2020 / volume 32 / number 4

ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA

FEATURE:
Performing with Pain: Tools to Guide Rehabilitation & Injury Prevention for Professional Ballet Dancers

APTA
American Physical Therapy Association

The Running Athlete

Long-distance running is one of the most common forms of daily exercise due to its low cost and accessibility. The popularity of long-distance running has increased over the past 15 years and according to data compiled by Running USA, over 18.3 million United States runners participated in formal races in 2017.

Common Running Injuries

Running injuries to the lower leg, foot, ankle, and hip all show high rates of injury with ample literature examining the details for each region.

- Patellofemoral Syndrome
- Iliotibial Band Syndrome
- Medial Tibial Stress Syndrome
- Achilles Tendinopathy
- Plantar Fasciitis

Running Footwear

A Brannock device is used to determine proper shoe size. Three separate measurements ensure a correct fit: heel-to-toe, heel-to-ball/arch length, and foot width.

Types of Running Footwear:
- Traditional
- Minimalist
- Maximalist
- Racing Spikes
- Trail vs Road vs Cross-training

Care Considerations

Consideration for how running injury factors relate to injury onset for each runner level is essential to establish a clinical picture of why an athlete suffered from an injury.

- Injury Location
- Biopsychosocial Influences on Injury
- Making the Decision to Withdraw from Sport
- Alternatives to Running
- Exercise Prescription
- Return to Running
- Recovery Aids

Considerations for Adolescent Runners

Adolescent runners are unique in many ways and, therefore, cannot be managed in the same way as an adult. The adolescent body is still growing and developing, making adolescents more prone to certain types of injuries. Understanding the growth and development phases is pertinent to effectively manage this population.

- Sex Differences
- Endurance Runners vs Sprinters
- Training Experience
- Running Experience

Exercise Progressions

It has been said that one of the top causes of running-related injuries is due to training errors.

- Core Stability
- Hip Stability
- Single Leg Balance and Control
- Low Leg and Foot Strength
- Power and Strength

Biomechanics and Energetics

The goal of every runner is to optimize kinematics and kinetics to minimize the chance of injury and to improve efficiency.

- Running Kinematics
- Muscle Activity During Running
- Running Kinetics
- Running Economy
- Factors Influencing Running Economy
- Spatiotemporal Measures,Kinematics, Kinetics, Leg stiffness, Flexiblity, Training

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3. Provide recommendations on nutrition to optimize rehabilitation protocols and recovery from injury.
4. Identify events occurring during each phase of the sleep cycle.
5. Understand the implications of sleep loss on health.
6. Implement a sleep screening instrument in clinical physical therapy practice.
7. Understand of the physiology underlying the effectiveness of blood flow restriction.
8. Identify populations with whom to consider the use of blood flow restriction.
9. Appropriately prescribe blood flow restriction with resistance exercise based on current evidence.

Topics and Authors

Current Trends in Nutrition and Supplementation with Relevance to the Physical Therapist—Leslie Bonci, MPH, RD, CSSD, LDN

Let Me Sleep On It: Sleep for Healthy Aging and Optimal Performance—Kristinn I. Heinrichs, PhD, PT, NCS, SCS, ATC; Melanie M. Weller, MPT, OCS, CEEAA, ATC

Blood Flow Restricted Exercise: Physical Therapy Patient Management Using Current Evidence—Johnny G. Owens, MPT; Luke Hughes, PhD; Stephen Patterson, PhD

3 OPTIMIZING PERFORMANCE

Learning Objectives

1. Identify psychosocial strategies to enhance adherence to injury rehabilitation.
2. Appreciate the role of an inter-professional approach to injury rehabilitation.
3. Describe the varied uses of wearable technologies in clinical practice.
4. Discuss the benefits and limitations of using wearable technologies in monitoring performance.
5. Differentiate among training methods for runners with different levels of ability.
6. Develop a return-to-running program based on a runner's level of ability.

Topics and Authors

Mental Techniques for Performance—Scott B. Martin, PhD, FACSM, FAASP; Rebecca Zakrajsek, PhD, CMPC®; Taylor Casey, MEd; Alexander Bianco, MS

Wearable Technologies for Monitoring Human Performance—Mike McGuigan, PhD, CSCS

Training Methodologies for Runners—Jerry-Thomas Monaco, PT, DPT, OCS; Richard G. Hubler, Jr., PT, DPT, OCS, FAAOMPT

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In this issue

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Editor's Note

Readers of the editorial page since I have started as *OP* Editor have noticed a trend towards associating the current state of the world with music. This editorial follows this theme.

Along with many of you during these terrible, life-changing pandemic times, I have been home. No sports, tired of Zoom meetings, tired of negative news, doing too much computer work, and in need of some form of positivity. For me, the two items that saved me were *The Last Dance*, the Michael Jordan special and *Beyond the Lighted Stage*, a documentary on the band Rush.

