTRODUCTION

Plantar fasciitis is a common condition affecting 7% to 24% of the overall population, approximately two million Americans per year, and 10% of the population over the course of a lifetime.[1] It may become chronic with symptoms persisting longer than one year before treatment is sought.[1] Despite investigation, the cause is poorly understood and the mechanisms are likely multifactoral.[2] The biomechanical etiology usually involves theorized mechanical tension overload via the windlass mechanism resulting in pain at the medial calcaneal tubercle, referred to as plantar heel pain (PHP).[3]

Regional interdependence (RI) is the concept that seemingly unrelated impairments in a remote region may be associated with the patient's primary complaint.[4] Attention to RI has broadened both examination and treatment recommendations for other lower extremity conditions, including patellofemoral pain syndrome and anterior cruciate ligament injury.[5-8] The current clinical practice guidelines in the treatment of plantar heel pain only include local intervention to the foot and ankle.[1] Just as attention to RI has improved outcomes in other lower extremity conditions, the authors feel that a similar approach may have the potential to improve outcomes for PHP. The purpose of this case report is to supplement a "tension" theory of PHP with a "compression" theory and broaden the examination and treatment focus from local dysfunction to include the entire kinetic chain.

The plantar fascia has 3 bands made of strong collagen with interwoven elastic fibers that, when loaded with hallux dorsiflexion, create osseous compression and stabilization during gait.[9-11] Risk factors for injury include limited dorsiflexion, high body mass index, running, and work-related weight-bearing activities.[1] Evidence implicating biomechanical risk factors is lacking.[12]

The diagnosis of PHP considers history, examination, and palpable tenderness in the medial portion of the calcaneus and medial longitudinal arch.[2,12] Differential diagnoses include plantar fascia rupture, neural entrapment, bony injury, and systemic illness (Table 1).

Stance phase, which is 60% of the gait cycle, allows collagen in the lower extremities to absorb shock, decrease friction, store and release energy, and increase propulsion efficiency.[13-15] Contact initiates with lateral heel strike and ends with forefoot weight bearing.[15,16] The internal rotation of the leg is eccentrically controlled by the gluteus maximus, medius, and deep hip external rotators.[5,17-19] The primary movements occurring at lateral heel strike are eccentrically controlled plantar flexion of the talocrural joint and pronation of the subtalar joint that unlocks the talonavicular and calcaneocuboid joints, allowing pronation during forefoot loading toward the first ray.[14,17]

In midstance, the absorptive function of the subtalar joint and lateral foot transition to the rigid, propulsive function of the medial foot.[17] As the ankle dorsiflexes, continued forward displacement of the tibia and the innate tension within the gastrocnemius lift the heel.[14] Dorsiflexion of the first metatarsophalangeal (MTP) joint tightens the plantar fascia via the windlass mechanism, increasing propulsion efficiency.[16,20]

The windlass effect is a passive lifting mechanism of the medial longitudinal arch as tension increases in the plantar fascia with first metatarsophalangeal dorsiflexion prior to resupination.[10,21] The windlass test is performed by forcefully dorsiflexing the first MTP joint to elicit traction-induced PHP and has 100% specificity but poor sensitivity (13% in nonweight bearing and 31% in weight bearing).[22] However, very few patients have symptoms with specific tensioning of the plantar fascia, suggesting that fascial tensioning in isolation may not be solely responsible for PHP, or it requires forces equal to body weight to elicit pain. This suggests that compression of the enthesis (transition between plantar fascia and bone) and proximal fascia during weight bearing create a painful fasciopathy. Thus, any kinetic chain impairment that increases medial calcaneal weight bearing (ie, compression of the proximal plantar fascia) may have a role in PHP.

In recent years, there has been an increase in the awareness of the role of compression in tendinopathy, with atrophic changes having been shown to occur in the transversely compressed side of various insertional tendinopathies.[23-25] The authors suggest that PHP may have a similar etiology secondary to compression of the plantar fascia between the medial calcaneal tubercle and the ground.

Several cases for plantar fasciopathy exhibiting traits of tendinopathy have recently been presented.[23,26] Novel high-load strength training of the plantar fascia under maximal weight-bearing tension was compared to fascia stretching and produced statistically significant improvements in pain and function, with positive results similar to those obtained from high load training in Achilles and patellar tendinopathy.[23,26]

Published reviews challenging the view that plantar heel spurs develop in response to tensile strain from plantar fascia pull, suggest instead, that spurs may be a response to vertical compression rather than longitudinal traction.[27-31] Further support of compression as a causative factor in PHP is provided by an MRI review showing a prevalence of increased superficial and deep peri-fascial signal intensity and altered bone marrow signal as compared to the intra-fascial signal.[32]

Regional interdependence applied to PHP considers the effects of the lower extremity and spine on enthesis compression. Unfortunately, PHP literature often applies local interventions to heterogeneous patient populations. A patient-specific RI examination of PHP should consider the relationship of the lumbar spine, lower quadrant, and gait, as well as evidence-based local treatment.[33]

Our specific evaluation included observation, gait, and range of motion of the thoracolumbar junction, lumbar spine, sacroiliac joint, hip, knee, ankle, and foot, with a more detailed manual biomechanical examination when indicated. In addition, manual muscle testing and general lower extremity functional assessment are tailored to the patient's specific needs and fitness level. Functional assessment may include double and single leg squats, multi-directional step testing, lunges, and double or single leg hopping.

Excessive femoral adduction and internal rotation is associated with weak hip abductors and external rotators–this pattern increases subtalar pronation during stance that amplifies plantar calcaneal loading.[7,8,18,34,35] There are other possible causes of valgus collapse such as congenital femoral anteversion, ankle dorsiflexion limitation, lower lumbar neurological weakness, painful inhibition from osteoarthritis, greater trochanteric bursitis, gluteal tendinopathy, and sacroiliac instability.[15,36,37]

Heel strike forces descend from hip internal rotation and are absorbed by tibial internal rotation and foot pronation. Normally, subtalar pronation ceases at the end of the contact phase, and supination begins at midstance. Inadequate eccentric neuromuscular control of hip internal rotation may cause excessive femoral internal rotation and pronation resulting in increased medial calcaneal tubercle weight bearing.

Inadequate dorsiflexion is a common risk factor for PHP.[34] Decreased talocrural dorsiflexion impairs shock absorption and may lead to compensation via excessive subtalar pronation and medial calcaneal weight bearing.[1,2,13,17,20,38] It is accepted that a tight triceps surae complex places excessive stress on the plantar fascia during gait and is often treated with stretching and a night splint. However, dorsiflexion loss is also associated with a history of ankle sprain and joint mobilization may be successful at restoring motion when stretching programs fail.[39] Restoring ankle dorsiflexion may serve to improve the shock absorption of the talocrural joint and diminish the load to the medial calcaneal tubercle.

Subtalar joint dysfunction may also contribute to increased plantar calcaneal loading. Previous injury is not a prerequisite for subtalar joint laxity, as laxity can result from congenital causes, as well as from muscular deficiencies in the tibialis posterior, flexor hallucis longus, and the flexor digitorum longus.[38] In the authors' clinical experience, prolonged, excessive subtalar joint pronation due to prior ligamentous injury, congenital hypermobility, or muscular deficit may result in the subtalar joint becoming fixated in a pronated position with calcaneal valgus, which may require mobilization or manipulation to correct, followed by specific strengthening of the tibialis posterior and arch support as necessary.

## CASE REPORT

An experienced 33-year-old male runner sought direct access physical therapy (PT) after 6 months of left PHP following a gradual increase in running frequency. His pain level rated by a Numeric Pain Rating Scale was 7 out of 10 and his Care Connections Functional Index™ lower extremity scale was 92% out of a maximum of 100%, suggesting a low level of functional limitation. He described his symptoms as sharp morning pain, which improved after walking, as well as progressive soreness with prolonged weight bearing. He took pause from running for 6 weeks and tried anti-inflammatories, without symptom resolution, so he resumed running 20 to 30 miles per week, half his desired distance, secondary to pain. His past medical history included a left fibular fracture because of a sprain 15 years prior that was treated with a Controlled Ankle Movement boot and did not result in any residual pain or lasting functional limitation. He reported a lower lumbar disc herniation on MRI 3 years prior that was treated conservatively and left him with periodic lower back pain brought on by prolonged positions but did not cause any significant functional limitation. He also reported a more recent, resolved left ankle sprain that he sustained while running in the snow 4 months prior to the onset of his PHP.

The patient's history and objective findings were consistent with PHP. The therapist's findings suggested a multifactorial etiology with both local and remote factors related to early and excessive pronation collapse and increased medial calcaneal weight bearing. Potential remote contributions

**Table 1. Differential Diagnosis of Plantar Heel Pain**

| Diagnosis | Distinguishing Clinical Features |
|---|---|
| Ruptured Plantar Fascia | Recollection of rapid onset of pain possibly accompanied by swelling and bruising |
| Enthesopathy | Usually accompanied by underlying spondyloarthropathy (eg, ankylosing spondylitis, psoriatic arthritis, etc) |
| Fat Pad Syndrome/atrophy | Occurs in the elderly, palpatory tenderness middle of heel, morning pain on first steps typically absent |
| Nerve Entrapment(s), Tarsal Tunnel Syndrome, Baxter's Neuropathy, Jogger's Foot | Pain, numbness/tingling, dysesthesia in distribution of affected nerve, possibly accompanied by muscle atrophy of innervated muscle(s) |
| Neuropathic Pain | Diffuse pain, nocturnal pain, metabolic syndrome |
| Calcaneal Stress Fracture | Diffuse pain over whole calcaneus, subjective history of recent activity increase |
| Calcaneal Bone Bruise | Generalized pain over the inferior calcaneous, typically following trauma |
| Bone Cancer | Deep bone pain, nocturnal pain |

included the unilateral loss of left lower lumbar extension and poor hip strength. This motion loss and weakness may change load transference through the lumbopelvic and hip region and may contribute to the valgus collapse of the left lower extremity. Local contributing factors included dorsiflexion weakness and hypomobility, lateral ankle ligament, and loss of mobility of the subtalar joint. A summary of examination findings is noted in (Table 2 & 3).

The patient's goals were to return to pain-free running. Our plan was to educate the patient, restore lower lumbar extension, normalize talocrural dorsiflexion and subtalar eversion, strengthen dorsiflexion and inversion, and use hip muscle recruitment exercises to reduce standing valgus.

The loss of dorsiflexion was hypothesized to decrease shock absorption of the talocrural joint, increasing medial calcaneal weight bearing. The etiology behind the loss of dorsiflexion range of motion was hypothesized to be due to his prior ankle sprain resulting in altered "tracking" of the talus in the mortise which subsequently limits full dorsiflexion. This serves to alter the "tracking" of the talus in the mortise and subsequently limits full dorsiflexion.[37] The treatment selected was a talocrural distraction manipulation as described by Young et al,[33] resulting in a cavitation and a return to normal mobility (Figure 1). His subtalar joint was determined to be hypomobile by passive mobility testing. This was manipulated (Figure 2), and an improvement in mobility was appreciated with passive assessment testing following the intervention. Kinetic chain exercises were completed both in the clinic and assigned for completion as a component of a home exercise program (Table 4).

The loss of left lumbar extension was theorized to contribute to his complaints of lower back pain with prolonged positions. The extension loss was hypothesized to increase torsional forces through the spine with running. The lower lumbar spine was mobilized with endrange segmental mobilization to restore full extension (Figure 3). Segmental multifidi training exercises were completed both in the clinic and as a component of a home exercise program (Table 4).

**Table 2. Examination Summary**

| Examination | Finding |
|---|---|
| **General Observation** | Thin male, left foot slightly pronated with increased calcaneal eversion left vs right |
| **TL Junction** | Active ROM – unremarkable, assessed with seated rotation to minimize contribution of lumbar spine |
| **Lumbar Spine** | Active ROM - unilateral loss of extension on the left tested with movement from above and confirmed with movement from below with alternating unilateral hip drop, palpable multifidi deficits at lower lumbar spine on the left |
| **Sacroiliac joint** | Active ROM – unremarkable Gillet Test and pain provocation testing |
| **Hip** | Passive ROM – unremarkable, including scour, FABER, and combined movements into extension/internal rotation<br>MMT – abduction and external rotation 4-/5 |
| **Knee** | Passive ROM – unremarkable<br>MMT – unremarkable |
| **Ankle** | Passive ROM – decreased talocrural dorsiflexion, limited posterior talar glide in Talar Swing Test (see Table 3), hypomobile subtalar eversion (see Table 3)<br>Stability – positive Anterior Drawer Test<br>MMT – dorsiflexion and inversion 4-/5<br>Palpation – tender at medial calcaneal tubercle |
| **Midfoot** | Unremarkable |
| **1st Metatarsophalangeal** | Unremarkable |
| **Squat – Double Leg/ Single Leg** | Valgus collapse demonstrated with single leg squat |
| **Single Leg Hop** | Decreased spring left vs. right, firmer, louder landing |

Abbreviations: TL, thoracolumbar; ROM, range of motion; MMT, manual muscle test; FABER, flexion, abduction, external rotation

## DISCUSSION

One month after the initial evaluation, the patient continued running 20 to 30 miles per week, and rated his pain at 2/10, decreased from 7/10. Given that his pain was decreasing, his joint mobility was normal, and he was compliant with a strengthening program, he began a one-month period of self-management with continued strengthening. One month later, he increased his mileage to 30 to 40 per week, his visual analog scale was 0 mm, his Care Connections™ Functional Index was 100%, and his Global Rate of Change score was 7/7. His lower extremity muscle strength improved, and he had no low back pain, despite it not being a reason to seek PT.

## CONCLUSION

Plantar heel pain is a relatively common condition with an average resolution taking longer than 12 months and 5% of patients choosing surgery.[2] The authors demonstrated the combined impact of addressing both local (talocrural and subtalar joints) and remote (lumbopelvic and hip strength and joint mobility) contributing factors, with a significant improvement within 4 weeks and a complete resolution in 2 months.

This case report discussed the complex coordination of gait and advocated a more patient-specific RI approach to PHP. The concept of treating PHP specific to the patient's impairment is not new. More recently, Young et al[33] presented 4 case studies successfully treating patients with PHP using interventions specifically targeting the patient's impairments. Similarly, Cleland et al[39] showed that manual therapy specific to the patient's impairments (both local and remote, as noted with our case) along with exercise was more efficacious than modalities and exercise.

A patient-specific biomechanical approach to treating PHP must consider the RI of the lumbar spine and the lower extremities. The authors illustrate how both local and remote impairments in strength and mobility may contribute to increased medial calcaneal weight bearing and subsequent PHP. The authors described a patient-specific biomechanical approach to treating PHP that considered both the RI of the lower quadrant and local PHP interventions.[33,39] It may be impossible to determine the exact cause of PHP, but addressing local and remote impairments simultaneously in this patient case was appropriate.

**Table 3. Examination Summary Talocrural & Subtalar Joint Technique**

| Motion | Technique |
|---|---|
| **Subtalar Eversion** | Standing at patient's foot with the patient supine, heel off edge, and leg slightly externally rotated. Stabilize talus laterally through mortice with outside hand. The inside hand's thenar eminence will be over the sustentaculum tali and fingers wrap around the lateral aspect of the calcaneus. Take up full eversion. Spin posterior aspect of calcaneus medially with fingers and with radial deviation of the hand for assessment of posterior aspect of the subtalar joint. Glide anterior aspect of talus laterally with thenar eminence and with radial deviation of the hand for assessment of the anterior aspect of the subtalar joint. |
| **Subtalar Inversion** | Standing at patient's foot with the patient supine, heel off edge, and leg slightly externally rotated. Stabilize talus laterally through mortice with inside hand. The outside hand's thenar eminence will be over the anterior lateral aspect of the calcaneus and fingers wrap around the medial aspect of the calcaneus. Take up full inversion. Spin posterior aspect of calcaneus laterally with fingers and with radial deviation of the hand for assessment of posterior aspect of the subtalar joint. Glide anterior aspect of talus medially with thenar eminence and with radial deviation of the hand for assessment of the anterior aspect of the subtalar joint. |
| **Talocrural Talar Swing Test**[40] | Patient seated on edge of table with feet hanging. Place thumbs on neck of talus and fingers palpate tubercles of talus. Keep foot parallel to floor as you take ankle through full plantar flexion and dorsiflexion range of motion, palpating for smoothness and fullness of motion. |

**Figure 1. Talocrural distraction manipulation technique.[33] Therapist grasps the foot with thumbs along the plantar aspect and fingers interlaced along the dorsal aspect with the 4th digits attempting to hook the anterior aspect of the talus. With the foot in neutral dorsiflexion, a high velocity low amplitude long-axis distraction force is applied.**

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**Figure 2. Subtalar eversion manipulation technique. Thumbs are placed on the sustentaculum tali on the top side and the fingers support the talus on the underside. A quick "flick" force high velocity low amplitude is applied to the foot to create an eversion force with pressure through the thumbs into the sustentaculum tali.**


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**Table 4. Therapeutic Exercise Interventions**

All weight-bearing exercises are performed barefoot with the toes spread and the arch raised as well as the deep hip external rotators engaged and belt line level. With foot/feet planted, use hip muscles behind greater trochanter to spin knee out as far able without losing 1st ray ground contact, which should result in arch lift as well as minimize knee valgus.