For those unfamiliar with this rock band, Rush originally started in 1968 and to date, have produced 19 studio albums, 11 live albums, and 11 compilation albums, with their latest release on May 29, 2020. This 3-man band inspired many musicians and fans with their lyrical complexity and musical flexibility. Those familiar with Rush will know the importance of Neil Peart, aka The Professor, to this famous rock band. Interestingly, Neil Peart was not only a drummer but he was an avid reader of authors such as Ayn Rand and J.R.R. Tolkien, who inspired him to write the majority of the lyrics across 41 albums. Peart was also famous for being an author of 7 non-fiction novels that were loosely based on his traveling and adventure escapades. Unfortunately, Neil Peart passed away at the beginning of 2020.

When we consider all that has happened and changed over 2020 that has affected each of us such as Kobe Bryant passing, George Floyd's death, and the COVID-19 pandemic with the upheaval of everything in our lives, I think we need to hear something positive to break up the spiral of negativity. As I dusted off some of my Rush music in different forms, I also investigated more about Neil Peart. I found that not only his God-given talents as a musician were truly amazing but the thought and intention that he put into his lyrics were impressive and unequaled. I also believe that no matter where you are in life, Peart's philosophical quotes are inspiring and applicable to the profession of physical therapy as we touch the hearts and minds of our patients daily. I hope that you agree.

"From the point of ignition. To the final drive. The point of the journey is not to arrive."

"A spirit with a vision is a dream with a mission."

"Half the world hates what half the world does every day. Half the world waits while half gets on with it anyway."

"From first to last, the peak is never passed. Something always fires the light that gets in your eyes."

"You can't get wise with sleep still in your eyes no matter what your dream might be."

"A quality of justice, a quantity of light. A particle of mercy makes the color of right."

"What is a master but a master student? And if that's true, then there's a responsibility on you to keep getting better and to explore avenues of your profession."

"I always thought if I could just put something in words perfectly enough, people would get the idea, and it would change things. That's a harmless conceit. With people, too, you constantly think, 'If I'm nice to people and treat them well, they'll appreciate it and behave better.' They won't, but it's still not a bad way to live."

"Each of us, A Cell Of Awareness... imperfect, and incomplete. Genetic blends, with uncertain ends."

"Too much attention and hoopla doesn't agree with my temperament."

"Even as a kid, I never wanted to be famous; I wanted to be good."

"I want to be an improviser, and I've worked very hard at that. It's an art. You don't just play whatever comes into your head; you have to be very deliberate about what you do."

Respectfully submitted,

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

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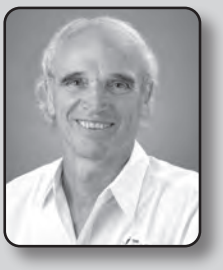

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Patellofemoral Pain

Often known as "knee cap pain" or "runners knee"

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Affects 25%

of the general population every year.

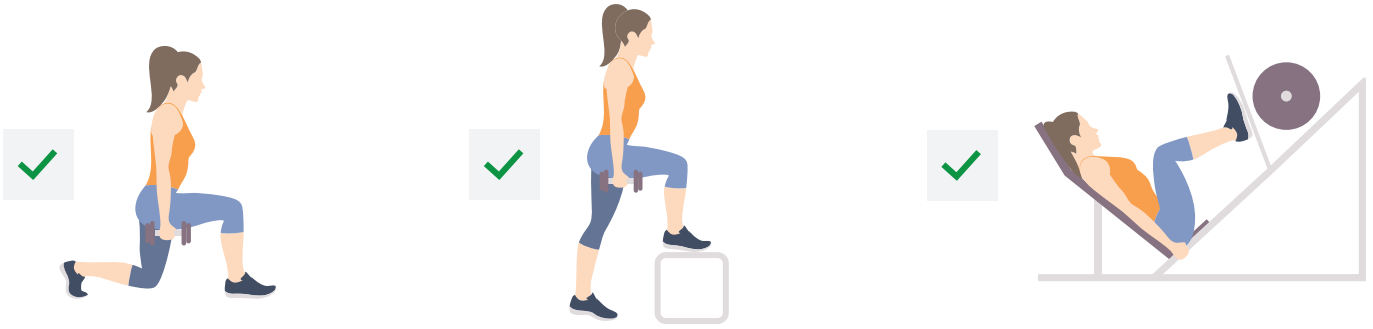
Women experience knee cap pain twice as often as men.

Prevention of knee cap pain is challenging, based on the Clinical Practice Guidelines by the Academy of Orthopaedic Physical Therapy*, here are some suggestions:

- Gradually increase the amount of activity you are doing.
- Do a variety of activities; adolescents who specialize in a single sport have greater risk of knee cap pain.
- Maximizing knee strength may reduce the risk of developing knee cap pain.
- Age, height, weight, and leg posture are not risk factors in developing knee cap pain.

How can a physical therapist work with you and your kneecap pain?

- Hip and knee exercises are the best thing for people with knee cap pain.
- Knee taping or inexpensive shoe inserts can be helpful, but should be combined with an exercise program.
- There are no quick fixes: Exercise is the best treatment option over other options.
- Improving the way a person runs, jumps, or adjusting a training routine often helps reduce kneecap pain.



*This infographic is based on the guideline by Willy et al titled "Pallofemoral Pain" (*J Orthop Sports Phys Ther.* 2019;49(9):CPG1-CPG95. doi:10.2519/jospt.2019.0302)

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Performing with Pain: Tools to Guide Rehabilitation and Injury Prevention for Professional Ballet Dancers

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ABSTRACT

Background and Purpose: Professional dancers may suffer from unrecognized central pain problems since negative experiences with past injuries may increase the intensity of pain. Classification of injuries into nociceptive, neuropathic, and central/nociplastic pain may improve injury management. The purpose of this review was to create a dance specific decision tool to screen for central/nociplastic pain. **Methods:** A literature review was conducted using PT Now, CINAHL, and PubMed. Key words included pain, ballet, dance, prevalence, incidence, pain management, pain rehabilitation, and dancer mentality. **Findings:** Results of the dance specific review were applied to existing pain classification models and dance specific interview questions were identified to assist physical therapists managing professional dance injuries. **Clinical Relevance:** Categorizing dance injuries using pain science models may better guide rehabilitation, including recognizing nociplastic pain that is likely more prevalent in dancers than expected by most clinicians. **Conclusion:** The review presents a novel dance-specific pain decision tool and pain questions for the categorization of ballet injuries.

Key Words: dance, pain, management

BACKGROUND AND PURPOSE

Prevalence of Injury and the Dancer Mentality

Identifying injury in professional ballet dancers is often a complex task due to a variety of factors, particularly the dancer's mentality about injury and pain. This mindset often involves both denial of pain and acceptance of it as an inevitable part of a career in dance.[1] Because of this paradoxical attitude, previously used definitions of injury, including conditions that require time off or medical attention, have been shown in the research to underestimate the true burden of injury in the dance population. Hence, using an all-inclusive injury definition considering any physical limitation is recommended as more appropriate for dancers.[2]

When providing physical therapy services to a professional dance company, phrases such as "tightness, reduced range of motion, or spasm" are frequently used to describe ailments. It is uncommon for the dancers to report "pain." Dancers also frequently show satisfaction with painful experiences during treatment such as trigger point release or dry needling involving large twitch responses, using phrases such as, "it hurts so good."

It is important to note that the professional dancer is unique to other athletes. Dancers combine both art and athletic ability in an intricate and precise manner that requires multiplex ties of neural processing at the brain and spinal cord.[3] In addition, dancers often do not have the luxury of having health care services available at all times. In fact, many dancers who are professional but not employed in principal roles for the most prestigious companies are grossly underpaid. The median hourly pay for professional ballet dancers, including those in the most reputable companies, was $14.25 in 2017.[4] Thus, many dancers feel they cannot afford decent health insurance or the cost of health care, and they avoid seeking care unless their injuries are bad enough to threaten their careers.[5] Coupled with the fact that dancers often hide injuries out of fear that they may not be given roles if their injury is recognized by the director, dancers are placed in a position of unique vulnerability.

Current research struggles to accurately quantify injury with the dance population due to a skewed injury definition and perception of pain. However, injury is common in this population and a majority of injuries are due to overuse from high physical demands.[6] It was shown by Kenny et al[2] that using a more inclusive injury definition increases prevalence rates of seasonal injury from 9.4% to 82.4% and incidence rates from 0.1 to 4.9 per 1,000 dance hours. Based on these factors, a more comprehensive definition of pain including any physical limitations will be used in this article in an attempt to account for the true injury burden for professional ballet dancers.

Treatment for Injury

Physical therapists are presented with a unique opportunity to positively impact the health of professional dancers because physical therapy is the most common medical treatment sought out by dancers.[2] Typical physical therapy evaluation often involves examination of flexibility, strength and range of motion, as well as other physical tests and self-report outcome measures.[7] This typical approach often guides therapists to treating only these physical signs, and may neglect to delve deeper into the psychological factors and biological mechanisms that create pain, especially the chronic and recurrent overuse injuries often endured by dancers.

Research Purpose

The purpose of this research was to perform a literature review to create a decision-making tool that can be used to screen for dancers who may benefit from physical therapy services, and to classify their symptoms into "nociceptive," "neuropathic," or "central" (nociplastic) pain categories.[8] Each classification in the tool would then lead the provider to the most evidence-informed treatment strategies for the associated pain type, taking into account their unique health beliefs and injury perceptions. This decision-making tool will help to identify dancers who could benefit from therapy services by unraveling the unique dancer mentality of pain and injury. Using pain categorization in this manner may help to elucidate the most successful ways to treat and manage an individual's distinct condition.[8]

METHODS

A literature review was conducted using various databases, PTNow, *JOSPT*, CINAHL and PubMed, along with inclusion criteria. Key words such as "pain, ballet, dance, prevalence, incidence, pain management, pain rehabilitation and dancer mentality," were entered to perform the search. A comprehensive list of keywords is shown in Table 1.