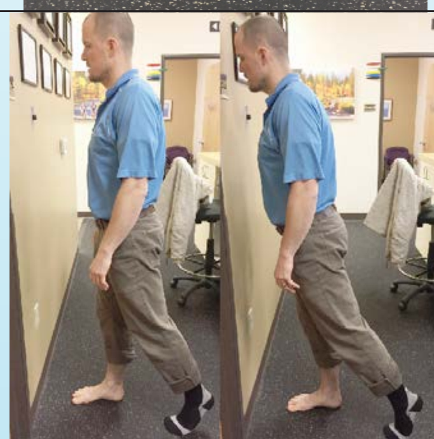
| Exercises | Photo | Description |
|---|---|---|
| Single leg squat with arch control |  | Patient performs a single leg partial squat only as far as able while maintaining arch height, knee tracking over second toe, and belt line level with mirror feedback |
| Wall nod/woodpecker |  | Patient stands facing wall with uninvolved foot 12 inches from wall and uninvolved foot behind with toes on ground for stability, with a soft knee patient controls a "tipping" forward motion from ankle only as far forward as able without arch collapse and then returns to start position |
| Single leg stance with resisted toe touching |  | Patient stands with wall to one side on involved foot with band anchored to wall and looped around uninvolved foot, while maintaining soft knee, the uninvolved foot is pulled back and forth across the stance leg while maintaining arch height, repeat facing both directions |

**Table 4. Therapeutic Exercise Interventions *(continued)***

| | | |
|---|---|---|
| Single leg bent knee heel raises with arch control |  | With a slight knee bend, a full heel raise is performed with a slight inversion of the heel at the top of the motion to enhance posterior tibialis challenge, heel is then lowered in a controlled fashion back to start position |
| TheraBand resisted inversion |  | Patient seated with band anchored to wall and looped around midfoot of involved ankle, ankle is inverted and plantar flexed against resistance and then eccentrically controls into dorsiflexion and eversion |
| Quadruped over plinth tailbone lift lower lumbar multifidi training |  | Patient kneeling over weight bench, ottoman, coffee table, etc, perform a small tailbone lift using the muscles at the base of the spine |
| Lumbar extension over ball |  | Patient supported on ball with toes or heels stabilized under firm surface, maintaining a relatively neutral spine (ie, not excessively rounded or arched), raise torso to horizontal and then lower, use hand support if necessary in the beginning |

**Figure 3. L5-S1 extension mobilization/manipulation technique. Technique was applied to L5-S1 segment in this case. Pictured is L4-5 segment. Therapist applies a Grade 4 or 5 high velocity low amplitude force through forearm and finger(s) from below to extend S1 under L5.**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# Pain Science Education Within an Early Intervention Physical Therapy Model Leads to a Rapid Return to Full Function for a Patient Following an Acute Hip Injury

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## ABSTRACT

**Background:** The early intervention of physical therapy has been shown to provide patients with significantly more efficient return to function and improved outcomes of pain and disability compared to the wait and see model. Studies have demonstrated that early, aggressive, active functional rehabilitation improves patient outcomes, decreases fear-avoidance behaviors (FABs), lessens negative physiologic changes in response to decreased mobility, less time away from work, and, ultimately, a decrease in the overall likelihood of more invasive procedures. Pain science education has been shown to be effective in the management of central sensitization in a chronic pain population, but it is not commonly used in acute musculoskeletal injuries. **Purpose:** The purpose of this case study is to examine the effectiveness of pain science education within an early intervention model of physical therapy for a patient with acute hip pain. **Description:** A 53-year-old female presented with acute hip pain after falling at work, one day prior to evaluation. The patient arrived in a wheelchair, unable to walk without severe hip pain. The patient was treated for a total of 3 visits over a one-week period. The impairments included limited hip joint mobility, neural tension, faulty breathing pattern, and impaired muscle function. Interventions included pain science education and physical therapy to empower her to reach functional goals. **Outcomes:** Outcome measures included Fear-Avoidance Beliefs Questionnaire, physical activity and work subscales (FABQ-PA, FABQ-W, respectively), modified Oswestry Low Back Pain Disability Questionnaire, The Keele STarT Back Screening tool, Numeric Pain Rating Scale (NPRS), and the Patient Specific Functional Scale (PSFS). Over 3 visits the patient FABQ-PA decreased from 15/24 to 0/24, the FABQ-W from 33/42 to 6/42, the modified Oswestry Low Back Pain Disability Questionnaire decreased from 34% to 0%, the NPRS for hip pain decreased from 8/10 to 0/10, and the PSFS improved from 2/10 to 10/10 for standing, walking, and carrying. **Clinical Relevance/Conclusion:** The early intervention of pain science education and empowerment along with usual care were found to be successful in decreasing FABs, improving function, and returning to work rapidly in acute hip pain. The patient was able to achieve patient-specific goals of returning to work and recreational activity with no pain.

**Key Words:** musculoskeletal, occupational health, fear-avoidance beliefs

## INTRODUCTION

Physical therapists in an occupational health setting have the unique opportunity to evaluate patients in the acute stage of their injury. It is becoming increasingly known that the early intervention model is very effective for decreasing fear-avoidance behaviors (FABs), physiological responses due to decreased mobility and improved rate of return to work.[1] The early intervention model strives to decrease the amount of musculoskeletal, physiological, and psychological sequelae that often follow when a patient limits movement. Although there is evidence supporting use of pain science education in chronic pain, there is limited research with acute injuries.[1] Following a traumatic injury, peripheral nerves in the local area become sensitized therefore the central nervous system responds immediately from the sympathetic nervous system, releasing adrenaline and cortisol to protect from the perceived threat.[2] This response is natural and helpful immediately following an injury; however, if it continues for a prolonged period, the body is unable to heal and rest. The ability to activate the parasympathetic nervous system is key to improve healing and decrease stress. Pain science education is a useful tool to provide patients with the knowledge and awareness of these responses.

### Case

A 53-year-old female presented to physical therapy with severe hip pain following a fall one day prior. The patient arrived to the clinic in a wheelchair and reported severe pain that worsens with hip extension, weight-bearing positions and passive range of motion specifically of the hip joint. The patient was able to find some minor relief in a sitting position and with mild distraction to the hip joint in flexion. She demonstrated high FABs as captured by Fear-Avoidance Belief Questionnaire (FABQ), and expressed fear and stress associated with hip pain. Pain related fear and pain catastrophizing have been proven to be significant predictors of perceived disability, pain intensity, and performance.[3] The purpose of this article is to show the effectiveness of early intervention pain science education in deceasing FABs and a rapid return to function in an acute hip injury.

## INTERVENTION

### Visit 1

Due to the severe pain reported, the initial evaluation was limited to ruling out red flags, increasing patient comfort, and patient education. Since the patient demonstrated increased pain with weight bearing and a history of a fall, hip fracture was the first consideration. Fracture was ruled out by radiographs taken by the referring physician immediately prior to physical therapy evaluation. Once the fracture was ruled out, the next steps were to determine if the pain was related to a muscle, ligament, capsular, or nervous system injury.

The patient was able to tolerate a sitting position; however, in supine any passive or active movement of the hip joint exacerbated her pain and minor relief was achieved by distraction in hip flexion. After a thorough examination including subjective questioning to confirm pain changes with changes in position, normal sensation, reflexes, full range of motion, and a negative sign of the buttock confirmed, red flags were ruled out. It was determined that increased sympathetic nervous system activity was contributing to the patient's pain.

The first visit solely focused on patient comfort and education with the goal of decreasing the sympathetic nervous system activity. Pain was explained using verbiage and ideas from Lorimer Moseley's *Painful Yarns*,[4] explaining that pain does not necessarily correlate with tissue damage. When tissues are under perceived threat, the unconscious brain causes reactions in the form of motor output changes, blood flow changes, and the immune system and autonomic system activate.[4] Pain is a conscious experience that motivates us to take action in order to protect the tissues from perceived threat. "When the brain is satisfied that enough has been done to get the tissues out of danger, then it stops making the body part painful."[4] This is the same principle that explains why placebo pills often have the same effect in decreasing pain as the real medication. Since the pain experience is based on the evaluation of how much danger the tissues are in, it is important to identify the Dangers in Me (DIMs) and Safeties in me (SIMs). The DIMs are described as anything that is dangerous to your body tissues, life, lifestyle, job, happiness, your day-to-day function, or a threat to who you are as a person.[5] In the case of an acute injury, the DIMs often consist of potential harm to her body tissues, her job security, money issues, emotional support, etc. A SIMs is anything that makes you stronger, healthier, more confident, more sure, and certain within and about yourself.[5]

In relation to this patient the initial DIMs included the potential of disabling tissue damage, inability to participate in normal activities including working out and going to work. It was important to determine the SIMs to create a patient-centered treatment plan, which included being physically active and having a supportive husband and a supportive job that allowed for work modifications. The initial visit was important to decrease the DIMs by explaining that we have cleared all red flag pathology extensively with a thorough examination and education regarding the normal sympathetic response. Then increasing the SIMs by allowing for open communication and reassuring her that she is in the right place and that her injury was not going to prevent her from getting back to working out, therefore decreasing the anxiety and fear associated with this injury. The patient's active participation in creating goals and understanding the cause of the tissues response to the injury allowed her to be active in the rehabilitation process. The interventions given that day included diaphragmatic breathing to help transition from the sympathetic "fight or flight" state to the parasympathetic "rest and digest" state to decrease stress, anxiety, and pain.[6]

### Visit 2

At the second visit the next day, the patient walked in to the physical therapy clinic with mild antalgia and a pain rating of 2/10. The patient education then changed focus from pain to improving function to continue the treatment plan of SIMs outweighing the DIMs. Patient reported that although being able to move better, she had reservations about the pain coming back and still had twinges during squatting down and gait. The goal for this visit was to decrease the DIMs and increase SIMs. Education included patient-specific function, muscle activation, and movement corrections allowing for success with movement. Empowerment during this stage of early movement was powerful in giving the patient the confidence to overcome her DIMs. The home exercise program consisted of diaphragmatic breathing, foam roll, and gluteus medius activation.

### Visit 3

On the third and final visit, two days later, the patient reported to the physical therapy clinic with normal gait and a pain rating of 0/10. The patient reported feeling better since the last visit and with her compliance with the home exercise program, as she noticed improvement from performing the exercises. Although she felt virtually back to normal at work, she continued to be nervous about engaging in and completing her workout routine. The goal for this visit was to create a treatment plan that simulated all activities necessary for work and decreased her fears associated with working out. Again, empowerment was key to improving confidence and decreasing fear associated with these activities. One strategy used to empower the patient was including her in the decision-making process, deciding which activities or exercises were most important for her to practice. This patient-centered care allowed for an increase in SIMs and decrease in DIMs as she completed all activities with confidence and no pain.

## OUTCOMES

The outcome measures given at the beginning and end of care included Fear-Avoidance Beliefs Questionnaire, physical activity and work subscales (FABQ-PA, FABQ-W, respectively), modified Oswestry Low Back Pain Disability Questionnaire, The Keele STarT Back Screening tool, Numeric Pain Rating Scale (NPRS), and the Patient Specific Functional Scale (PSFS). Within 3 physical therapy visits this patient's FABQ-PA decreased from 15/24 to 0/24, the FABQ-W from 33/42 to 6/42, the modified Oswestry Low Back Pain Disability Questionnaire decreased from 34% to 0%, the NPRS for hip pain decreased from 8/10 to 0/10, and the PSFS improved from 2/10 to 10/10 for standing, walking, and carrying and the patient returned to full activity and recreational functions.

## CONCLUSION

The goal of this article was to demonstrate the importance and effectiveness of pain education, empowerment, and patient-centered care within an early intervention approach of physical therapy. This patient initially presented in 10/10 pain, afraid to walk due to pain, unable to walk due to fear and pain, and had decreased hip range of motion. After ruling out red flags following a thorough examination, the patient responded well to patient education regarding the normal sympathetic response after an injury, the techniques to increase parasympathetic response, and allow for gentle return to functional activities. At each of the 3 visits, progression to more functional activities with patient-centered goals of returning to work and specific exercises for working out at home were advised.

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## Recognizing One of Our Own Leaders: AOPT President, Joseph Donnelly


**Joseph Donnelly was awarded a Healthcare Hero Award from the Atlanta Journal Constitution Business Chronicle this past May. Congratulations, Joe!**

# Medial Elbow Joint Space Assessment During Shoulder External Rotation and Internal Rotation in Various Forearm Positions Using Musculoskeletal Ultrasound

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## ABSTRACT

**Background:** There are various recommendations for glenohumeral internal rotation (IR) post ulnar collateral ligament (UCL) reconstruction. **Purpose:** Observe ulnohumeral joint space by dynamic ultrasound to determine potential stress on the UCL during glenohumeral external rotation (ER) and IR. **Methods:** Subjects performed a submaximal isometric hold determined via handheld dynamometer and an ultrasound (US) clip was taken throughout the contraction with medial elbow joint gapping recorded. Trials included glenohumeral IR and ER in various forearm positions. **Findings:** A significant change in medial elbow joint space was found during all resisted IR positions and approximately half of resisted ER positions. **Clinical Relevance:** Medial elbow stresses exerted by early initiation of IR following UCL reconstruction requires further investigation. **Conclusion:** Current concepts in rehabilitation following UCL reconstruction advocate for delayed ER, however only few mention delaying IR. Further research is needed to investigate the relationship between medial elbow joint space and the stress exerted on the UCL with resisted ER and IR.

**Key Words:** postoperative rehabilitation, Tommy John Surgery, ulnar collateral ligament

## BACKGROUND

The ulnar collateral ligament (UCL) is the primary stabilizer at the medial elbow for valgus stress. Anatomically, the UCL is divided into 3 bundles: anterior, posterior, and transverse.[1] The anterior bundle is the most commonly injured bundle,[2] and thus is typically the primary target of UCL reconstructive surgery. As the incidence of UCL reconstructions continues to increase,[3,4] there is further need to define and establish safe and effective postoperative rehabilitation protocols.

Current rehabilitation protocols advocate protection of valgus stress to the elbow in the early and intermediate phases of rehabilitation.[5,6] However, there is conflicting evidence among various sources in regard to the specific action that causes valgus stress at the elbow. Most studies and protocols caution against excess glenohumeral external rotation (ER) due to the resulting valgus stress produced at the medial elbow.[5,6] The literature less commonly advises additional precautions against internal rotation (IR) for medial elbow protection. A cadaveric study by Bernas et al[7] specifically advocated for the avoidance of IR in which they found that a 2.5 lb weight generated significant, deleterious strain at the elbow. Therefore, the potential of significant stress occurring at the medial elbow as a result of glenohumeral IR should also be considered during early postoperative management following UCL reconstruction. Better guidelines are needed to guide the inclusion of glenohumeral IR post-UCL reconstruction.

Dynamic musculoskeletal (MSK) ultrasound (US) is an effective, proven, and timely method of evaluating stress at the UCL. Draghi et al[8] demonstrated the use of US to capture medial joint space gapping of the elbow during an applied valgus stress. Bica et al[9] found that "medial elbow stress sonography is a reliable and precise method for detecting changes in ulnohumeral joint gapping and UCL lengthening." Nazarian et al[10] found that it took only 10.4 minutes to bilaterally assess the UCL, thus making dynamic MSK-US an efficient and effective procedure.

The purpose of this study was to evaluate potential stress on the UCL during resisted isometric glenohumeral ER and IR in various forearm positions via dynamic US measurements of the ulnohumeral joint space.

## METHODS

### Subjects

In this pilot study, subjects recruited within a research class from the University of Cincinnati Department of Rehabilitation Sciences. Eighteen subjects were examined bilaterally for a total of 36 elbows. All subjects were between the ages of 18 and 25 that included 4 males and 14 females. Exclusion criteria included recent elbow injury, history of elbow surgery, or history of significant elbow trauma.

### Study Procedures

Subjects were placed into 1 of 3 categories: overhead athlete (O), lax (L), or normal (N). Overhead athletes included subjects with a history of participation in baseball or volleyball (n=4). Lax was determined by a (+) Beighton Hypermobility Scale for the upper extremity (n=6). Remaining subjects were assigned to the normal group (n=8). Investigators were not blinded to group placement. All MSK-US recordings were obtained by a trained physical therapist, with 5 years of experience in MSK-US. Musculoskeletal-ultrasound was used via Biosound Esaote MyLab 25 Gold.

The first position for measurements was in standing with the elbow flexed at 90° and the glenohumeral joint in neutral rotation. Subjects performed maximal isometric glenohumeral IR and ER for each upper extremity. Force was obtained with the use of a hand-held dynamometer just proximal to the wrist. Three trials were performed and the average of the 3 trials was taken.

For the second measurement, the medial elbow joint space was captured with the MSK-US transducer probe LA435 with the subject in sitting, elbow flexed to 90°, and the glenohumeral joint in neutral rotation. Randomization was used to determine right versus left first, IR versus ER first, and order of forearm positioning. A picture was taken of the medial elbow joint space at rest. The subject then performed a submaximal isometric hold of at least 50% maximal contraction against a hand-held dynamometer just proximal to the wrist for 3 trials in the following positions with a 30-second rest between each trial: (1) resisted ER in each forearm position of pronation (p), supination (s), and neutral (n) and (2) resisted IR in each forearm position of pronation (p), supination (s), and neutral (n). For each isometric hold, a 10-second clip was captured with MSK-US from rest to a minimal 5-second contraction and back to rest.

The final measurements were with subjects in supine. Three trials were performed using a 10-second clip while the subject laid in supine with the arm positioned at 90° of glenohumeral abduction and 90° of ER, with 90° of elbow flexion (90/90 position). Males were given a 5 lb hand-weight and females were given a 3 lb hand-weight due to frequent substitutions seen in females with 5 lb weights. The subjects were instructed to relax as the weight induced further glenohumeral ER. This provided a passive valgus stress to the medial elbow. The above procedures were repeated on the contralateral upper extremity.

After image collection, the trochlea of the humerus and the coronoid process of the ulna were identified on each image via MyLab Desk Version 6.1. The greatest point of medial joint space separation was determined on each picture and video clip using the landmarks described. The distance of this separation in millimeters was recorded and used to calculate change in medial joint space opening from rest to maximal opening on isometric contraction or maximal lengthening in the 90/90 position. For data analysis, the data sets were categorized by group abbreviation (Overhead Athlete: O, Lax: L, Normal: N) followed by forearm position (p, s, n) and direction of isometric resistance (ER, IR). Thus the overhead group in neutral with resisted ER would be On-ER and the lax group in pronation with resisted IR would be Lp-IR.

### Data Analysis

Microsoft Excel was employed for data recording and to calculate percent change between resting joint space and maximal joint space during each trial. Paired t-tests were used for resting joint space vs. maximal joint space. One tailed paired t-tests, one-way analysis of variance, and multiple comparisons, using GraphPad Prism software, were used to determine significant differences between groups.

### Reliability and Validity of Measurement Tools

The accuracy and efficiency of MSK-US is well documented in current research. Previous studies have shown that MSK-US is as reliable as magnetic resonance imaging when diagnosing UCL tears.[9,11] Bica et al[9] evaluated the accuracy of MSK-US and determined that differences as small as 0.4 mm to 0.9 mm can be reliably and consistently detected. In addition to being precise, it is also a timely diagnostic tool that can be used in the clinic setting.[10]

## RESULTS

A significant increase ($p \leq 0.05$) in medial elbow joint space was found across all 9 resisted IR groups at each position of pronation (p), supination (s), and neutral (n). Within this data set, 6 of the 9 datasets obtained a p-value ≤ 0.01 (Np-IR, Lp-IR, Os-IR, Ns-IR, Ls-IR, Ln-IR). A significant increase ($p \leq 0.05$) in medial elbow joint space was found in 4 of the 9 datasets evaluating resisted ER (Np-ER, Lp-ER, Ls-ER, On-ER). Two of these obtained a p-value ≤ 0.01 (Np-ER, Ls-ER) (Figure 1). The 90/90 position reached a significant increase ($p \leq 0.05$) in medial elbow joint space for all 3 groups, two of which obtained a p-value ≤ 0.01 (O-90/90, L-90/90) (Figure 1).