The timeframe included only articles published within the last 15 years to main-

Table 1. Summary of Literature Review on Pain and Dance

Journal or Database	Search Criteria	Article Related to Themes	Topic
JOSPT	Search for: dance, ballet, pain. 2008 - present. 46 results.	The Influence of Injury Definition on Injury Burden in Pre-professional Ballet and Contemporary Dancers (Kenny 2017).[b]	Cohort study discussing how traditional definitions of injury can underestimate true injury burden in the dance population.
JOSPT	Search for: dance, ballet, pain. 2008 - present. 46 results.	Physical Therapy Rehabilitation of an Adolescent Pre-professional Dancer Following Os Trigonum Excision: A Case Report (Filipa 2018).[b]	Case report of physical therapy rehabilitation for a dancer.
JOSPT	Search for: dance, ballet, pain. 2008 - present. 46 results.	Psychometric Properties of the Dance Functional Outcome Survey (DFOS): Reliability, Validity and Responsiveness (Bronner 2018).[a]	Prospective cohort study validating the use of the DFOS.
JOSPT	Search for: dance, ballet, pain. 2008 - present. 46 results.	Injury Patterns in Elite Pre Professional Ballet Dancers and the Utility of Screening Programs to Identify Risk Characteristics (Gamboa 2008).[b]	Retrospective descriptive cohort study to determine the rate of injury in dancers and the effectiveness of screening.
PTnow	Search for: pain rehabilitation, pain classification nociceptive neuropathic. 2018 - present. 20 results.	A Mechanism-Based Approach to Physical Therapist Management of Pain (Chimenti 2018).[a]	Summary of the most recent research in pain classification.
Cinahl	Search for: ballet and epidemiology. 2015 - present. 25 results.	Epidemiological Review of Injury in Pre-Professional Ballet Dancers (Caine 2015).[b]	Epidemiological literature review of dance injury.
Cinahl	Search for: graded motor imagery and pain. 2010 - present. 32 results.	The Effects of Graded Motor Imagery and Its Components on Chronic Pain: A Systematic Review and Meta-Analysis (Bowering 2013).[a]	Systematic review/meta analysis on the effects of graded motor imagery.
Cinahl	Search for: dance and pain management. 8 results.	Perceptions of Pain, Injury, and Transition-Retirement. The Experiences of Professional Dancers (Harrison 2017).[b]	Pilot study examining the dancer experience with pain and eventual retirement.
PubMed	Search for: injury, ballet, dance, incidence, prevalence, risk. 2013 - present. Full Text. 42 results.	Injuries in pre-professional ballet dancers: Incidence, characteristics and consequences (Ekegren 2014).[b]	Prospective epidemiological study.
PubMed	Search for: dance, epidemiology, injury, pain. Full Text. 42 results.	Musculoskeletal Injuries and Pain in Dancers: A Systematic Review (Hincapie 2008).[b]	A systematic review on ballet musculoskeletal injury.
PubMed	Search for: overuse, injury, ballet, incidence. 2008 - present. 31 results.	Overuse Injuries in Professional Ballet: Influence of Age and Years of Professional Experience (Sobrino 2017).[b]	Descriptive epidemiology study on ballet injury.
PubMed	Search for: dancer mentality. 2 results.	Caring for the Dancer: Special Considerations for the Performer and Troupe (Shah 2008).[b]	Literature review discussing considerations that must be taken with dancer rehabilitation.
PubMed	Search for: ballet and centralized pain. 45 results.	Applying Current Concepts in Pain-Related Brain Science to Dance Rehabilitation (Wallwork 2017).[a]	Applied empirical evidence from pain neuroscience to dancer rehabilitation.
PubMed	Search for: chronic pain neuroscience biology psychology. 2013 - present. 27 results.	Fifteen Years of Explaining Pain: The Past, Present, and Future (Moseley 2015).[a]	A critical review on Explaining Pain (EP treatment.)
PubMed	Search for: dancing psychology pain. 2008 - current. 31 results.	Dancing in Pain: Pain Appraisal and Coping in Dancers (Anderson 2008).[b]	Study investigating the relationship between the pain and coping styles in dancers.

[a] *relating to theme (1) the classification of pain types and associated treatments*
[b] *relating to theme (2) the ballet dancer's experience with pain and injury*

tain relevance. Any type of research articles from reputable journals were accepted while encompassing case studies, systematic reviews, meta-analyses and more in order to gain a complete picture of the available dance research. If a search term resulted in over 50 hits, the search was narrowed further by adding search terms or narrowing the date range. Research focusing on the general athlete was not considered and only dance-specific articles were used to maximize the transferability of information. The goal of the literature review was to find articles discussing the following themes: (1) the classification of pain types and associated treatments, and (2) the ballet dancer's experience with pain and injury. After all relevant information was collected it was categorized into a decision-making tool in the form of a flowchart to be used by physical therapists when treating dancers (Figure 1).

FINDINGS

Literature Review Results

The results of the literature review using the previously described methods are summarized in Table 1.

Pain Categories

The leading researchers in pain accept that 3 main categories of pain exist: nociceptive, neuropathic and central. The central category of pain has recently been renamed nociplastic. Chimenti et al[9] use the following definitions to describe each of the 3 pain categories: Nociceptive: pain due to activation of nociceptors, (2) Nociplastic: pain due to disturbances in the central processing of pain, and (3) Neuropathic: pain due to a lesion or disease to the somatosensory system. Using this mechanism-based approach to pain allows treatment to be individualized by considering that even patients with the exact same diagnosis can have different mechanisms and biological processes that create different pain experiences. This approach can direct more personalized and appropriate treatment, which may lead to improved outcomes.[8]

The Dancer Pain Mentality

Applying the previously described pain mechanisms to the dance population is further complicated by the dancer mentality. Dancers often hide injuries out of fear of harming their careers and deny that they are injured.[1] This behavior may be due to the fact that the ability to dance and perform physically is deeply intertwined with dancers' self-identities and feelings of purpose in life. It is also common for dancers to either accept pain as a natural part of the dance experience, or to attribute it to a failure on their part to maintain proper technique.[1]

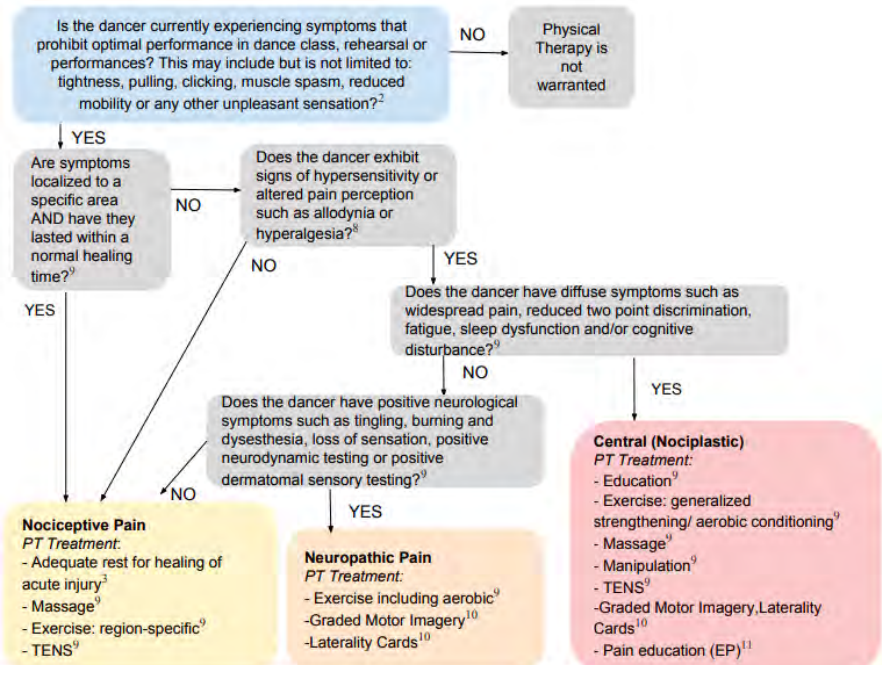

Figure 1. Pain decision tool for professional dancers.

A dance-specific decision-making tool for pain classification

The previously listed information on pain classification and the dancer mentality was then synthesized to create a comprehensive decision-making tool to be used by physical therapists in order to place dancers in a mechanism-based pain category with associated interventions (Figure 1). Definitions of the terms used are listed in Table 2. This tool will allow therapists to more effectively treat dancers by taking into account the specific pain process in place as well as psychological factors that may be skewing how dancers view their pain and injury. Future research is needed to validate the clinical application of the tool and to gather more data from therapists who have treated dancers successfully. It is hypothesized that the tool will be able to speed recovery in the dance population, due to the fact that pain mechanism classification has improved outcomes in the general population.[8]

Nociplastic Pain and Dance

The current study's hypothesis is that nociplastic pain is common but often goes unnoticed in dance rehabilitation. This idea is shown in the research of Wallwork et al[3] which described the presence of neurotags that can summon pain due to a past threat despite that there is no physiological cause. From our experience, one dancer who had a previous stress fracture, experienced the harmless foot stimulus of a plantar wart causing an intense pain feeling. The negative response was due to interconnections in the brain that related the unfamiliar foot stimuli to the fear of a possible career ending injury. Dancers often perform through pain that not only results in nociception in the presence of an actual threat, but creates neurotags to make dancers more prone to experiencing pain or feelings of unease to compromise motor output when no viable threat to the body is present.[3]