In the 90/90 position, the forearm is in a neutral position. Therefore, it was compared to neutral resisted ER and neutral resisted IR (Table 1). When comparing mean joint space changes between the 90/90 position and neutral resisted ER, a significant difference was found in the overhead athlete group in favor of more gapping in the 90/90 position ($p = 0.01$). A similar result was present in the comparison of the 90/90 position and neutral resisted IR, with a significant difference only in the overhead athlete group ($p = 0.02$).

Resisted IR was compared to resisted ER within each forearm position for each group (O, N, L) (Table 2). A significant difference was found in the lax group in the neutral position ($p = 0.03$) in favor of greater gapping during resisted IR than resisted ER. A significant difference was also found in the overhead athlete group in supination ($p = 0.00$), again in favor of greater gapping during resisted IR than resisted ER. No other significant differences in gapping during resisted IR vs resisted ER were found for any other group in any other forearm position.

Comparisons in joint gapping between forearm positions during resisted IR was also performed (Table 3). There was significantly greater gapping in the supination position compared to neutral in the overhead athlete group ($p = 0.03$). There was also significantly greater gapping in the pronation position compared to neutral in the normal group ($p = 0.01$). No other significant differences were found between forearm positions.

## DISCUSSION

The results indicate glenohumeral IR creates as much, or more, medial joint space increase than glenohumeral ER (Figure 1). This translates to as much, or more, increased stress on the UCL. Of the 9 resisted IR datasets, all 9 demonstrated significant joint gapping ($p \leq 0.05$) and 6 demonstrated significant gapping of $p \leq 0.01$. This is compared to only 4 of the 9 resisted ER datasets demonstrating significant gapping of $p \leq 0.05$, with only 2 demonstrating significant gapping of $p \leq 0.01$.

All current UCL reconstructive rehabilitation protocols advocate for protected glenohumeral ER in the early postoperative rehabilitation phase, but few pay homage to the idea that glenohumeral IR may also need to be protected. Ellenbecker et al's[6] UCL rehabilitation guidelines caution the providers in the following ways: "Internal or

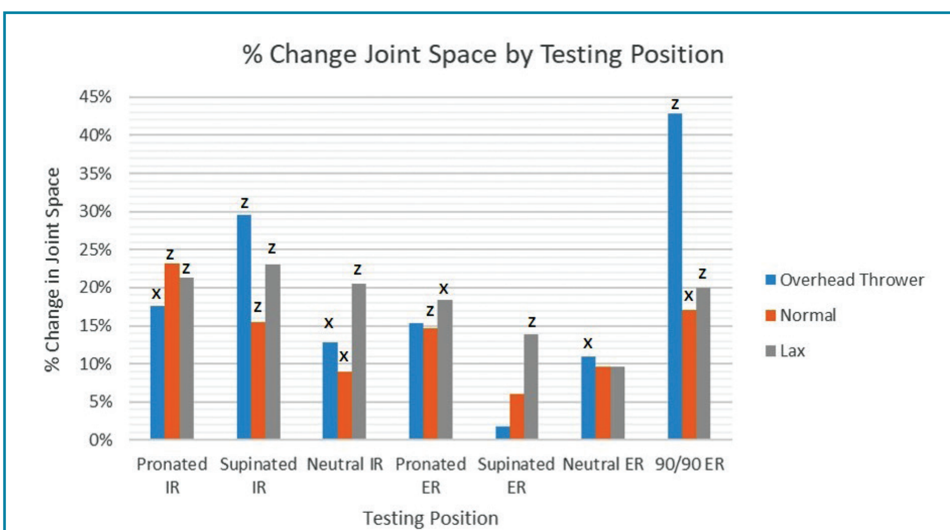


**Figure 1. Percent change in medial elbow joint space from rest to max. "x" denotes significant change ($p \leq 0.05$). "z" denotes ($p \leq 0.01$).**

**Table 1. Significant Differences in Joint Space Between 90/90 Position and Neutral Internal Rotation/External Rotation Compared via t-test**

| | Overhead | Normal | Lax |
|---|---|---|---|
| **90/90 vs Neutral External Rotation** | 0.01* | 0.20 | 0.06 |
| **90/90 vs Neutral Internal Rotation** | 0.02* | 0.13 | 0.47 |
| * Denotes significant change ($p \leq 0.05$) | | | |

**Table 2. Significant Differences in Joint Space Between Selected Groups Compared via t-test**

| | Overhead | Normal | Lax |
|---|---|---|---|
| **Neutral IR vs Neutral ER** | 0.37 | 0.46 | **0.03*** |
| **Pronated IR vs Pronated ER** | 0.39 | 0.12 | 0.36 |
| **Supinated IR vs Supinated ER** | **0.00*** | 0.09 | 0.06 |
| Abbreviations: IR, internal rotation; ER, external rotation | | | |
| * Denotes significant change ($p \leq 0.05$) | | | |

**Table 3. Significant Differences in Joint Space Between Forearm Positions Compared via t-test**

| ALL RESISTED INTERNAL ROTATION | Neutral vs Supinated | Neutral vs Pronated | Supinated vs Pronated |
|---|---|---|---|
| **Overhead Athlete** | **0.03*** | 0.26 | 0.11 |
| **Normal** | 0.13 | **0.01*** | 0.14 |
| **Lax** | 0.31 | 0.44 | 0.39 |
| * Denotes significant change ($p \leq 0.05$) | | | |

external glenohumeral rotation strengthening is permitted in a limited ROM. Excessive glenohumeral joint external rotation produces a valgus moment at the elbow joint." Wilk et al[5] also indirectly suggest that ER should be more protected than IR when in phase 2 of his rehabilitation protocol he suggests, "internal rotation motion is also diligently performed, as internal rotation range of motion of the shoulder may create a protective varus force at the elbow." However, the same study also suggests that "Shoulder isometrics may be performed during [phase 1] with caution against internal and external rotation exercises, if painful, as the elbow joint becomes a fulcrum for shoulder isometrics." The latter suggestion by Wilk et al[5] aligns with the findings of the Bernas et al[7] study, which found that strain at the UCL in cadaveric elbows is significantly increased with glenohumeral IR. Based on the results of our study, the Bernas et al[7] study, and the suggestions of Wilk et al,[5] glenohumeral IR needs to be further considered for its effect on the stresses at the UCL.

For overhead athletes, the 90/90 position created significantly more medial elbow gapping than both neutral resisted IR and neutral resisted ER. In addition, the results of this study state that the 90/90 position with passive ER creates the largest percent change in medial elbow joint space for the overhead athlete group (Figure 1). While our overhead group included both upper extremities of the overhead athlete, the research by Nazarian et al[10] indicates that only the dominant arm shows increased laxity at the medial elbow joint in the overhead athletes. Therefore, the significant difference between the 90/90 position and neutral resisted IR and ER would actually be greater if only the dominant arm was included in overhead athletes. Whether or not the stress to the medial elbow arises from the 90/90 position itself or the passive ER moment is not known. Ellenbecker et al[6] advocates waiting to add glenohumeral ER in the 90/90 position until the advanced phase of his rehabilitation protocol. With our limited sample size, this study also indicates that the 90/90 position should be delayed until more advanced phases of rehabilitation. More caution is warranted when starting overhead activities following a UCL reconstruction surgery. This suggestion may have implications for the 90/90 position itself or for the stress caused by active contraction of the glenohumeral musculature while in this position. Further research may examine the impact of the 90/90 position with active IR and ER to investigate potential protective or deleterious effects in this position.

This study also compared the difference in mean joint space gapping between resisted IR and resisted ER within the forearm positions of neutral, pronation, and supination for each group (O, N, L) (Table 2). As stated in the results, the only significant differences were found in the lax group in neutral forearm position ($p = 0.03$) and in the overhead group in the supinated position ($p = 0.00$). There were no other significant differences generated between resisted IR and resisted ER within any other group-position dataset. Therefore, these results lend further support to the idea that resisted IR is as or more stressful to the UCL as is resisted ER. This holds true regardless of forearm position. The clinical takeaway is that the motion occurring at the glenohumeral joint is more important to medial joint gapping than forearm positioning. Therefore, if resisted ER is a precaution or contraindication in certain phases following UCL reconstruction, the clinician should strongly consider if resisted IR should also fall into the same precaution or contraindication category regardless of forearm position.

Lastly, this study sought to determine the differences in gapping between forearm positions during resisted IR. As stated in the results above (Table 3), there was significantly greater gapping in the supination position compared to neutral in the overhead athlete group ($p = 0.03$) and significantly greater gapping in the pronation position compared to neutral in the normal group ($p = 0.01$). No other significant differences nor trends were found between forearm positions. However, Otoshi et al[12] in their study showed that the pronator teres and flexor carpi radialis function as dynamic stabilizers against elbow valgus stress. A study by Pexa et al[13] also showed the impact of forearm musculature on protection against valgus stresses, stating that "maximal wrist and finger flexor muscle contraction may assist in limiting medial elbow joint space." Our study however, did not evaluate or monitor the activation of the forearm musculature during resisted IR and resisted ER. Future studies should examine the effects of forearm muscle isometrics on joint gapping during resisted IR and resisted ER.

There were several limitations to this study. The small sample size could have influenced results. For example, classmates were recruited within research classes as subjects and testers were not blinded as to which group (O, N, L) the subject was placed in. However, the same experienced MSK-US user was used for each trial and testers used objective measurement criteria on the MSK-US video clips to measure joint space increases. Another limitation was that both elbows of the overhead athletes were placed in the overhead athlete group, while Nazarian et al[10] found significantly greater medial joint space in the pitching arm with applied valgus stress compared to the non-pitching arm. This suggests that the non-throwing/swinging arm of the overhead athlete may have been better suited to be placed in the lax or normal groups, dependent on which group was more appropriate.

## CONCLUSION

The results of our study indicate that resisted IR creates as much, or more, medial elbow joint space increase or stress on the UCL as resisted ER at the glenohumeral joint. In addition, the action at the glenohumeral joint has a larger impact on medial elbow joint space increase than forearm positioning. We clinically recommend the introduction of both glenohumeral IR and ER only as healing allows. Since separation was seen with 50% maximal isometric contraction of the glenohumeral internal and external rotators, caution needs to be considered when introducing glenohumeral IR and ER post-UCL reconstruction. In addition, caution is warranted when transitioning the overhead athlete into overhead activities as the 90/90 position demonstrates significant gapping. Further research is suggested to examine the effects of glenohumeral IR on the UCL, as well as the impact of isometric activation of forearm musculature on protection of elbow valgus stress.

### Clinical Applications

We suggest that isometric glenohumeral IR exercises following UCL reconstruction should be delayed for a similar length of time as the glenohumeral ER exercises. This holds true regardless of forearm positioning. When initiation of IR and ER exercises begins, caution should be taken to progress slowly only as the healing allows due to separation of medial elbow joint space observed at only 50% maximal contraction of both the internal and external rotators. In addition, exercises in the 90/90 position should be delayed until more advanced phases of healing due to gapping created at the medial elbow joint.

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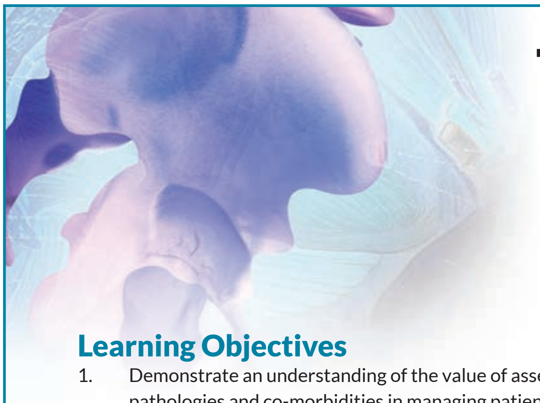

# THE LUMBOPELVIC COMPLEX: ADVANCES IN EVALUATION AND TREATMENT

Independent Study Course 28.3

## Learning Objectives

1. Demonstrate an understanding of the value of assessing serious pathologies and co-morbidities in managing patients with low back pain.
2. Demonstrate an appropriate interpretation of the patient's history and physical examination findings into patterns that guide the treatment.
3. Recognize acute and subacute low back pain patterns and the rehabilitation that is prescribed for each.
4. Understand the theoretical basis for spinal stability and movement coordination.
5. Formulate a structured evidence-based examination algorithm to identify relevant movement coordination impairments of the lumbopelvic complex.
6. Apply the examination algorithm to develop optimal procedural interventions with regard to proper exercise dosing.
7. Define different types of pain and identify common pain patterns.
8. Describe the relevant clinical anatomy of the lumbopelvic region to allow for accurate clinical examination and identification of possible sources of symptoms.
9. Understand the most common clinical presentations of low back pain with radiating pain conditions to provide a framework for the clinical examination.
10. Understand the basis and progression of neuropathic pain and the development of chronic pain syndromes.
11. Screen for possible sources of low back pain that require medical referral.
12. Use and interpret appropriate psychosocial screening tools to assist in identifying personal factors that influence patient management and prognosis.
13. Integrate research evidence to support the use of manual therapy, including high-velocity low-amplitude spinal mobilizations in the treatment of low back pain with radiating pain.
14. Discuss current evidence for non-pharmacologic and pharmacologic interventions for older adults with low back pain.
15. Identify one or more strategies for incorporating patient-centered care into the plan of care for an older adult with low back pain.
16. Develop an understanding of evidence-based management of adolescents with low back pain and when imaging is indicated.
17. Understand the concepts of exercise progression to prepare a treatment program for an adolescent athlete, beginning with simple, early stage exercises progressing to advanced, sport-specific movements.

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This course provides a comprehensive resource for the clinician who seeks evaluation and treatment expertise for patients who suffer low back pain. Particular emphasis is placed on defining the facets governing spinal stability, assessing movement patterns, and differentiating among types of pain and how each is effected in patients with low back pathology. Specific monographs are dedicated to the geriatric and pediatric populations. A unique feature of the course is the inclusion of 39 patient resource pamphlets that can be used for patient education.

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**Acute, Subacute, and Recurrent Low Back Pain with Movement Coordination Impairments**—Won Sung, PT, DPT, PhD; Ejona Jeblonski, PT, DPT

**Acute and Subacute Low Back with Radiating Pain**—Robert Rowe, PT, DPT, DMT, MHS, FAAOMPT; Laura Langer PT, DPT, OCS FAAOMPT; Fernando Malaman, PT, DPT, OCS, FAAOMPT; Nata Salvatori, PT, DPT, OCS, SCS, FAAOMPT; Timothy Shreve, PT, OCS, FAAOMPT

**Low Back in the Geriatric Population**—Jacqueline Osborne, DPT, GCS, CEEAA; Raine Osborne, DPT, OCS, FAAOMPT; Lauren Nielsen, DPT, OCS, FAAOMPT; Robert H. Rowe, PT, DPT, DMT, MHS, FAAOMPT

**Adolescent Spine**—Anthony Carroll, PT, DPT, CSCS, OCS, FAAOMPT; Melissa Dreger, PT, DPT, OCS; Patrick O'Rourke, PT, DPT, OCS; Tara Jo Manal, PT, DPT, OCS, SCS, FAPTA

**Patient Educational Resources for the Spine Patient**—W. Gregory Seymour, PT, DPT, OCS; J. Megan Sions, DPT, PhD, OCS; Michael Palmer, PT, DPT, OCS; Tara Jo Manal, PT, DPT, OCS, SCS, FAPTA

**Supplement: 39 Patient Resource Pamphlets**

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ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

APTA American Physical Therapy Association

# Congratulations 2019 Awardees

The American Physical Therapy Association (APTA) has announced the 2019 Honors and Awards program recipients. The following members of the Academy of Orthopaedic Physical Therapy have been selected by APTA's Board of Directors to receive the following awards:

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***Chattanooga Research Award***
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Steven George, PT, PhD, FAPTA
Trevor A. Lentz, PT, PhD, MPH

***Federal Government Affairs Leadership Award***
Phil Tygiel, PT

***Helen J. Hislop Award for Outstanding Contributions to Professional Literature***
Linda R. Van Dillen, PT, PhD, FAPTA

***Humanitarian Award***
Janelle O'Connell, PT, DPT, PhD, ATC

***Margaret L. Moore Award for Outstanding New Academic Faculty Member***
Meryl J. Alappattu, PT, PhD

***Marian Williams Award for Research in Physical Therapy***
Jennifer E. Stevens-Lapsley, PT, MPT, PhD

***Outstanding Physical Therapist/Physical Therapist Assistant Team Award***
Kathy Swanick, PT, DPT
*Board Certified Orthopaedic Clinical Specialist*

***Societal Impact Award***
Alison McKenzie, PT, DPT, PhD, MA
Kim Dunleavy, PT, PhD
*Board Certified Orthopaedic Clinical Specialist*
Marc Scott Rubenstein, PT, DPT
Abdulhamid Banafa, SPT

***Minority Scholarship Award for Physical Therapists***
Abdulhamid Banafa, SPT

***Mary McMillan Scholarship Award for Student Physical Therapists***
Allyson Barys, SPT

Award recipients were recognized during the Honors & Awards Ceremony held at the NEXT 2019 Conference and Exposition in Chicago, Illinois, this past June.

# Wooden Book Reviews

**Rita Shapiro, PT, MA, DPT**
**Book Review Editor**

Book reviews are coordinated in collaboration with Doody Enterprises, Inc.

**Psychosocial Elements of Physical Therapy: The Connection of Body to Mind,** Slack Incorporated, 2019, $59.95
ISBN: 9781630915537, 276 pages, Soft Cover

Author: Johnson, Hannah, PT, DPT, GCS

**Description:** This is a guide to identifying and implementing psychosocial elements of care in physical therapy. It addresses self-care for physical therapists and strategies for interacting with students, colleagues, patients/clients, and their families and caregivers. **Purpose:** The author aims to pull together multiple concepts addressed in other books into one central source: psychological aspects of healthcare, patient-sensitive communication, psychological conditions, the interdisciplinary team, and caring for complex aging/geriatric patients. This is a worthy objective. The author cites APTA's Healthy People 2020 vision, which strives to reduce health disparities among various patient populations and to treat the whole person well. The book meets its objectives by presenting the information in a clear and concise format. Using the thread of the Physical Therapy Clinical Reasoning and Reflection Tool (PT-CRT) and clinical cases and providing opportunities for reflection at the end of each chapter help to reinforce important concepts and make the information applicable to real clinical practice. **Audience:** This is an excellent resource for physical therapy students, faculty teaching in various entry-level and post-professional physical therapy programs, clinical mentors, and practicing therapists. The author earned her clinical board specialist certification in geriatric physical therapy and is currently working on her PhD in Interdisciplinary Health Sciences. **Features:** The author does an exceptional job addressing mental health and burnout of clinicians in the first chapter, "Maintaining the Clinicians' Therapeutic Presence." She points out that managing one's own mental status is paramount for being able to care for patients' mental health. The chapter on the interdisciplinary/interprofessional team presents general principles, as well as information regarding team dysfunction and repair. These concepts are directly applied to a case study in which the patient's care and outcome are affected by defects in the team's collaboration, support, and resources. Further chapters address cultural competence within the therapy setting and general treatment information and resources, the latter being more specific to the aging and geriatric population. One chapter provides general information on mental illness while additional chapters specifically address anxiety, depressive, bipolar, schizophrenia spectrum, personality, neurocognitive (dementia), and substance use disorders. The last two chapters discuss chronic pain and illness and their effects on mental health, as well as the impacts of caregiving, domestic violence, abuse, and neglect. Appendixes include a directory of the extensive acronyms used throughout the book, a glossary of terms, and a list of tests and measures the book references. There also is a link to a website for faculty members with ancillary materials for teaching in a classroom setting. **Assessment:** This is an excellent resource and a comprehensive guide for physical therapy students as well as practicing physical therapists. The author meets the objective of compiling the available information regarding multiple separate but related topics into a single user-friendly book. I witnessed the development of a psychosocial issues course in an entry-level Doctor of Physical Therapy curriculum, and it proved to be a piecemeal task that required pooling information from a variety of sources, articles, book chapters, etc. This book is an efficient resource and concise delivery method for the vast amount of information that is needed to complete a student physical therapist's education.

*Amanda M. Blackmon, PT, DPT, OCS, CMTPT*
*Mercer University College of Pharmacy and Health Sciences*

**Ethics in Physical Therapy: A Case-Based Approach,** McGraw-Hill, 2018, $49
ISBN: 9780071823333, 188 pages, Soft Cover

Author: Kirsch, Nancy R., PT, DPT, PhD

**Description:** This practical book provides an overall review of ethics throughout healthcare, with specific attention to physical therapy, ethical clinical decision-making models, and cases exploring common ethical dilemmas to demonstrate reasoning in ethics. **Purpose:** The book presents a method of ethical decision-making and serves as a framework to understand ethical problems in modern practice. Cases allow for practice using the proposed ethical decision-making model. As technology, responsibilities of physical therapists, and institutional productivity demands evolve, clinicians encounter new ethical challenges, which require careful consideration to determine the ethical path of practice. **Audience:** This book is intended for students and practicing clinicians in physical therapy. It can also be a resource for those teaching ethics in physical therapy practice, particularly the cases for group presentation and discussion. The author has experience teaching ethics and is author of an ethics column in the APTA's PT in Motion magazine. **Features:** The first of the book's two parts covers ethics in healthcare and how the ethical practice of physical therapy fits into this broader category. Part one also discusses professionalism, risks for ethical misconduct, the code of ethics by the APTA, and ethical decision-making models. Each chapter in part one ends with a section, "Ideas to Consider," which includes multiple choice questions for review. Part two, on types of ethical decisions, reviews the decision-making model through case analysis. Each chapter has a worksheet to help provide structure and consistency in case analysis. In addition, each chapter ends with a section, "Consider and Reflect," which prompts readers to consider the perspectives of all involved parties. **Assessment:** The book's format is useful for practicing clinicians as it provides a structure to help them make a decision when there is an ethical question. Students will find the most useful part of the book to be the cases, which apply the ethical decision-making models and the published Code of Ethics by the APTA.

*Monique Serpas, PT, DPT, OCS*
*Southeast Louisiana Veterans Health Care System*

**Educating Physical Therapists,** Slack Incorporated, 2019, $54.95
ISBN: 9781630914110, 283 pages, Soft Cover

Author: Jensen, Gail M., PT, PhD, FAPTA, FNAP; Mostrom, Elizabeth, PT, PhD, FAPTA; Hack, Laurita M., PT, DPT, MBA, PhD, FAPTA; Nordstrom, Terrence, PT, EdD, FAPTA, FNAP; Gwyer, Jan, PT, PhD, FAPTA

**Description:** Experts in physical therapy education, practice patterns, and ethics wrote this innovative book, based on their intensive four-year study: "Physical Therapy Education for the Twenty First Century: Innovation and Excellence in Physical Therapist Education Academic and Clinical Education." Their book provides a comprehensive discussion of the current state of physical therapy professional education. **Purpose:** Cathy Worthington performed the last extensive study of U.S. physical therapy education in 1960. The authors of this book found that the changes to the physical therapy profession over the past 50 years created a need to study the current physical therapy curriculum. The study has allowed the authors to provide recommendations for current programs and to inspire changes for the quality of physical therapy education in the future. The authors have accomplished their intentions for the book. They successfully provide a detailed description of their methods, a discussion of their conclusions, and examples of outstanding educational programs. Based on their conclusions, they developed a Conceptual Model of Excellence in Physical Therapy. They also promote discussion and analysis pertaining to advancing physical therapy professional education in the future. **Audience:** The authors promote discussion within the physical therapy academic and clinical education communities as well as other professionals interested in promoting education for physical therapists. This book will be useful for physical therapy organizational leadership, designers of residency programs, and clinical educators who want to promote a positive learning environment and cultural excellence. **Features:** The authors based their research on the Carnegie Foundation for the Advancement of Teaching studies performed in the 2000s. The authors studied six outstanding examples of graduate level physical therapy education programs as well as clinical education sites and residency programs. Recommendations by the authors include changes in academic and organizational structures, leadership styles, educational finance recommendations and many other paradigms to promote a culture of excellence and to protect the future of physical therapy through improved education. The first of the book's four sections provides a historical background on physical therapy education over the last 100 years, and the history of the Carnegie Foundation for the Advancement of Teaching Studies. The second section provides details of the study's design, methods, results, and conclusions while introducing the Conceptual Model of Excellence in physical therapy education. The next section provides 30 recommendations for educational modifications to promote positive change for future physical therapy professionals. The final section contains contributions from respected physical therapists who craft a positive vision of physical therapy education and the physical therapy profession in the future. **Assessment:** This is a must-read book for physical therapy academic professionals, clinical educators, clinic managers, or organizations trying to develop clinical and organizational excellence in physical therapy or physical therapy educational programing. The authors present an extensive re-imagining of the physical therapy educational system to address the current and future needs of the profession. The authors make recommendations from their extensive study and experience to promote positive changes within organizational, leadership, and educational structures to promote excellence as the common mission.

*Jennifer Hoffman, PT, DPT, OCS*
*Select Rehabilitation*

**Evidence Based Physical Therapy,** 2nd Edition, F. A. Davis Company Publishers, 2019, $69.95
ISBN: 9780803661158, 224 pages, Soft Cover

Author: Fetters, Linda, PhD, PT, FAPTA; Tilson, Julie, PT, DPT, MS

**Description:** This is the second edition of a comprehensive book on evidence-based practice (EBP) for physical therapy. The authors discuss how to use search engines, the use and interpretation of statistics in research, and how evidence can be applied in the clinical setting. The book includes plentiful illustrations, graphs, charts, and other visual aids to help in understanding of a challenging subject. The first edition was published in 2012. **Purpose:** According to the authors, the purpose is "to provide sufficient information to guide the development of the necessary skills to become an independent evidence-based practitioner." It easy to become inundated and overwhelmed by the research published on a daily basis. To remain current, many therapists use services that compile summaries of the research and send it directly to them. However, without an analytic method to critique the content, therapists could misinterpret findings or find themselves in a state of information overload. This book can help clinicians interpret research pertinent to their practice. Numerous learning exercises are provided to help readers develop the skills needed. This is a crucial as new research must constantly be applied to clinical practice. **Audience:** This intended audience is physical therapy students and clinicians who want to practice evidence-based physical therapy. The material applies to many different patient populations and the book will meet the needs of practitioners in many different specialties. Both authors are professors at the Division of Biokinesiology and Physical Therapy at the University of Southern California. Dr. Fetters is a Catherine Worthingham Fellow of the APTA and has been a clinician, published researcher, and is currently the Editor-in-Chief of *Pediatric Physical Therapy*. Dr. Tilson teaches EBP at USC's DPT program as well as to clinicians nationally and internationally. She is the Director of USC's hybrid DPT program and is the President of the Section on Research of the APTA. She is board-certified in neurologic physical therapy. Both authors have numerous published articles in peer-reviewed publications. **Features:** This book covers all aspects EBP from how to identify a need for information; how to conduct a search; how to appraise the evidence found for its quality and applicability; how to integrate the research with clinical expertise and the patient's values; and how to evaluate the clinician's efforts and how the clinician could improve. Each of these topics is presented in dedicated sections. Outcome measures, clinical prediction rules, and clinical practice guidelines are discussed in detail, along with how they can be implemented. An underlying concept that is a major theme throughout the book is the implementation of principles of EBP into clinical practice. The numerous case studies, practice scenarios, and self-tests support this effort and it is one of the strengths of the book. Chapter 2, "Asking a Clinical Question and Searching for Research Evidence," is especially enlightening as it discusses numerous search engines in detail to help readers navigate these tools efficiently. This includes many helpful how-to tips, such as setting up a private library within PubMed. The appendix includes tables that enable readers to assess the quality and applicability for interventional, diagnostic, prognostic, systematic reviews, clinical practice guidelines, and outcome measures, which are very thorough and easy to use. **Assessment:** This updated edition is timely and warranted. Much new information has come out since the first edition was published in 2012. The authors have also taken advantage of feedback from students who have used the book. This is a valuable addition to the physical therapy field. It has a comprehensive explanation of key concepts and methods to analyze the plethora of information that clinicians can be exposed to, whether in continuing education courses or in the literature. This book is intended to help entry level physical therapy students substantiate their clinical practice by using the principles of EBP to guide their practice. The authors have provided such a book to meet this lifelong learning need.

*Jeff B. Yaver, PT*
*University of Florida Health, Jacksonville*

## PRESIDENT'S MESSAGE

*Rick Wickstrom, PT, DPT, CPE*

The OHSIG has breaking news! APTA obtained a 5/26/2018 letter of clarification from OSHA to establish that all forms of soft tissue massage performed by physical therapy professionals are considered first aid for record keeping purposes. This was a collaborative effort by our OHSIG, APTA Government Affairs, and the Private Practice Section. I want to acknowledge the volunteer contribution by 3 OHSIG members who flew in to meet with OSHA officials: Lorena Payne, Drew Blossen, and Curt DeWeeze. This letter supports direct contracting by physical therapists with the industry. For more information about this initiative, see http://www.apta.org/PTinMotion/News/2019/06/05/OSHAMassagePTs.

Last month, we got a fantastic response to the launch of our mentorship program that is led by our Communications Chair, Caroline Furtak. Our Work Rehab CPG Writing Team led by Lorena Payne is now wrapping up the quality review of additional articles identified in an updated literature search. We have launched a new subcommittee to review Current Concepts in Regulatory Compliance for occupational health. The OHSIG is forming two new standing committee's for Practice/Reimbursement and Membership. If you are interested in serving on either of these committees, please contact any member of our nominating committee.

Next, I would like to put out a call for OHSIG members to share best practice examples from your state on our closed Facebook page that we can leverage to improve the practice environment for physical therapy professionals in occupational health. For example, did you know that Washington State Labor and Industries created special codes for functional capacity evaluations (FCEs), telehealth conferences, and functional job analyses? Washington State has established quality expectations for physical and occupational therapists when performing a complex functional capacity evaluation. They have also designed a useful functional job analysis form that may be downloaded from their website at the following link: https://www.lni.wa.gov/ClaimsIns/Voc/BackToWork/JobAnalysis/default.asp. The most exciting feature of the Washington State Job Analysis form is that the last page contains a release to return the worker to full duty or back to work with restrictions that may be certified by the treating physical therapist/occupational therapist or an independent FCE Examiner!

Finally, in this issue of *Orthopaedic Physical Therapy Practice*, the OHSIG is pleased to introduce a review article about the Chester Step Test (CST). Mindy Renfro, PT, DPT, PhD, and her physical therapy students at Touro University Nevada volunteered to review the Chester Step Test for inclusion in our PTNow database of tests and measures after a suggestion was made to include functional capacity performance measures in PTNow that are relevant to occupational health practice. This review article led by "Team Touro" is the first "fruit" to emerge from this request. It was truly a pleasure to collaborate with Mindy and her group of students on this article. You will discover that the CST has some advantages over self-paced walk tests to help bridge the gap between wellness and rehabilitation. Enjoy!

# The Chester Step Test: A Graded Performance Measure of Aerobic Capacity for Physical Therapy

*Mindy Oxman Renfro, PT, DPT, PhD[1]; Rick Wickstrom, PT, DPT, CPE[2]; Emigdio Angeles, SPT[1]; Colton Cardon, SPT[1]; Madison Ho, SPT[1]; Andrea Valdez, SPT[1]; Dallan Valle, SPT[1]*

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## BACKGROUND

In rehabilitation, an array of factors must be considered to ensure that interventions prescribed lead to desired outcomes. One factor that is crucial to evaluation and progression of physical therapy clients is ensuring that appropriate tasks are prescribed to challenge the fitness of cardiorespiratory and musculoskeletal systems. Failing to challenge a client's abilities leads to inadequate gains, while overworking may lead to fatigue and injury.[1] A hot topic in rehabilitation practice is finding a quick, efficient, and low-cost test of cardiorespiratory fitness (CRF) that is reliable and valid. Low CRF is a stronger predictor of all-cause mortality and cardiovascular events than risk factors such as physical inactivity, obesity, smoking, hypertension, abnormal lipids, and diabetes mellitus.[2,3] Maximum oxygen consumption ($VO_2$max) is often estimated less costly submaximal exercise tests to prescribe suitable physical activity or classify fitness based on normative results for healthy adults.[4]

The Chester Step Test (CST) is a simple, submaximal test of aerobic capacity that was originally designed by Kevin Sykes to predict maximal aerobic power, based on the heart rate responses to progressive workloads.[5] The CST is a versatile step test that has been used in a broad range of fitness and clinical applications that include (1) tracking of changes in aerobic fitness in healthy adults,[6] (2) assessing of fitness-for-duty of disaster deployment personnel,[7] and (3) assessing of exercise capacity in patients with chronic lung disease.[8] The CST protocol allows the examiner to choose a suitable fixed step height that ranges from 15 cm (6") to 30 cm (12"), based on factors such as age, functional capacity, activity level, height, and obesity. The subject steps on and off the step platform (Figure 1) in cadence with a metronome beat that is increased by 5 steps per minute at each 2-minute stage (15, 20, 25, 30, and 35 steps per minute). Heart rate (HR) and rating of perceived exertion (RPE) are measured at the end of each stage to assess the participant's response to each incremental workload. Step pace is increased with each stage, until individuals reach 80% of their predicted HR maximum (based on 220-age), reports an RPE ≥ 14 using the 6 to 20 Borg scale,[9] or completes all 5 stages in a 10-minute period. The CST uses the ACSM stair-stepping equation to estimate the workload oxygen cost ($mlO_2$/kg/min) for the step height and pace at each stage.[10] A visual or statistical line of best fit is drawn using datapoints for HR (y-axis) and workload (x-axis) that is extended up to maximum HR to estimate maximum aerobic capacity ($mlO_2$/kg/min) from the x-axis.[5]

**Figure 1. Chester Step Test administration.**

## PURPOSE

The purpose of this literature review is to assess the validity and reliability of the CST as a tool for assessing aerobic capacity of individuals during physical therapy care. This review was requested to provide useful information about CST for practicing clinicians in the PTNow website of Tests and Measures of the American Physical Therapy Association (APTA).

## METHODS

### Search Strategy and Selection Criteria

The literature search was conducted in the databases CINAHL, Cochrane Library, Embase, Google Scholar, PTNow, PubMed, Scopus, and SPORTDiscus. The search terms used included "Chester step test", Chester step test, "Chester step test" AND $VO_2$max AND aerobic capacity AND cardiorespiratory fitness. The searches were completed in January 2019 by five reviewers (EA, CC, MH, AV, and DV). Search filters were used with Google Scholar and PTNow, which limited results to more recent literature from 2010-2019 and 2003-2019, respectively. The reviewers independently screened the titles and abstracts of the acquired articles to determine if they met the inclusion and exclusion criteria. After duplicate articles were extracted and inclusion and exclusion criteria were assessed, 22 relevant articles remained. Studies were included if (1) they analyzed the validity or reliability of the CST, (2) access was available to the full text article, (3) subjects were adults age 18+, and (4) the article was published in English in a peer-reviewed journal. Articles were excluded if the CST was not studied. Reference lists of included articles were also screened for other applicable articles.

### Quality Assessment

A two-step process was used to appraise the selected articles. The appraisal tool of 11 questions from *Evidence Based Physical Therapy* by Fetters and Tilson[11] was used to assess article quality and applicability. The total score for each article varied depending on the number of questions applicable to the article. If a question was inapplicable, it was removed from the total score. Therefore, some articles were rated out of a total score of 11 and other articles were rated out of a total score of less than 11. Each article was appraised by two independent reviewers, who then compared scores. Disagreements between scores were resolved through consensus and a third-party adjudication. Articles that did not fit inclusion criteria were removed.

## FINDINGS

Thirteen articles (Table 1) were identified as appropriate based on inclusion and exclusion criteria.[5,12-23] These articles were high quality based on the reviewers' appraisal and the ratings ranged from 62.5% to 100%. The samples described in the articles involved various populations, such as healthy adults, university students, steel workers, and patients with lung diseases. Sample sizes in the studies ranged from 13 to 171 subjects. The studies were conducted internationally in countries including the United Kingdom, Brazil, Australia, United States, and Iran.