In order to treat dancers more effectively, nociplastic pain in dancers must be recognized and treated accordingly. Some examination measures for dancers who have nociplastic pain may include a pain body diagram, McGill Pain Questionnaire, Numeric Pain Rating Scale, pressure algometer and a Von Frey monofilament test for allodynia.[8] In addition, nociplastic treatment will differ from the nociceptive treatment because nociplastic pain intervention should incorporate a broader biopsychosocial approach to rehabilitation. Nocioplastic treatment may include pain education,[11] graded motor imagery,[3]

Table 2. Pain Definitions from the Literature

Pain Definitions	
Allodynia	Painful response to a nociceptive stimuli.[8]
Hyperalgesia	Increased pain sensitivity.[8]
Neural Mobilization	Designed to restore the ability of the nerve and surrounding structures to shift.[8]
Dysesthesia	An unpleasant abnormal sensation, whether spontaneous or evoked.[8]
Nociceptive Pain	Pain arising from the activation of nociceptors.[8]
Neuropathic Pain	Pain arising as a direct consequence of a lesion or disease affecting the somatosensory system.[8]
Nociplastic (Central) Pain	Pain arising from disturbances in the central processing of pain.[9]
Graded Motor Imagery	A 3-stage treatment to engage cortical motor networks without triggering pain.[10] *Step one* - left/right judgements of photographs (laterality cards) *Step two* - motor imagery of the affected area *Step three* - mirror therapy

exercise, massage, TENS, and manipulation,[8] as well as other methods to reduce a centralized inclination to pain and altered movement patterns. Therapeutic exercise may benefit nociplastic pain mechanisms in dancers to improve optimal loading and resolve excessive protection.[12] Movement is a very effective protector of body tissues that must be considered in rehabilitation of nociplastic pain.[3] Movement imagery is commonly used with dance injuries to modulate neurotags.[3] A summary of causes of nociplastic pain and associated questions to identify it in dancers is pictured below (Figure 2).

CLINICAL RELEVANCE

This review presents decision-making tools based on research that attempt to more specifically guide the rehabilitation of professional ballet dancers. It is hypothesized that nociplastic or recurrent pain problems are likely more prevalent in dancers than expected by most clinicians. High levels of injury have been shown in dancers, including statistics showing that 67% to 95% of dancers are injured per year.[15] In addition, recurrent pain levels as high as 90% after a 6-year follow-up have been reported,[16] alluding to many of these injuries becoming chronic, and may result in nociplastic pain. Nociplastic pain can also be identified with highly emotional situations, such as the previously mentioned dancer who experienced allodynia even with minor foot stimuli. New methods of multimodal intervention are needed for better management of recurrent injuries that may be both nociceptive or nociplastic. However, it is important to recognize that the type of pain dancers have can alter their experience with pain. In summary, nociplastic pain is expected to be prevalent in this population due to the unique dancer experience with pain coupled with grueling physical demands. This phenomenon must be recognized for effective management.

CONCLUSION

The decision-making tool proposed in this article uses a new approach on the treatment of ballet dancers for physical therapists. This method takes into account the mechanism-based approach to pain management by classifying the root cause of pain while meshing it with the unique dancer's mentality regarding pain and injury. This decision-making tool presents opportunities for new research to validate the usefulness of the tool, and encourages continued investigation on the dancer's experience with pain to optimize physical therapy treatment for this unique population.