Step heights used in these studies for the CST ranged from 17 cm (7") to 30 cm (12"). In studies of patients with chronic obstructive pulmonary disease (COPD) or lung diseases, the step height was lowered to 17 cm (7")[20] or 20 cm (8").[12,14-16,19] A 30 cm (12") step height was used in studies looking at healthy subjects or university students.[5,10]

Criteria for stopping the test varied somewhat between studies:

- When the subject obtained 80% to 90% of age predicted HRmax[5,13,17-18, 20,23]
- When $SpO_2$ levels dropped below 84% to 88%[14,19]
- The subject was unable to maintain pace with the metronome[12,14,15,19,20]
- The subject reported symptoms of dyspnea or fatigue[12,14,15,19,20]
- One study[20] used a different equation to predict maximum HR = 210-(0.65*age)

If a subject experienced any of the above criteria, then the test was terminated, and the subject would not continue onto the next stage of the CST. Subjects who were able to complete all 5 stages of the CST were tested for a maximum duration of 10 minutes.

Many of the studies found the CST to be a reliable tool for assessing CRF.[5,13-15,23] Sykes and Roberts,[5] Buckley et al,[13] and Saremi et al[23] concluded that the CST is a reliable test for assessing aerobic capacity among healthy subjects. The CST has been found to be reliable for assessing aerobic capacity in patients with bronchiectasis and COPD.[14,15]

In addition to assessing CRF, the CST can be used to assess functional performance and fitness levels.[18-20] Several studies found that the CST can assess functional capacity in patients with COPD and acute lung diseases.[19,20] Karloh et al[20] found that CST was significantly correlated with TShuttle (r=0.67) and the Six Minute Walk Test (6MWT) (r=0.83), which require more space to administer. Several studies used the total number of steps completed on the CST at a lower 20 cm (8") step height as the main outcome measure for COPD patients.[12,14,16,19] Total steps were found to be highly reliable and correlated with 6MWT results. Several studies evaluated a modified pacing protocol to reduce the initial pace to 10 steps per minute and provide for a more gradual progression of 1 step every 30 seconds with COPD patients.[12,14-16] Gray et al[18] found that male steel workers with lower CRF based on the CST were more likely to have greater cardiovascular disease risk. Additionally, this study provides evidence that the CST has good prognostic value for prediction of cardiovascular disease.[18]

**Table 1. Studies Included in this Review**

| Study Reference | Sample [Country] | Step Height | CST Procedure/Modifications | Reliability |
|---|---|---|---|---|
| Andrade et al 2012[12] | 32 subjects with COPD (ages 67±8) with COPD [Brazil] | 20 cm | a. Main outcome was NOS performed.<br>b. Stopped test when participant was unable to maintain step pace, dyspnea, or fatigue.<br>c. Substituted Borg 0-10 category ratio scale to assess dyspnea and lower limb fatigue. | MIST and CST showed similar cardiopulmonary responses and exertion effort at peak exercise.<br>CST Test-retest HR (ICC 0.88), $SpO_2$% (ICC 0.91), NOS (0.99). |
| Buckley et al 2003[13] | 13 healthy university students (age 22.4±4.6, 7 males) [UK] | 30 cm | Only change was that end point of test was increased to 90% predicted HRmax and/or RPE 17. | CST is reliable for test-retest assessment of aerobic fitness in healthy young adults. Recommended a practice trial to improve RPE and %HRmax correlation and not using datapoints for Stage 1. |
| Camargo et al 2011[14] | 17 patients (6 men, age 52±17) with bronchiectasis (BCT) [Brazil] | 20 cm | a. Main outcome was NOS performed.<br>b. Stopped test when participant was unable to maintain step rate, $SpO_2$ <88%, dyspnea, or fatigue.<br>c. Substituted Borg 0-10 category ratio scale to assess dyspnea and lower limb fatigue. | Test-retest for NOS highly reproducible (66±41 steps, 68±41 steps) |
| Camargo et al 2013[15] | 17 patients with bronchiectasis [Brazil] | 20 cm | a. Main outcome was NOS performed.<br>b. Stopped test when participant was unable to maintain step pace, $SpO_2$ <88%, dyspnea, or fatigue.<br>c. Substituted Borg 0-10 category ratio scale to assess dyspnea and lower limb fatigue. | CST and MIST were reliable in BCT patients. Test-retest reliability for CST was: HR (ICC 0.88), $SpO_2$% (ICC 0.91), and NOS (0.99). Test-retest means for NOS was similar for CST (124±65 and 125±67) and MIST (158±83 and 156±76). No difference between MIST and CST for cardiopulmonary responses and exertion at peak exercise level. |
| Dal Corso S et al 2013[16] | 34 patients (age 67±9) with COPD [Brazil] | 20 cm | a. Main outcome: Vertical distance calculates by multiplying step height by NOS.<br>b. Symptom-limited IST is a modification to CST with lower initial step rate (10 steps/min) and pace increased by 1 step/min every 30 sec. Allowed handrail. Stopped with intolerable dyspnea, fatigue, or pace.<br>c. Substituted Borg 0-10 category ratio scale to assess dyspnea and lower limb fatigue. | IST test-retest was highly reproducible 2-5 days later with NOS (ICC 0.98), VO2 (ICC 0.99), VE (ICC 0.97), HR (ICC 0.92), $SpO_2$ (ICC 0.96). Most had better performance on IST2. |
| Elliot D et al 2006[17] | 25 healthy subjects [UK] | Not specified | CST performed with active and passive arm action on separate occasions. | Not stated. |
| Gray et al 2016[18] | 81 male steel workers [UK] | Not specified | | |
| Jose and Dal Corso 2016[19] | 77 patients with acute lung diseases and 20 healthy subjects [Brazil] | 20 cm | a. Main outcome: NOS.<br>b. Substituted Borg 0-10 category ratio scale.<br>c. Test ended when participant had dyspnea, fatigue, unable to maintain pace, or $SpO_2$ < 84%. | N/A |
| Karloh et al 2013[20] | 10 patients with COPD and 10 healthy sedentary subjects (age 63±7 [Brazil] | 17 cm | a. Test stopped when subject could not keep pace, showed limiting symptoms, or reached 90% predicted HRmax, calculated with 210-(0.65*age).<br>b. Substituted Borg 0-10 category ratio scale to assess dyspnea. | N/A |

| Validity |
| --- |
| Exercise tolerance (test time) higher in MIST (6.1±2.2 min) compared to CST (8.8±2.8 min). Similar correlation for NOS with 6MWT distance for CST NOS (r=0.72) and MIST (r=0.80). Similar correlation for NOS with FEV1 for CST (r=0.62) and MIST (r=0.66). |
| Questionable validity in predicting $VO_2$max. Estimated vs. actual maximum $VO_2$ show errors ranging from 11 to 17%. Age-estimated HRmax significantly overestimated actual HRmax by a mean of 5 beats/min. CST1 underestimated actual $VO_2$max by 2.8 ml/kg/min (p=0.006) and CST2 by 1.6ml/kg/min (not significant). |
| NOS correlates with FEV1 (r=0.43), 6MWT distance (r=0.60), and incremental cycling test (r=0.69). |
| CST compared with 6MWT and MIST with lower initial step rate and pace increased by 1 step/min every 30 sec. Better exercise tolerance (test time) for MIST (8.6±3.0 min) than for CST (6.0±2.2 min). Similar correlation with 6MWT distance for CST NOS (r=0.72) and MIST (r=0.80). Similar correlation for CST NOS with FEV1 for CST (r=0.62) and MIST (r=0.66). |
| NOS and weight explained 80% of variance in peak V02. IST elicits maximal cardiopulmonary and metabolic responses and is well-tolerated. Peak $VO_2$ was higher for IST1 and IST2 (1.19±0.39 L, 1.20±0.40 L) than cycling (1.07±0.35 L) with no difference in ventilation, HR, or RPE responses. |
| Active arm action during CST had no significant impact on predicted $VO_2$max, but did increase Heart Rate by about 7 beats/min across all stages. |
| CST can be used for cardiorespiratory fitness testing for prediction of cardiovascular disease. CRF level of 34.5 ml/kg/min identified persons over QRISK2 threshold with sensitivity (0.80) and specificity (0.687). Five times higher cardiovascular risk for Average-Below Average vs. Good-Excellent fitness classification. |
| Number of steps of CST and MIST were similarly correlated with length of hospitalization, lung function, dyspnea, and 6MWT (r=0.59, r=0.64). CST and MIST are safe and can be used to assess functional capacity in patients hospitalized for acute lung diseases. |
| CST is valid for assessment of functional capacity of COPD patients and distinguished between performances of COPD patients and healthy subjects. CST correlated with TShuttle (r=0.67) and 6MWT (r=0.83). |

*(Continued on page 176)*

Several studies have evaluated the validity of the CST in estimating $VO_2$max.[5,13,23] The study by Sykes and Roberts[5] found there is a high correlation between $VO_2$max and the CST; therefore, this suggests that the CST can be used to estimate $VO_2$max. Additionally, Saremi et al[23] found that the CST is a valid test for estimating cardiorespiratory capacity among university students that was significantly correlated (r=0.868) with actual $VO_2$max as calculated by the Astrand-rhyming cycle ergometer test. Buckley et al[13] used the same CST procedure as the one outlined in Sykes and Roberts's[5] study, with the only difference being that Buckley et al[13] changed the end point of the test to 90% of predicted HRmax and/or RPE 17 (out of 20) to get vital sign measurements for $VO_2$max estimation from as many stages of the CST as possible. Despite using the same CST procedure, Buckley et al[13] found the validity of the CST to estimate $VO_2$max to be questionable. These two studies demonstrate conflicting evidence regarding the validity of the CST.[5,13]

## CLINICAL RELEVANCE

The reliability, validity, versatility, and low cost of the CST makes it an attractive option for many clinical settings. The CST provides many advantages over other step tests[6] and self-paced walking tests due to the option to adjust the step height based on an individual's fitness, use of a small evaluation space, external pacing, and short completion time. The CST can be performed safely in a small clinic room, at home, the workplace, and other community settings.

Many studies used to establish the reliability and validity of the CST were performed on young, healthy participants who were able to tolerate the intensity of the 30 cm (12") step. Physical therapists performing the CST must use sound clinical judgment when deciding what step height and increment of cadence to use with each patient. Three modifications to accommodate less-fit populations include:

1. **Step Height:** Lower steps of 15 cm (6") and 20 cm (8") may be used to provide accurate data while increasing patient safety for patients in hospital settings or those with chronic diseases. A higher step of 40 cm (16") may provide a greater physical challenge for fitter athletes. A much lower step of 10 cm (4") would be an alternative to consider to accommodate patients with more severe obesity, lower extremity impairments, or cardiopulmonary impairments.
2. **Testing Intervals:** One concern with the CST in less athletic individuals is the rigor of keeping up with the two-minute phases. Reducing these 5 two-minute phases into 10 one-minute phases is less strenuous on those with respiratory issues or other frailties. This would also make findings more sensitive, giving better estimates of CRF or highest workload completed.[15]
3. **Activity Prescription:** The CST is an incremental functional performance test of aerobic capacity that may be used to assess readiness for physical activity.[19-20] The predicted maximum $VO_2$ and peak workload level that was performed on the CST may be compared to representative aerobic demands of specific occupation or lifestyle tasks that are contained in ACSM's Guidelines for Exercise Testing and Prescription.[4] For example, Table 1.1 in the ACSM Guidelines reports that the metabolic equivalent for mowing the grass with a push mower is 5.5 METs. Table 2 may be used to look up the peak workload achieved by a client, based on the highest accept-

OCCUPATIONAL HEALTH

**Table 1. Studies Included in this Review** *(continued from page 175)*

| Study Reference | Sample [Country] | Step Height | CST Procedure/Modifications | Reliability |
|---|---|---|---|---|
| Lau HM, et al 2005[21] | 171 patients (ages 37±12, 60 men) with SARS [Australia] | Not stated | None stated. | N/A |
| Lau HM, Ng GY et al. 2005[22] | 133 SARS patients (62 Controls: age 38.3±11.2 n=62, 71 Exercise: age 35.9±9.3) | Not stated | None stated. | N/A |
| Saremi et al[23] | 63 (age 20.17±1.8, 29 male) university students [Iran] | Not stated | | Stepped to metronome at 15 steps/min with step rate increasing by 5 steps/min every 2 min. Max test duration 10 min. Test ended when subject showed signs of over-exhaustion or reached 85% HRmax. Step height unspecified. |
| Sykes and Roberts[5] | 68 healthy subjects [UK] | 30 cm | Standard protocol. | Mean difference of -0.7ml/kg/min between sessions. |

Abbreviations: CST, Chester step test; COPD, chronic obstructive pulmonary disease; NOS, number of steps; $SpO_2$, peripheral capillary oxygen consumption; MIST, modified incremental step test; HR, heart rate: ICC, interclass coefficient; 6MWT, 6 minute walk test; $FEV_1$, forced expiratory volume; HRmax, maximum heart rate; RPE, rate of perceived exertion; $VO_2$max, maximum oxygen consumption; BCT, bronchiectasis; $VO_2$, oxygen consumption; VE,ventilatory efficiency; CRF, cardiorespiratory fitness; QRISK2, cardiovascular disease risk algorithm; SARS, Severe Acute Respiratory Syndrome

able pace completed for a given step height. A client who only achieves a peak workload of 3.94 METs for stepping at 15 steps per minute to a 20 cm (8-in) step platform is not ready to perform this task, but could be cleared to perform light household chores that require 2.0-2.5 METs.

4. **Heart Rate Effects Due to Age, Medication, or Pain:** The 220-age method to estimate maximum HR has been shown to underestimate $VO_2$max results for older adults.[24] Gellish et al[25] recommended 220 – (0.7 * age) to estimate maximum HR for healthy adults. One of the limitations with using HR for extrapolation is that medications such as betablockers may lower the HR response, resulting in overprediction of aerobic capacity. Brauner et al[26] recommended 164 – (0.7 * age) to estimate maximum HR for patients with coronary artery disease on beta-blocker medications. Another challenge for orthopaedic patients is that pain may not allow a sufficient HR response for a valid prediction of $VO_2$max. While medications or musculoskeletal symptoms may invalidate prediction of $VO_2$max, workload at the highest stage completed and HR/RPE responses still provides useful functional performance data to justify therapy progress or readiness for physical activity.

It is recommended that the test be performed as instructed whenever possible. Deviations from the CST's original protocol[5] may compromise its validity and reliability. However, researchers have shown that modifying the workload progression of the CST with COPD patients resulted in equivalent cardiopulmonary stress at exertion at the peak exercise level.[12] This validates the use of functional performance outcomes such as total number of steps or peak workload completed to assess improvements in CRF and weight-bearing exercise tolerance. Figure 2 illustrates how modification of step height may be used to provide a different workload progression for clients based on whether recent physical activity level was vigorous, moderate, or inactive. Choosing a suitable step height allows the clinician a simple and inexpensive way for a clini-

**Table 2. Workloads for Step Test in METs at Different Combinations of Step Pace and Height[10]**

| | | Step Height | |
|---|---|---|---|
| **Step Pace** | 10cm (4in) | 20cm (8in) | 30cm (12in) |
| 35 | 5.43 | 7.86 | 10.3 |
| 32.5 | 5.12 | 7.37 | 9.63 |
| 30 | 4.80 | 6.88 | 8.97 |
| 27.5 | 4.48 | 6.39 | 8.3 |
| 25 | 4.17 | 5.90 | 7.64 |
| 22.5 | 3.85 | 5.41 | 6.98 |
| 20 | 3.53 | 4.92 | 6.31 |
| 17.5 | 3.22 | 4.43 | 5.65 |
| 15 | 2.90 | 3.94 | 4.98 |
| 12.5 | 2.58 | 3.45 | 4.32 |
| 10 | 2.27 | 2.96 | 3.66 |
| (steps/min) | METs | METs | METs |
| Workload METs = [3.5 + (0.2 x steps/min) + (1.33 x 1.8 x Step Height (cm) x 0.01cm/m x steps/min)]/3.5 | | | |

| Validity |
| --- |
| Values of predicted maximum $VO_2$ (mL*kg-1*min-1) lower for significantly lower for SARS patients than normative data (43 Men: 38.47±7.39, 91 women: 36.12±7.42). 41% completed all 5 levels of CST. |
| Randomized Controlled Trial revealed significant improvement for exercise group compared to control for CST predicted $VO_2$ (3.6±5.4), six-minute walk distance, hand grip, curl-up, and push-up. |
| CST is a valid and reliable test for estimating cardiorespiratory capacity among university students. |
| High overall correlation (r=0.092) for predicted with directly measured $VO_2$max from a graded treadmill test with a standard error of predicted CST1 of ±3.9 ml/kg/min. |
| |

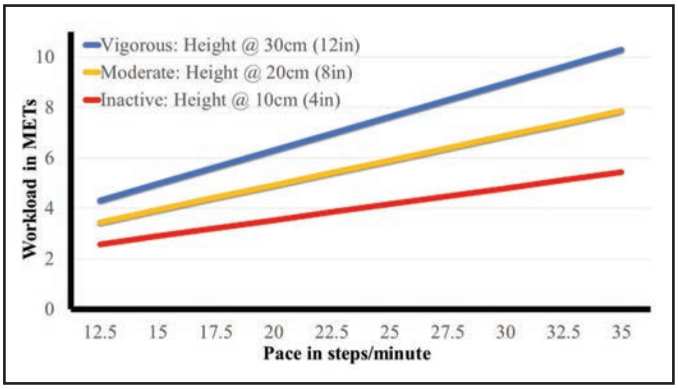


**Figure 2. Effect of step height on workload progression.**

cian to assess functional progress and readiness for more weight-bearing physical activity.

## CONCLUSIONS

This review of the literature supports the use of the CST as a reliable and valid measure of functional performance for physical therapy practice. The CST offers many advantages over other aerobic fitness tests that include low cost, portability, minimal space requirements, brief administration time, adjustable step heights based on fitness status, and standardized pacing progression.

Although most of the research for the CST has been done with healthy adults and patients with cardiopulmonary conditions, the evidence reviewed suggests that the test would be a safe and relevant alternative to the 6MWT. It also suggests that the CST may be used as a functional performance test with patients that have orthopaedic and other health conditions, ranging from acute cardiopulmonary disease to high-functioning, physically active individuals. The CST allows the clinician to safely establish baseline CRF and observe how the patient tolerates and responds to increasing physical activity.

The reliability and validity of the CST to estimate $VO_2$max rely on normal HR response to increasing workloads. Common cardiorespiratory medications such as beta-blockers will inhibit the patient's heart rate response to increasing workload. This may limit their performance and cause the CST calculations to underestimate maximum cardiorespiratory function. Additionally, the performance of patients with lower extremity musculoskeletal impairments may reach mechanical limitations prior to their maximum aerobic capabilities. This may lead to the underestimation of their actual cardiorespiratory capacity. For this reason, clinicians must adjust the test to appropriately accommodate these variables.

The available literature on the CST indicates a number of possible areas for future research. These include validation of the CST as a measure of/with:

- specific functional capacities,
- modifications with a variety of patient populations,
- using the highest tolerated workload as an outcome measure of performance, and
- guidelines for concluding the test.

This literature review concludes that the CST is a valid and reliable clinical measure of aerobic capacity for physical therapists to use for a wide range of patients and settings. Its future study and expansion will benefit the profession as we investigate and establish the best tests and measures for evidence-based clinical practice.

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# President's Letter

*Annette Karim, PT, DPT, PhD*
*Board-certified Orthopaedic Clinical Specialist*
*Fellow of the American Academy of Orthopaedic Manual Physical Therapists*

As we look ahead to summer and prepare for the fall, I would like to encourage you to look at our mission and vision statements and then consider how you might participate at the leading edge of performing arts physical therapy. Leadership contact for areas of interest are listed at the end of this section.

### Mission Statement

The mission of the Performing Arts Special Interest Group (PASIG) is to be the leading physical therapy resource to the performing arts community.

### Vision Statement

Advancing knowledge and optimizing movement and health of the performing arts community through orthopaedic physical therapist practice through the following guiding principles:

- *Identity*
- *Quality*
- *Collaboration*

### Your Contribution

Would you consider submitting a literature review, critically-appraised topic, case report, or pilot study to the *OPTP*? This is a way to help others with evidence-informed practice. Please contact me if you are interested. Student submissions are welcome!

Perhaps you could help with updating the performing arts resource pages? The updates are in process and we could use more help. Contact Marissa Schaeffer if interested, https://www.orthopt.org/content/special-interest-groups/performing-arts/resources

Do you have an annotated bibliography or list of current literature on a research topic to contribute? Contact Sarah Edery-Altas for instructions on how to do this for the monthly citation blasts.

Are you interested in presenting a performing arts platform or poster at CSM 2020? Go for it!

The submission deadline is July 12, 2019. For more information, visit http://www.apta.org/CSM/Submissions/

If you are a student and your platform or poster gets accepted, let Anna Saunders know and you can apply for the PASIG student scholarship.

### A Look to the Future

Summer is a great time to write, rest, and plan for the next year, then the next 3, 5, and 10 years. Please feel free to contact me or any of our leaders with your ideas or to just say hello and introduce yourself. The PASIG leadership will have a conference call this summer to update our goals in regards to the strategic plan and to prepare for CSM. Therefore, this is an optimum time for you to weigh in on your interests with the respective leaders.

Students interested in mentorship please keep an eye out for an updated application in the fall via the Academy of Orthopaedic Physical Therapy. If you are interested, contact Megan Poll: meganpoll@gmail.com

Clinicians with board-certification or residency education, if you are looking for performing arts fellowship education, we now have four! We congratulate the following performing arts fellowship programs:

- The Ohio State University Sports Medicine Performing Arts Fellowship
- The Johns Hopkins Hospital Performing Arts Fellowship
- Harkness Center for Dance Injuries Performing Arts Fellowship
- Columbia University Irving Medical Center & West Side Dance Performing Arts Fellowship

If you are interested in developing a performing arts fellowship, the Description of Fellowship Practice is available online, and you should contact Laurel Abbruzzese.

http://www.abptrfe.org/uploadedFiles/ABPTRFEorg/For_Programs/DFPs/ABPTRFE_PerformingArtsFellowshipDFP.pdf#search=%22Performing%20Arts%22

For clinicians and academicians who are screening pre-professional dancers, collegiate dancers, and adolescent dancers, please contact Mandy Blackmon to connect with other folks doing the same.

For those interested in the issues, policies, and other items that influence how we practice performing arts physical therapy, contact Andrea Lasner.

### Finance Update

As of March 31, 2019, our non-rolling fund is $2,072.11 and our 2018 encumbered fund is $1,578.40.

Please take a few minutes to join our PASIG membership, free to all AOPT members. Frequently asked is if you can join anytime. Yes, you can, for both the AOPT and the PASIG.

https://www.orthopt.org/content/special-interest-groups/performing-arts/become-a-pasig-member

Then, go to our Facebook page and request to become a member.

https://www.facebook.com/groups/PT4PERFORMERS/

Thank you for joining us in the journey!

## HOW DOES IMPLEMENTATION SCIENCE APPLY TO FOOT AND ANKLE CARE?

*Jeffrey Houck, PT, PhD*

I am at the airport just wrapping up a day and a half of discussions at the *2019 CoHSTAR Implementation Science Institute* meeting. CoHSTAR stands for Center on Health Services Training and Research. The director is Linda Resnick, PT, PhD, Professor in the Department of Health Services, Policy and Practice in the Brown University School of Public Health and VA RR&D funded Research Career Scientist at the Providence VA Medical Center.

The conference focused on translating evidence-based interventions to practice. A theme of the meeting was the gap between evidence-based practice and the actual practice a physical therapist delivers. There were several compelling examples of good treatments that could benefit patients that therapists were hesitant or could not adopt for many practical reasons. I imagined many therapists wanting to implement a novel foot and ankle treatment that promises to really make an impact but wondering how a single therapist can make this happen. *I think we have all been there*. What are the steps? How do I get administration buy in? How do I get consensus from other therapists? Will patients and referring physicians really buy in? Will insurance companies pay for these new treatments? These are real challenges we all face and were included in the day and a half seminar. Several different frameworks to facilitate the conversion of evidence to practice were presented and discussed. Some standout examples we might consider for the FASIG were presented by Dr. Jennifer Moore on the knowledge to action (KA) framework[1,2] and Dr. Julie Tilson's physical therapist education for actionable knowledge (PEAK) translation.[3-5] Dr. Moore demonstrated that using the KA framework could be used to award grants to clinicians for implementation of *known* evidence-based strategies to improve clinical care. Dr. Tilson presented evidence that using the PEAK process engaged clinicians and that clinicians were committed to evidence-based care. Dr. Paterno also presented a focused process to achieve over 90% compliance with patient-reported outcomes in routine clinical care. This was especially impressive, because therapists appeared to change their beliefs associated with patient-reported outcomes. Initially, therapists had poor adoption (37%), likely believing these scales were redundant with standard physical therapy assessment. After, implementing knowledge translation approaches routine clinical practice incorporated these scales into clinical decision-making for greater than 90% of patient interactions. Therapists appeared to see these scales as representing a different, but important construct, compared to the routine physical assessments they were typically performing. As a clinician, researcher, and FASIG Vice President I took away several key important lessons from this conference. First, that good evidence of a treatment, prognostic factor, or diagnostic test does not assure that therapist adoption will occur. Second, there are important actions that the AOPT and special interest groups can take to facilitate implementation of key evidence-based treatments, prognostic factors, and/or diagnostic tests. Third, that clinicians, working in teams with appropriate facilitation and support of administration can be empowered to change everyday practice. The immediate mandate of the *2019 CoHSTAR Implementation Science Institute* meeting is that there is important work to do to implement evidence-based care for patients with foot and ankle problems. And, that clinician-initiated efforts working in collaboration with researchers and other stakeholders constitute the ideal team to lead these efforts. The FASIG is ideally positioned to engage clinicians and other stakeholders to lead these efforts.

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Editorial Note: 2019 CoHSTAR Implementation Science Institute was co-sponsored by the Foundation for Physical Therapy and the Academy of Orthopaedic Physical Therapy.

## President's Message

*Carolyn McManus, MPT, MA*

Through the spring and early summer, the Pain SIG (PSIG) Board has been working on strategic plan activities that support our mission to promote excellence in pain education, practice, research, engagement, and advocacy by physical therapy professionals. We have been devoting both time and energy specifically to action items associated with our Practice Goal to identify and promote best practice standards for pain management by physical therapists. Pain SIG VP/Education Chair, Mark Shepherd, DPT, OCS, coordinated our first in a series of webinars on pain topics. On May 8, Megan Pribyl, PT, CMPT, presented a webinar on the topic *Nutrition and Pain: Building Resilience through Nourishment*. Megan is a physical therapist and pelvic rehab specialist with degrees in both physical therapy and nutrition. The webinar received rave reviews. Her clinically relevant presentation provided an understanding and appreciation for the role of nutrition in rehabilitation. She discussed how nourishment status relates to health and healing and explored the connections between physical therapy, pain, and nutrition. If you missed the webinar, a recording has been posted on the PSIG website. In addition to the webinar recording, you will also find a lifestyle blog and a link to additional information on probiotics. We want to thank the wonderful AOPT Executive Associate, Tara Fredrickson, for all her behind-the-scenes logistical efforts that brought the program together. We are thrilled to have this format available to disseminate cutting edge pain education to our members. Topics under consideration for future webinars include Mechanisms of Pain, Educating Patients about Pain Science, and Screening for Risk of Chronic Pain.

Public Relations Chair, Derrick Sueki, PT, PhD, has continued efforts to advance our initiative to establish a pain specialty and residency/fellowship. Derrick has submitted a grant proposal to the AOPT board to provide funds for the initial phases of the process. Additionally, funds may be drawn from PSIG funds as needed for this project. The initial phase of the process involves the development of a practice survey and conducting a practice analysis based upon the survey results to determine whether there is a need for a Pain Specialization Certification and Residency/Fellowship process. Jean Bryan Coe, PT, DPT, PhD, has been secured as a consultant for the project and will assist us throughout the process. Currently, a task force is being formed to develop the survey and to analyze the results. Joe Donnelly, AOPT President and our Board Liaison, has reached out on our behalf to Presidents of other Academies/Sections requesting recommendations of therapists who should be included on this task force, as the scope of the project extends across multiple areas of specialty. Our membership and profession are extremely fortunate to have someone as dedicated and knowledgeable as Derrick taking the lead on this important project. Look to future President's Messages for further updates on this initiative.

In addition, Pain SIG Practice Chair, Craig Wassinger, PT, PhD, has continued his involvement in developing the Clinical Practice Guideline (CPG) for Patient Education/Counseling to Treat Pain. Most recently, Craig and the CPG team have been working on the data extraction and critical appraisal process for the primary questions for the CPG. A proposal was submitted to present the CPG at CSM 2020. If accepted, initial findings from the guideline will be presented at that time. It is anticipated a full draft will be in review or published in 2020.

I hope you have found our monthly Research and Clinical Pearl emails of interest. Bill Rubine, MPT, and I are always looking for experienced therapists to contribute their expertise by providing a Clinical Pearl to be shared with our members. Clinical Pearls reflect succinct, clinically relevant information drawn from your experience that can benefit patient care but may not be found in the medical literature. We would love to hear from you. Please send your suggestions for a Clinical Pearl to Bill at Rubineb@ohsu.edu or me at carolyn@carolynmcmanus.com. In addition, Dana Dailey, PT, PhD, Research Chair and coordinator of the Research emails, welcomes your ideas on topics for the Research emails. Please send your suggestions for a research topic to dana-dailey@uiowa.edu.

I would now like to introduce you to PSIG member, Janet Carscadden, PT, DPT, OCS, E-RYT. Janet received a Bachelor of Science degree in Physical Therapy from the University of Western Ontario, Canada in 1995 and completed her Doctoral Degree in Physical Therapy at Massachusetts General Hospital Institute of Health Professionals in 2014. From 1998 to 2006 she worked at the Spine Institute of New England where she served as clinical lead in their Interdisciplinary Chronic Pain Program. Janet is owner of Evolution PT and Yoga Studio Inc. in Burlington, VT, where she provides patient care informed by both evidence-based physical therapy and eastern-based yoga therapy methods. Janet has been a certified yoga instructor since 2006 and, in addition to patient care, she offers training and continuing education courses for health care providers in yoga. I want to thank Janet for contributing the following article, Yoga: An Ancient Practice as a New Approach for Chronic Pain.

## Yoga: An Ancient Practice as a New Approach for Chronic Pain

*Janet Carscadden, PT, DPT, OCS, E-RYT*

Chronic pain is perhaps one of the most frustrating conditions for health care providers to treat. The model used to train many of us was to identify a disease or injury by looking for mechanical or chemical causes of pain and then address those causes. We now have a better understanding of how changes in neural pathways, trauma, and psychological factors, not necessarily the amount of tissue damage, contributes to the chronic pain experience. Yoga is uniquely positioned as a useful treatment approach for chronic pain as it encompasses simple practices that are accessible to people of all abilities. Through breathing exercises, physical postures, and practices to train the mind, yoga helps to address the complex physical, psychological, and neurological components of chronic pain. This ancient technique dating back to 1500 BCE was practiced by ascetic monks in the forests and caves of the Himalayan region.[1] They are now being studied and integrated into health care centers around the world.

## Modern Yoga Therapy

Yoga teaches us how to regulate our breath and the nervous system, bring balance to the musculoskeletal system and focus the mind. These are all tools that physical therapists use to treat their patients. They fit neatly into the codes we use for billing including therapeutic exercise and neuromuscular re-education. There is a growing body of evidence to support the use of yoga for chronic pain. A systematic review and meta-analysis by Cramer et al in 2013 found strong evidence for short-term pain relief and reduction in disability and moderate evidence for long-term pain relief and reduction in disability in patients with chronic low back pain.[2] Cancer treatment centers have been some of the first clinics to include yoga in their treatment programs. A meta-analysis in 2011 on yoga for patients with cancer found that yoga interventions provided improved psychological health, and a reduction in anxiety, depression, distress, and stress.[3] A topical review in 2011 found that yoga can alter the pain experience and can produce behavioral changes that influence pain. Group classes performed in a social environment can reduce isolation. Psychological changes can occur that improve pain acceptance and positive emotions.[4]

## Yoga in a Physical Therapy Setting

A barrier to yoga for people with chronic pain is that they envision yoga as a practice that requires great flexibility and strength. In reality, yoga is incredibly accessible and can be adapted to most people's abilities (Figure 1).

**Figure 1. Modified shoulder stand.**

A yoga therapy session generally includes the following components:

- Centering - mindfulness exercises
- Pranayama - breath control exercises
- Asana - active or restorative yoga postures
- Systematic Relaxation - guided exercises to calm the nervous system
- Meditation - practices to focus the mind

## CENTERING

One of the differences between a traditional physical therapy session and yoga therapy is how a session is started. In physical therapy, we often start chatting with our patients, finding out about their day. Conversation plays an important role in learning more about how our patients are coping with their impairments but is also used to distract patients from their exercises, especially when they have to move through the pain. It is a social component of therapy that many patients enjoy. However, this prevents patients from learning how to perform techniques on their own at home. In chronic pain literature, there is a lot of interest in the neuroplasticity of the brain and the importance of using this ability to treat chronic pain.[5] The entire practice of yoga is a series of strategies that are used to help focus the mind. Each session begins with a centering exercise that comes often in the form of a mindfulness exercise. Common techniques include attention on the breath or systematically relaxing the body. When a session begins with centering, the patient is allowed to directly experience a safe, quiet space (Figure 2). Mindfulness exercises have been shown to have physiological effects such as reducing stress hormones and inflammatory markers in the body.[6] Prolonged exposure to stress has long-term negative health outcomes such as contributing to the risk for cardiovascular disease and metabolic syndrome.[6] Chronic stress is also associated with maladaptive neuroplastic brain changes that promote reactive rather than reflective behaviors.[7] In addition, these stress-associated brain changes overlap with brain changes observed in some chronic pain conditions.[8]

**Figure 2. Seated position with hips elevated for centering, pranayama, or meditation.**

## Pranayama - Breathing Exercises

In yoga, the breath is one of the most important methods that we can use to control the movement of energy in the body. In more traditional medical language, Pranayama could be understood as a means to regulate the balance between sympathetic and parasympathetic nervous system activity.

Teaching diaphragmatic breathing is a foundational technique as it can be performed in any position. However, it can be a challenging technique for some to learn. Lying on the belly with the floor in contact with the abdomen as in Figure 3 or alternately placing a folded blanket on one's own hands across the belly is a great strategy to provide feedback for diaphragmatic breath training. Slow breathing exercises at a rate of 6 to 10 breaths per minute have been shown to be the optimal level for a parasympathetic nervous system shift.[9] Once a relaxed breathing pattern is established, patients are encouraged to maintain relaxed breathing throughout their practice.

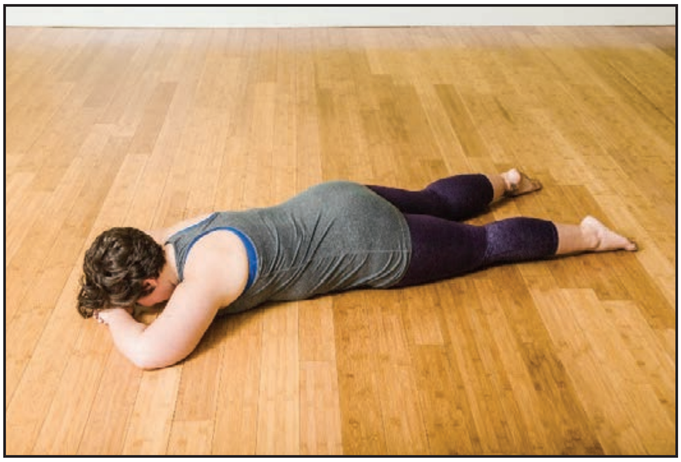

**Figure 3. Crocodile pose for diaphragmatic breath training.**

## Asana - Postures

Postures in yoga can be linked together into a flowing sequence in time with the breath. They can also be held for shorter or longer periods to improve flexibility and strength. Many postures have the added benefit of helping to improve balance. All of this is done with intention and focus on the breath. Patients who have not been exposed to yoga often visualize a yogi in a complicated pretzel like posture that requires incredible skill and years of practice. However, many techniques can be performed in a hospital bed, in a chair, or simply on the floor with a few blankets. The key is matching the technique to the needs of the patient. Restorative yoga can be a practice in itself or included in a sequence of postures. Rolled or folded blankets or bolsters are used to support the patient in a position that gently stretches the body or facilitates a particular breathing pattern. Figure 4 demonstrates a posture that facilitates chest breathing, lengthening the adductors, and improving external rotation of the hips. When the hands are moved to the belly, diaphragmatic breathing is encouraged.