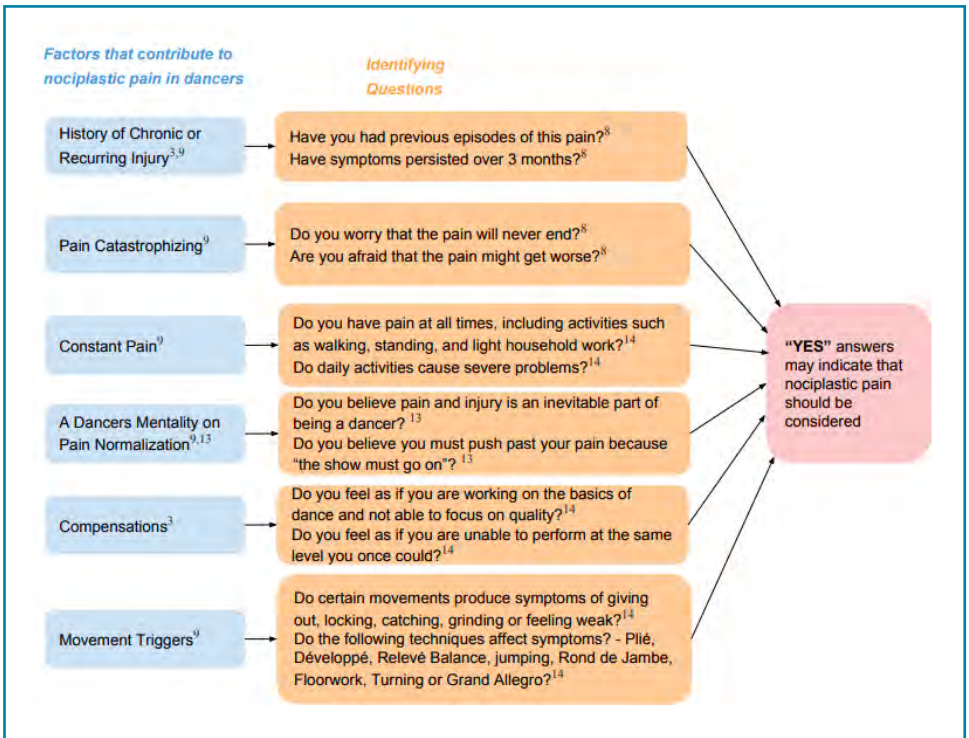

Figure 2. Nociplastic pain questions for professional dancers.

REFERENCES

1. Harrison C, Ruddock-Hudson M. Perceptions of pain, injury, and transition-retirement. The experiences of professional dancers. *J Dance Med Sci*. 2017;21(2):43-53. doi: 10.12678/1089-313X.21.2.43.
2. Kenny SJ, Palacios-Derflingher L, Whittaker JL, Emery CA. The influence of injury definition on injury burden in pre-professional ballet and contemporary dancers. *J Orthop Sports Phys Ther*. 2018;48(3):185-193. doi: 10.2519/jospt.2018.7542. Epub 2017 Dec 13.
3. Wallwork SB, Physio B, Bellan V, Moseley GL. Applying current concepts in pain-related brain science to dance rehabilitation. *J Dance Med Sci*. 2017;21(1):13-23. doi: 10.12678/1089-313X.21.1.13.
4. Dancers and Choreographers Pay. Bureau of Labor Statistics Web site. https://www.bls.gov/ooh/entertainment-and-sports/dancers-and-choreographers.htm#tab-5. Updated April 30, 2018. Accessed September 10, 2018.
5. Shah S. Caring for the dancer: special considerations for the performer and troupe. *Curr Sports Med Reports*. 2008;7(3):128-132. doi: 10.1097/01.CSMR.0000319716.56169.29.
6. Cain D, Goodwin BJ, Caine CG, Bergeron G. Epidemiological review of injury in pre-professional ballet dancers. *J Dance Med Sci*. 2015;19(4):140-148. doi: 10.12678/1089-313X.19.4.140.
7. Filipa A, Barton K. Physical therapy rehabilitation of an adolescent pre-professional dancer following os trigonum excision: a case report. *J Orthop Sports Phys Ther*. 2018;48(3):194-203. doi: 10.2519/jospt.2018.7508. Epub 2017 Nov 7.
8. Sluka K. *Mechanisms and Management of Pain for the Physical Therapist*. 2nd ed. Philadelphia, PA: IASP Press; 2016.
9. Chimenti RL, Frey-Law LA, Sluka KA. A mechanism-based approach to physical therapist management of pain. *J Phys Ther*. 2018;98(5):302-314. doi: 10.1093/ptj/pzy030.
10. Bowering KJ, O'Connell NE, Tabor A, et al. The effects of graded motor imagery and its components on chronic pain: a systematic review and meta-analysis. *J Pain*. 2013;14(1):3-13. doi: 10.1016/j.jpain.2012.09.007. Epub 2012 Nov 15.
11. Moseley L, Butler DS. Fifteen years of explaining pain: the past, present, and future. *J Pain*. 2015;16(9):807-813. doi: 10.1016/j.jpain.2015.05.005. Epub 2015 Jun 5.
12. Hodges P. Motor control and pain. In: Sluka K. *Mechanisms and Management of Pain for the Physical Therapist*. 2nd ed. Philadelphia, PA: IASP Press; 2016:67-81.
13. Anderson R, Hanrahan SJ. Dancing in pain: pain appraisal and coping in dancers. *J Dance Med Sci*. 2008;12(1):9-16.
14. Bronner S, Chodock E, Urbano IER, Smith T. Psychometric Properties of the Dance Functional Outcome Survey (DFOS): reliability, validity and responsiveness. *J Orthop Sports Phys Ther*. 2018:1-48. doi:10.2519/jospt.2019.8247.
15. Gamboa JM, Roberts LA, Maring J, Fergus A. Injury patterns in elite pre professional ballet dancers and the utility of screening programs to identify risk characteristics. *J Orthop Sports Phys Ther*. 2008;38(3):126-136.
16. Hincapie CA, Morton EJ, Cassidy JD. Musculoskeletal injuries and pain in dancers: a systematic review. *Arch Phys Med Rehabil*. 2008;89:1819-1829. doi: 10.1016/j.apmr.2008.02.020.