**Figure 4. Reclined bound angle posture.**

One of the differences between the active postures in yoga and general stretching is that often the whole body is involved. In a downward facing dog, a staple of many yoga sequences, the entire back myofascial line of the body is lengthened. This posture requires upper body, lower body, and core strength. Downward dog illuminates how limitations in shoulder flexion and hamstring length can restrict the mobility of the thoracolumbar fascia. In people with hypermobility, this posture can be adapted to work on building strength. In the image sequence shown in Figures 5, one can see how the foundation for a downward dog is built on a wall with periscapular strength, shoulder, and hip flexibility, and transitioned to hands on a chair, then the patient can eventually be progressed to blocks or to the floor as appropriate.

This total body stretch is important to improve myofascial mobility. Thoracolumbar shear strain has been shown to be approximately 20% less in people with chronic low back pain.[10] This lack of movement may reduce functional mobility and contribute to movement impairments. Chronic low back pain is associated with motor control impairments due to multiple factors including prolonged fear-avoidance behavior.[11] Yoga is one strategy to offer graded motor activity that can be progressed over time in tandem with techniques such as breathing exercises to calm the sympathetic nervous system. Chair yoga can be used where motor control and balance retraining can be addressed. The chair is used to provide support to hold a posture or as a strategy to get a deeper stretch (Figure 6).

## Systematic Relaxation

Systematic relaxation is a component of a practice called Yoga Nidra or yogic sleep. The mind is given a series of tasks to improve its ability to focus. The goal is to attain a deep state of relaxation but remain awake and aware. In a yoga therapy session, it is easy to record a custom systematic relaxation program for patients that meet their specific needs of time and content. Content of the relaxation can be extremely important to avoid triggering terminology for those who have experienced trauma. Most people now have a smartphone or tablet that you can use to record a short systematic relaxation program that will work for them. The therapist can try out several different scripts and find out which strategy works best, then combine the scripts for optimal effect. There are many online or app-based programs that can be useful tools in guiding patients through relaxation exercises.[12] A recent systematic review found that e-Health based relaxation or mindfulness interventions had positive effects on physical functioning, disability, depression, and anxiety in subjects with chronic illnesses such as irritable bowel syndrome, chronic fatigue syndrome, cancer, chronic pain, surgery, and hypertension.[13] Systematic relaxation often starts with breath awareness and a body scan and may include progressive muscle relaxation and focusing on different points in the body. Patients are instructed to practice these techniques outside of their bedtime to learn to how to achieve a deep state of relaxation. Then when they have trouble falling asleep, if they wake up at night, or if they need a strategy to manage their pain during an acute pain episode, they have developed a skill that can be used effectively.

## Meditation

Everything that is done in a yoga therapy session is a preparation for perhaps the most important practice, meditation. Meditation is simple in its concept of learning to focus the mind but complex to master. The mind is constantly at work. The modern lifestyle is full of rapid stimulation that reduces one's ability to maintain focus for more than a few moments on one task. Meditation is not about emptying the mind but is about being fully present in the moment. Because of our addiction to screens and constant stimulation, it is being learned that our brains are becoming rewired in ways that affect the ability to manage stress and one's health. Meditation is perhaps the most studied of all of the yogic


**Figure 5. A, Forearms on wall. B, L-Shaped posture at wall. C, Downward dog with hands on a chair.**


**Figure 6. A, Half Moon pose. B, Chair cobra. C, Seated spinal twist.**

practices. There is evidence that meditation activates areas in the brain that are involved in self-regulation, problem solving, processing of self-relevant information, and adaptive behavior.[14] Meditation also appears to change the brain. Functional and structural brain modifications have been seen in areas of self-awareness and self-regulation, attention, executive functions, and memory formation.[14] Typically meditation is taught sitting with the spine erect, but meditation can be performed in any position, even in a hospital bed with lines in place. Here are 4 steps to meditation:

1. Find a comfortable position that can be maintained without movement and without falling asleep.
2. Scan the body from head to toe and allow any areas of holding or tension to release.
3. Move the attention to the breath at the belly. Allow the breath to occur naturally without trying to change it.
4. As the mind wanders, gently bring the focus back to the breath.

If being still is too challenging, a patient can perform meditation while walking. Walk slowly in a room in a circle or back and forth down a hallway. Walk at a slow, comfortable pace focusing on the contact the feet make with the earth. You may take several steps on each inhale or exhale. Allow a natural easy pattern to establish itself. In the beginning, just a few minutes can be incredibly challenging, but over time many people find that they can lengthen their period of meditation. Each of the yogic practices previously described build on each other to form the skill set needed for meditation.

### An Example Treatment Session Sequence From my Practice

I often start simply with a centering exercise, diaphragmatic breathing and 3 physical postures that address the physical issues found in the exam. I finish with a restorative posture and guided relaxation. The patient is provided with a handout to practice the sequence between sessions. Once the patient can complete the first sequence, I add a few postures, refine the breathing techniques, and then add meditation. An important component of the practice is to instruct patients to notice the before and after effects of each practice. If they are able to see even a small benefit, this direct experience helps to improve home program compliance. As with any technique, this author recommends that one seeks instruction in each of the practices and learns them before teaching them to a patient. There are many types of trainings for health care providers on how to integrate yoga into their treatment programs. This ancient practice is starting to be recognized as an effective, accessible, low risk strategy to treat chronic pain.

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**About the Author**

Janet Carscadden is the sole owner of Evolution Physical Therapy and Yoga Studio Inc, which offers training and continuing education courses for health care providers in yoga from which she has a financial interest.

# Revisiting the Imaging Education Manual

Are you affiliated with a physical therapy educational curriculum? Do you know if that curriculum is making use of the educational resources and recommendations available for informing future practitioners about imaging in physical therapy practice?

Boissonnault et al's study[1] published in 2014 revealed remarkable inconsistency in imaging content in educational curricula. The Imaging Education Manual was subsequently published in 2015 to provide guidance to educational curricula for imaging content. Instructional methodologies, examples of curricular content, and even sample exam questions are provided in the manual to assist faculty in preparation for incorporating imaging related content into respective curricula across the country.

The use of the structure and content provided in the manual are of value not only in entry-level educational curricula, but also helpful for residencies and fellowships incorporating imaging related clinical reasoning.

The Imaging Education Manual is available at orthopt.org under the Imaging SIG web page (left side bar). Students would also likely benefit from reading the "white paper" (linked in the same location) titled "Diagnostic and Procedural Imaging in Physical Therapist Practice" (2016).

## REFERENCE

1. Boissonnault WG, White DM, Carney S, Malin B, Smith W. Diagnostic and procedural imaging curricula in physical therapist professional degree programs. *J Orthop Sports Phys Ther.* 2014;44(8):579-586, B1-12. doi: 10.2519/jospt.2014.5379. Epub 2014 Jun 23.

## CSM Scholarship

The Imaging SIG established a scholarship with the first being awarded in 2018 at CSM in New Orleans. The purpose of the scholarship is to encourage growth of research of imaging in physical therapist practice. The prior two winners are Andrew Sprague (2018) and Ruth Maher (2019). Once abstract/proposal acceptances are available for CSM 2020 in Denver, the scholarship application will become available on the Imaging SIG's web page (linked on left sidebar at orthopt.org). The received applications are reviewed by the Imaging SIG's Scholarship Committee, headed by Lena Volland, and a winner selected.

Watch for more information about the scholarship application becoming available.

Also, if you are interested in becoming involved with the Imaging SIG or have prior experience in serving in scholarship or award selection processes, here is a perfect opportunity for you. The Scholarship Committee is looking for additional members. If you are interested, please contact lvolland@usa.edu for more information.

## Ultrasound in Physical Therapist Practice

If you have even a modest interest in ultrasound as part of physical therapist practice, a recently published article by Whittaker et al titled "Imaging with Ultrasound in Physical Therapy: What is the PT's Scope of Practice? A Competency-based Educational Model and Training Recommendations" is a worthwhile bit of reading for you. In this open access publication, Jackie Whittaker and colleagues provide an excellent overview of ultrasound imaging in physical therapist practice from perspectives of diagnosis, rehabilitation, intervention, and research. They also describe a framework for education and training along with basic competencies. This is highly recommended reading. The article can be accessed at the *British Journal of Sports Medicine's* website at: https://bjsm.bmj.com/content/early/2019/04/25/bjsports-2018-100193 or you can simply search by author name and topic.

## AIUM Webinars

Webinars with the American Institute of Ultrasound in Medicine (AIUM) have continued. On May 6, Bruno Steiner, PT, DPT, LMT, RMSK, presented "Monitoring Joint Health, Damage, and Disease Activity Using MSKUS: The MSKUS Experience in Hemophilic Arthropathy Management." On March 12, Charles Thigpen, PT, PhD, ATC, provided "Optimizing Treatment of Rotator Cuff–Related Shoulder Pain Using Diagnostic Ultrasound."

If you missed these webinars, please recall they remain available for your viewing on AIUM's website and on their YouTube channel. These webinars are great opportunities for extremely valuable information at no personal cost.

If you have interest in a particular topic for a webinar or you are interested in presenting or collaborating for a webinar, please contact crhazl00@uky.edu.

## Strategic Plan Activities

As part of the Imaging SIG's evolving support for residencies and fellowships, the SIG plans to assist residencies and fellowships with imaging content to encourage growth toward future demands of practice. Exponential growth in orthopaedic residency and fellowship programs has occurred in recent years. Through the efforts of dedicated members, the Imaging SIG is planning to provide instrumental resources for professional entry-level education curricula to enhance the quality and consistency of imaging instruction. Imaging SIG members, Dale Gerke and Evan Nelson are leading a project to determine the educational curricula and instructional design of imaging content in physical therapy residency and fellowship programs in the United States. Electronic surveys will be distributed to orthopaedic residency and fellowship programs in late summer or early fall.

The research arm of the strategic plan is in the final stage of development of the imaging mentor webpage to be posted on the Imaging SIG website. Currently, 16 mentors have agreed to be listed. The imaging modalities include ultrasound, MRI, CT scan, and PET scan. Applications vary across body regions, but include muscle and tendon morphology, muscle and brain activation, joint pathology, tissue stiffness, peripheral nerve entrapment, and image processing. We are currently seeking final approval of the latest version of the webpage from our mentors. Once approved, the webpage will be posted.

# President's Message

*Matt Haberl, PT, DPT, OCS, ATC, FAAOMPT*

Spring and summer are now upon us. Just like the flowers and plants around us with just the right amount of water and sunshine, our world is filled with beautiful color. As many of you know at our past Combined Section's Meeting in Washington, DC, several new seeds were planted with our strategic plan as we continue to grow a Community of Excellence in Residency and Fellowship Education. To help our community grow, we are turning to the support of our members to assist in several of our different work groups and task forces. If you have not done so already, please make sure to reach out to our task force leaders in how you can help:

- Residency/Fellow Applicant Sharing Work Group: Steve Kareha (Stephen.Kareha@sluhn.org)
- Mentorship Task Force: Darren Calley (dcalley@mayo.edu)
- Curriculum Task Force: Molly Malloy (mollyscanlanmalloy@gmail.com)
- ABPTRFE Task Force: Kirk Bentzen (kirk.bentzen@ah.org)
- Research Task Force: Mary Kate McDonnell (mcdonnellm@wustl.edu)

**Here is the latest update on the growths since CSM:**

### A New Face Lift! ORFSIG Website

Thank you to Matt Stark and Bob Schroedter for giving our website a new face lift. Surfers of the web will now be able to better choose which wave best fits them with a more condensed experience. Upon arrival, individuals will choose what path best fits them either a **Program Participant** or **Resident/Fellow**. All individuals will first find our meeting information, webinars, and workgroups. **Program Participants** will then be provided with information directed to either Developing/Accredited Programs, Additional residency/fellowship (R/F) Resources, and information regarding the AOPT Curriculum and Grant. **Resident/Fellows** will be provided with information in how to choose a program, the process for applying, and available programs.

### NOW OPEN! Facebook No Longer a Closed Group

To better generate communication and information sharing, we have lifted the closed group status of our Facebook Page. The Facebook page will still serve as a point of communication for ongoing updates within R/F education. All formal communication will still come from our Osteoblasts and *OP* messages. Please feel free to share ongoing research and other R/F information here (https://www.facebook.com/groups/741598362644243/)

**Residency & Fellowship Education SIG (RFESIG) of the Academy of Physical Therapy Education (APTE) Update**

### RFESIG Think Tank

- The RFESIG Think Tank work group continues to collect, review, and organize resources from established R/F programs. These resources are available to all APTA members and housed in the "RFESIG's Think Tank Compendium" on the APTE's website at the following link: https://aptaeducation.org/special-interest-group/RFESIG/think-tank-compendium.cfm.
- Two new resources will be added to the Think Tank Compendium soon. The RFESIG will announce the new additions through an e-blast and their quarterly newsletter.
- If you would like to share unique or creative resources with other programs, please submit to the Think Tank at the above link.

### Upcoming Learning Opportunities

- The RFESIG, in collaboration with the ORFSIG, plans on conducting a second webinar. The first webinar "Mentoring the Mentor: Maximizing the Annual Observation and Beyond" was incredibly successful. If you would like to present a topic or have ideas on future topics, please contact Christina Gomez at cgomezpt@gmail.com.
- The RFESIG has submitted two proposals focusing on the value of R/F education to the upcoming Education Leadership Conference. With increased awareness of the benefits of R/F education, we hope to foster more research studies on our shared interest of post-professional education. Cross your fingers they get accepted!

### ABPTRFE New Substantive Changes Policies and Procedures

In June 2018, the ABPTRFE released their new Policies and Procedures (P&P) connected to the Quality Standards. In November, complimentary documents to the P&P were released including Substantive Changes documents. To fully understand the impact the new policy 13.4 - Substantive changes would have on programs, the ORFSIG in collaboration with the AAOMPT PD-SIG released a survey to its members. The survey results identified there being a significant impact on Residency and Fellowship Programs noting 63% of Residency programs and 77% of Fellowship Programs were not in favor of the new policy changes. In response, the APTA set up a Key Stakeholders meeting in April and the ABPTRFE put a hold on the implementation of Substantive Change Policy 13.4. More information is expected following the May ABPTRFE board meeting. We will continue to keep you updated as processes change.

### Applicant Sharing

To identify developmental changes in residency and fellowship education that are impacting programs and their participants, it was brought to our attention that some programs were turning away applicants due to lack of space in their programs while other programs were unable to fill their spots. This information as well as the release of the ABPTRFE Aggregate data lead the ORFSIG to survey orthopaedic residency and fellowship programs to query the interest in participating in a standardized offer date for orthopaedic residency programs in the Fall 2018. Of all respondents, **only 46% were interested** in exploring a common application date for orthopaedic residency programs. Due to a limited interest in a common offer date program, there is still interest in possibly sharing applicants who have been turned away from programs who were full. Given the range of possibilities either through RF-PTCAS or other sharing platforms, a work group has been devised. To assist with this work group please contact Steve Kareha (Stephen.Kareha@sluhn.org)

### ACAPT White Paper on Terminal Internship Interviews

In 2018, the Clinical Education Special Interest Group released a white paper presented by a partnership of several DPT programs about DPT students in their terminal affiliation requesting time off for residency interviews. The controversial paper outlined challenges and barriers DPT programs encountered with clinical sites and advocated for students to focus on their terminal experiences. Given these new perspectives, the ORFSIG is working with ACAPT to publish recommendations for both residency directors as well as education of prospective residents by setting expectations of DPT students while in the professional program, helping DPT students/potential residents identify a single area of residency practice to pursue, and educating Directors of Clinical Education (DCEs) and clinical instructors (CIs) regarding the perspectives of residency programs. We look forward to completing this work.

### ABPTRFE Communication and Quality Standards

Please make sure to sign up on the APTA HUB to receive ongoing communication from the ABPTRFE. We encourage all programs to contact ABPTRFE in addition to the ORFSIG with any specific questions or concerns. Directions on how to sign in and receive weekly emails regarding posts to the APTA HUB visit our website at https://www.orthopt.org/content/special-interest-groups/residency-fellowship

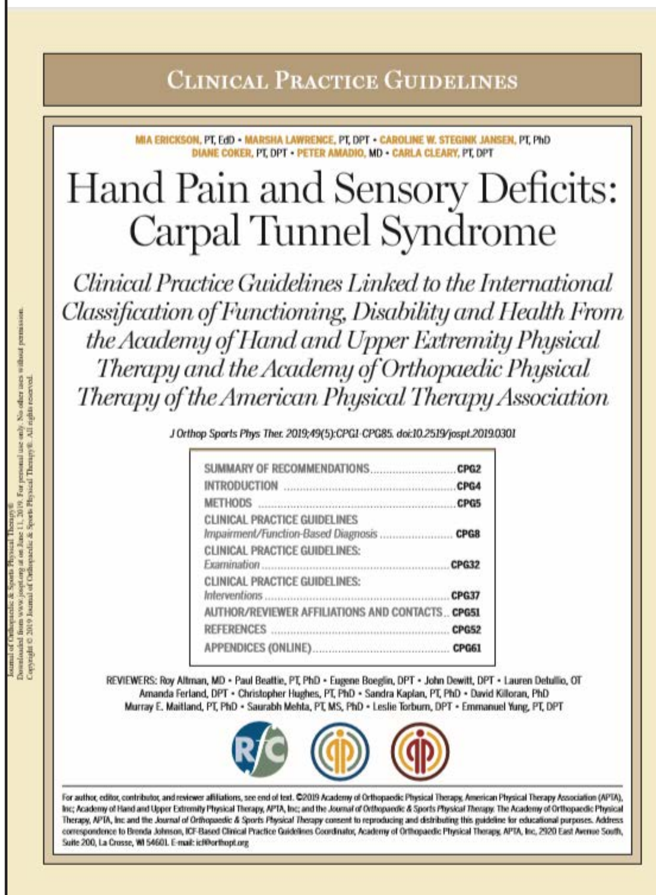
### *OPTP* Quarterly Submissions

The ORFSIG will continue to accept case reports, resident/fellowship research, etc to be highlighted in future issues of *Orthopaedic Physical Therapy Practice*. Take this opportunity to highlight your program's participants' work!

Thank you to all our members for your hard work. We look forward to great things in 2019!

## *JUST PUBLISHED:*
## Hand Pain and Sensory Deficits: Carpal Tunnel Clinical Practice Guideline

Additional Resources Include:
Decision Tree, Perspective for Patient, and Perspective for Clinicians



CLINICAL PRACTICE GUIDELINES

MIA ERICKSON, PT, EdD • MARSHA LAWRENCE, PT, DPT • CAROLINE W. STEGINK JANSEN, PT, PhD
DIANE COKER, PT, DPT • PETER AMADIO, MD • CARLA CLEARY, PT, DPT

Hand Pain and Sensory Deficits: Carpal Tunnel Syndrome

*Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Academy of Hand and Upper Extremity Physical Therapy and the Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association*

*J Orthop Sports Phys Ther. 2019;49(5):CPG1-CPG85. doi:10.2519/jospt.2019.0301*



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Amanda Ferland, DPT • Christopher Hughes, PT, PhD • Sandra Kaplan, PT, PhD • David Killoran, PhD
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Link to Full CPG:
https://www.jospt.org/doi/pdf/10.2519/jospt.2019.0301

Perspectives for Practice:
https://www.jospt.org/doi/full/10.2519/jospt.2019.0501

Decision Tree and Perspectives for Patients:
https://www.orthopt.org/content/practice/clinical-practice-guidelines

Link to all AOPT Sponsored CPGs and CPG resources:
https://www.orthopt.org/content/practice/clinical-practice-guidelines

****PUBLISHING SOON in JOSPT**:**
**Patellofemoral Pain CPG**

# Letter From the President

*Jenna Encheff, PT, PhD, CMPT, CERP*

The ARSIG has some exciting news to report. On April 15, 2019, the Board of Directors of the Academy of Orthopaedic Physical Therapy approved the first ever completed Animal Rehabilitation Practice Analysis and subsequent Standards of Clinical Practice. Kirk Peck, ARSIG Past President describes the importance of this accomplishment below.

We'd also like to introduce you to Tara Jo Manal, PT, DPT, who is our newly appointed liaison to the AOPT Board. The ARSIG will work closely with Tara Jo as we strive toward reaching the goals outlined in our strategic plan. We would like to thank Stephen McDavitt, our former liaison for his assistance and help over the past several years. With the completion of the Practice Analysis and Standards of Clinical Practice, the momentum for the practice of animal physical therapy can continue to move forward. Additionally, the path to meeting our strategic plan goals has opened up immensely. The strategic plan for the ARSIG can be accessed on the ARSIG website at https://www.orthopt.org/content/special-interest-groups/animal-rehabilitation.

## ARSIG Practice Analysis Finalized - A Defining Moment In History

*Kirk Peck, PT, PhD, CSCS, CCRT, CERP*
*Past ARSIG President*

A historic landmark event occurred on April 15, 2019, and marked a beginning for the future of animal rehabilitation in the United States. On this date, the Board of Directors of the Academy of Orthopaedic Physical Therapy formally approved the first ever completed Animal Rehabilitation Practice Analysis and subsequent Standards of Clinical Practice. The Standards are now posted on the ARSIG website at https://www.orthopt.org/content/special-interest-groups/animal-rehabilitation.

The purpose of the Practice Analysis was to identify post entry-level physical therapy education core clinical competencies for the practice of physical therapy on animals. The resulting clinical competencies now serve as a foundational description of animal practice with a goal to formally establish animal rehabilitation as a unique niche within the profession of physical therapy.

The Standards were derived from a statistical analysis of data from a nationally distributed survey completed in 2016. Competencies are divided into 6 major categories including (1) Foundational Knowledge of Animal Rehabilitation, (2) Patient/Client Management Model, (3) Interventions and Procedures, (4) Equine Specific Competencies, (5) Clinical Reasoning, and (6) Professionalism. Of 322 individual practice competencies assessed on the survey, 289 (89.8%) were found to be statistically significant and therefore comprise the current Standards of Practice for animal physical therapy.

I encourage all of you to please access the Standards of Clinical Practice for animal rehabilitation on the ARSIG website, and review the extensive outline of competencies for this distinct specialty within the profession of physical therapy. The comprehensive outline of Standards not only establishes a foundational description of animal practice, but also serves as one of the most influential accomplishments of the ARSIG in 21 years since its inception.

**In Remembrance:**

The ARSIG would like to take this opportunity to remember Jennifer Hubbard Brooks, MEd, PT, CERP, CCRP, a longtime member of the AOPT/ARSIG and strident supporter of physical therapy treatment for animals. Jennifer passed away unexpectedly on June 9th, 2019. Jennifer, along with Maggie Donahue and Charles Evans negotiated changes to the PT and Veterinary practice acts in New Hampshire allowing physical therapists to treat animals in both practice acts, one of the first and few states to allow this. She served as an instructor in the University of Tennessee's Equine Rehabilitation Practitioner certification program for many years as well as serving as faculty in Notre Dame College and University of Massachusetts Masters of Physical Therapy programs. Most recently, Jennifer had a very successful animal physical therapy practice in Hollis, NH, Horse 'n Hound Physical Therapy. Past president of the ARSIG, Amie Hesbach relates: "I knew Jen from our mutual work at Massachusetts Veterinary Referral Hospital in Woburn, MA. She was an enthusiastic student, learning canine physio to enhance her work in equine physio. She was a great teacher as well, taking time to expose physical therapy students to equine physio during their rotations/internships at MVRH. Always willing to try new things. Jen actually helped to broaden my horizons as an animal physio, referring a neurologic adolescent alpaca to me when I was first starting my mobile business west of Boston." Jennifer served as past Research Chair for the ARSIG and positively influenced many colleagues, students, and clients in both human and animal physical therapy. She will be greatly missed.

# Myofascial Trigger Point Dry Needling and Manual Therapy in a Yorkshire Terrier: A Case Report

Cynthia Kolb, PT, DPT, *Certified Canine Rehabilitation Therapist*
William Kolb, PT, DPT, OCS, FAAOMPT

Currently, there are few published studies that investigate the effectiveness of myofascial trigger point dry needling (MTrP DN) in animals. The patient in this case report is a 10-year-old SF Yorkshire terrier with left thoracic limb lameness of greater than one year who received MTrP DN. This, along with manual therapy and exercise resolved her lameness. On initial assessment, the patient presented with reactive tenderness to palpation of trigger points that were located in the latissimus dorsi, teres major, and tricepital muscle areas. The end outcome measures demonstrated improved functional scores, improvement in gait evaluation, and a resolution of altered sensation in the left front paw. The purpose of this case report is to demonstrate the effective inclusion of myofascial trigger point dry needling in conjunction with manual therapy in reaching goals in an animal rehabilitation case.

Sadie was referred by her veterinarian for lameness of the left front leg (LFL) with a diagnosis of left elbow arthritis that has been ongoing for greater than 1 year. In addition to the lameness, her owners reported that Sadie was chewing on her left front paw and the intensity of her chewing was gradually getting worse. The clients reported that past treatments have included under water treadmill therapy at one canine rehabilitation office and cold laser at another without significant improvement. Current treatment includes a pharmaceutical regimen of Dasuquin daily, Rimadyl (12 mg b.i.d.), and Tramadol (50 mg q.d.). Rest, medications, and massage help to ease her discomfort. They stated that Sadie can run and perform all functional activities during the day, but then demonstrates offloading inconsistently.

On initial assessment, Sadie greeted the Certified Canine Rehabilitation Therapist (CCRT) on a full run with quick turns, then immediately stopped, lifting high the LFL. On slick surfaces, Sadie gaited on 3 legs, carrying the LFL, but used all 4 legs on carpeted areas 80% of the time. In standing, she would immediately off load the LFL. Winging of the LFL elbow was noted with the swing phase of gait, using circumduction to advance. Decreased step length of right hind leg (RHL) limited as compared to the left hind leg (LHL). The LHL was advanced with stifle extension and decreased flexion was noted.

Grade 2 patellar subluxation was palpated on LHL. Multiple trigger points noted in the left latissimus dorsi/teres major area, and subscapularis that when manually palpated elicited a pain response. No medial shoulder instability was noted with shoulder abduction. Full range of motion (ROM) was noted in right front leg (RFL) and cervical spine. No tenderness was noted with manipulation of left or right first rib. Tenderness noted T with dorsal/ventral (DV) grade 2 mobilizations. Conscious proprioception and withdrawal were intact throughout. (Refer to Table 1 for further objective values on initial assessment.)

In summary, Sadie is seen as a highly energetic dog. She is reserved to run on slick floors but continues to run on non-slick surfaces and to jump up onto small furniture. Multiple areas of compensation are seen. Due to patellar subluxation of the LHL, she off loads to the RHL. Limited range of motion (ROM) of the right hamstrings causes her to pull more with the LFL, over working this area. Chewing on the dorsum of the left front paw may be indicative of a nerve/tingling sensation due to referred pain from the latissimus dorsi and /or subscapularis area. The proposed pattern of compensation that was seen in Sadie by the CCRT was explained to the owner, along with the fact that this dysfunctional movement pattern will continue to escalate unless the cycle is disrupted. The client was educated on the benefits of trigger point DN for Sadie to which she voiced her agreement. Written approval was received by Sadie's veterinarian for dry needling by visit 3.

### Visit 2 (1 week after evaluation)

The order for DN had not been received by the second visit appointment time. The clients reported frustration with performing stretches over the past week as Sadie was highly resistant to the stretching and kept pulling away. The stretches were reviewed with the clients for proper technique, and an ice pack was used over Sadie's thoracic area while in sidelying for a calming technique during treatment. Little to no change was noted in the ROM of Sadie's LFL or BHLs (see Table 1). Class 3b cold laser to BHL hamstrings, sartorius, thoracic and lumbar spine, LFL latissimus dorsi, teres, and triceps at 6-8 Joules/cm$^2$ prior to stretching and mobilizations. Grade 2-3 mobilizations used x 15 oscillations to T1-L1. Manual stretching to the LFL latissimus dorsi, teres major, tricep and to BHL, including hamstring and sartorius muscles was performed. No change in gait activities noted prior to or after treatment.

### Visit 3 (2 weeks after evaluation)

The clients reported improvement in Sadie since last treatment (see Table 1 for the objective measurements on visit 3). No change noted in the LFL with passive ROM. The written order was received to perform MTrP DN, and this technique was used with a Seirin J type needle, No.5 (0.25) x 30 mm. Multiple trigger points noted in the left latissimus/teres major area and left subscapularis that when palpated elicited a pain response from Sadie. Areas that were dry needled included the left latissimus dorsi, teres major, and triceps. Gentle coning and pistoning were used until a local twitch response was achieved. The insertion time for each was less than 10 seconds for each trigger point. Due to Sadie's quick reactions when a jump sign occurred from DN, a cold compress was again laid across her thoracic area to provide a calming effect. Range of motion of the left latissimus dorsi at 15% before DN. After needling 2 areas, the ROM improved to 75%. Sadie then allowed grade 2-3 mobilization of the radial/ulnar joint, carpals, and sesamoids. Range of motion of the left elbow after needling at 90% (see Table 1). Decreased tenderness noted at T4-12 after needling. Passive ROM of the left sartorius and bilateral hamstring was also performed with Sadie in sidelying.

After treatment, Sadie gaited on carpeted surfaces at a trot, weight bearing on all 4 extremities. She was called toward the therapist, having to cross a tile surface, which she performed at a faster

**Table 1. Summary of Outcome Measures**

| Outcome Measures | Visit 1 (IA) | Visit 2 | Visit 3 | Visit 4 |
|---|---|---|---|---|
| Lameness Scale | 4/5 | 4/5 | 4/5 | 0/5 |
| Bioarth Scale[6] | 24/38 | 24/38 | 16/38 | 3/38 |
| R hamstring | 45% Full ROM | 45% Full ROM | 75% Full ROM | 75% Full ROM |
| L hamstring | 50% Full ROM | 50% Full ROM | 80% Full ROM | 80% Full ROM |
| L sartorius | 10% Full ROM | 10% Full ROM | 50% Full ROM | 60% Full ROM |
| L latissimus dorsi | 25% Full ROM | 25% Full ROM* | 75% Full ROM* | 85% Full ROM* |
| L triceps | 75% Full ROM | 75% Full ROM | 90% Full ROM* | 95% Full ROM* |

*Note:* [Values seen after myofascial trigger dry needling was performed on visit 3 and visit 4]
Abbreviations: ROM, range of motion; IA, initial assessment; L, left; R, right

trot on all 4 legs. She continued weight bearing on all 4 limbs in standing. Sadie was then taken outside to perform hill work at various gait speeds on a grassy surface while weight bearing during and after all activity.

### Visit 4 (1 week after visit 3)

Clients stated, "This is the best that she has been for months and months! She is running wide open outside, is jumping on and off furniture, and is not favoring that leg. She is enjoying the stretches and looks forward to it, lying down in the middle of the floor." The clients also stated that since the last visit, Sadie had not chewed or licked on her LFL the entire week.

Sadie was reassessed with a grade 1 patella subluxation (see Table 1 for the objective measures for visit 4) and limited ROM of the left latissimus dorsi at 45% prior to treatment. Latissimus dorsi, teres major, and triceps were again chosen as DNtargets due to tenderness with palpation. The hamstrings of the BHL, and the sartorius were not chosen for DN due to the LFL having priority because of the poor response to passive ROM, whereas the BHLs ROM were progressing without the use of DN. After needling 2 trigger point areas in the left latissimus dorsi, teres major and triceps region, passive ROM increased to 85% with shoulder extension, and to 95% with elbow flexion (see Table 1). Sadie then allowed mobilization of the radial/ulnar, carpals, sesamoid, without resistance. No tenderness noted T4-12 after needling.

After treatment, Sadie ambulated with at least 4 different gait speeds over varying surfaces with consistent weight bearing on all 4 limbs. She did not demonstrate offloading in standing, or carrying of the LFL at any time. Improved stride length noted of the bilateral hind legs with swing phase of gait. Sadie also demonstrated proper alignment of the LFL without compensation or winging of the elbow in order to advance the limb. All goals were met by the fourth visit. Due to the clients being out of the country for an extended period, they stated that they would continue with the stretches on a daily basis and contact the CCRT if Sadie began to favor her LFL or regressed in any way. Communication was attempted by the therapist at 2 and 5 months as a follow-up, but was unable to reach the clients to see how Sadie continued to progress.

This case report describes the successful implementation of DN as an adjunctive treatment to a musculoskeletal dysfunction in a Yorkshire terrier. The full, predisposing factors and cause of Sadie's dysfunctional movement pattern and resultant gait abnormalities is speculative. It can be reasoned that the beginning of Sadie's issues started with the subluxating patella of the LHL. This condition is primarily seen in small dogs, especially breeds such as the Boston and Yorkshire terriers, and is one of the most common orthopedic conditions.[1] The muscle imbalance noted in the initial assessment of the LHL lacking in girth size of the quadriceps and hamstrings as compared to the RHL along with decreased ROM noted in the hamstrings of the RHL as well, demonstrates this pattern of compensation.

In Sadie's case, the typical rehabilitation protocol of stretching and strengthening was proved to be insufficient due to the painful condition of the left front shoulder, questionable numbness/tingling via trigger points in the left front paw, and her energetic temperament. Where she responded well to the passive ROM stretches of the hind limbs, she did not tolerate the stretches to the left shoulder girdle. For this reason, DN was chosen as an intervention and supported with a prescribed home exercise program. This case report demonstrated that DN may be a justifiable option for a diagnosis of shoulder pain in order to relieve pain/numbness/tingling referral patterns, but also to increase scores on functional outcome tools.

The referral pattern to the dorsum of the right front paw where Sadie was prone to lick and chew corresponds with the referral pattern described by Travell and Simons (for a human hand) of the latissimus dorsi muscle.[2-4] A similar human case using dn is described by Lane, Clewley, and Koppenhaver[6] with two visits of DN that alleviated complaints of upper extremity numbness and tingling. Cervical radiculopathy and compression along the course of the nerve had been ruled out in Lane's case report, with the overall diagnosis being unclear. The patient's complaints were elicited with manual compression of the trigger points in the teres minor and infraspinatus muscles.

Many different components and theories were incorporated for a successful result in Sadie's case. This collaboration of treatment methods that were drawn from the human side of physical therapy and applied to the animal population demonstrates a full circle of research. As therapists, this knowledge is applied to our human population with success. As animal rehabilitation therapists, one must take the knowledge that has been gained in working with our human population, employ this to research, and validate the most effective and evidence-based treatment program for our patients in order to meet their needs and improve their quality of life. The need for future research in the area of animal rehabilitation cannot be stressed enough.

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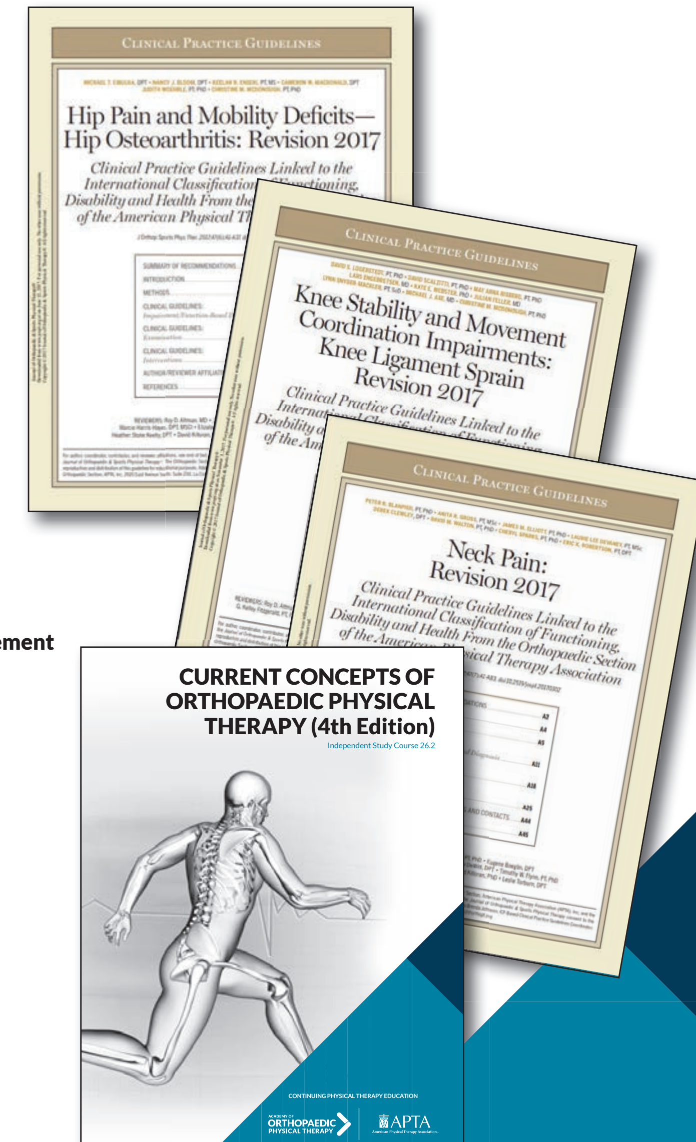


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