Clinical Application of the Neck Pain Clinical Practice Guidelines

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ABSTRACT

Background and Purpose: Neck Pain Clinical Practice Guidelines (CPG) have been available to physical therapists since 2008; however, there are a limited number of publications describing their application in the clinical setting. The purpose of this article is to demonstrate use of this guideline in 4 patients with neck pain. **Methods:** Four student physical therapists (SPTs) and a faculty member reviewed existing literature related to clinical practice guideline use. The Neck Pain CPG was reviewed and synthesized, and the SPTs identified a patient during their final clinical experience who was appropriate for their application. **Findings:** Three of the 4 patients had positive outcomes with application of the Neck Pain CPG. Three of the 4 clinical instructors had limited familiarity with the CPG and were not using them in the clinic. **Clinical Relevance:** This paper describes the clinical application of the Neck Pain CPG, and demonstrates the value and ease of use of this tool for the clinician. **Conclusions:** Students found the CPG to be clinically useful and were able to educate and model their application for their clinical instructors.

Key Words: clinical practice guideline, knowledge translation, student physical therapist

INTRODUCTION

Neck pain is a common complaint in the general population, with a 12-month prevalence of 12% to 72%.[1] Clinical Practice Guidelines (CPG) for physical therapist management of individuals with neck pain were first introduced in 2008, with revisions published in 2017.[2,3] These guidelines were created to assist clinical decision-making of physical therapists in the diagnosis, examination, and intervention for patients with neck pain.[3] Despite the availability of the neck pain CPG for over 10 years, a search of PubMed and CINAHL completed in 2017 and 2018 using the search terms "neck pain" and "clinical practice guidelines" found no prospective clinical studies related to the use of these guidelines, and only a single retrospective study.[4]

Horn et al[4] retrospectively studied patient outcomes, health care use, and costs associated with physical therapist adherence to the Neck Pain CPG. They used data collected from a single health care system in the Salt Lake City, Utah, region on 298 patient episodes of care from 13 outpatient physical therapy clinics. Adherence to the CPG was determined by examining the use of active versus passive treatments based on Current Procedural Terminology (CPT) codes used for billing, with adherence defined as at least 75% of codes considered active treatments. They found 11% of episodes of care for patients with neck pain were adherent to the Neck Pain CPG. Those in the adherent care group had fewer physical therapy visits, lower costs, and fewer prescription medications; however, the non-adherent group had better improvement in pain, with no difference in disability scores between the groups.[4]

Several studies were identified that examined adherence to low back and upper extremity CPG using paper vignettes, which may not translate well to the clinical setting.[5,6] While paper vignettes provide standardization of patient presentation, the generalizability to clinical practice is questionable. Similar studies using paper vignettes for the neck pain CPG were not found in the literature search. A 2014 study by Berhardsson et al[7] examining attitudes, knowledge, and behavior of Swedish physical therapists found limited awareness and use of the CPG, with 33% reporting awareness and only 13% knowing where to find the guidelines.

The purpose of this report is to describe application of the Neck Pain CPG of the Academy of Orthopaedic Physical Therapy in the clinical setting by 4 student physical therapists, and to discuss their experience using the guidelines. Each student selected and collected information on a single patient during his or her final clinical experience. Each patient signed an informed consent form that had been approved by the Institutional Review Board of Gannon University, Erie, Pennsylvania. The Health Insurance Portability and Accountability (HIPAA) guidelines were followed to protect the privacy of each subject.[8]

Pre-clinic Preparation

The student physical therapists and a faculty member performed a review of current literature related to use of the CPG, a review of the 2008 Neck Pain CPG, and the 2017 revisions CPG. Recommended self-report outcome measures, examination techniques, classification/diagnosis, and interventions were reviewed by the group. Four impairment-based diagnostic categories are recommended in the Neck Pain CPG. These include (1) neck pain with mobility deficits, (2) neck pain with headaches, (3) neck pain with movement coordination impairments, and (4) neck pain with radiating pain. The CPG provides common symptoms and expected examination findings for each category, and suggests interventions for each based on acuity of the patient. The 2017 revisions provide updated evidence; however, the 2008 version remains pertinent as it provides detailed descriptions of some of the examination techniques.[2,3]

To ensure standardized collection of patient information from the clinic, forms were developed based on the CPG for demographic/history information and examination/evaluation. An intervention list was developed for each of the diagnostic categories in the CPG. The students had been taught the examination and intervention techniques recommended in the CPG during their second semester of the program. Two 1-hour review sessions were held just prior to their final clinical experiences to practice the techniques. This was designed to ensure consistency in performance and interpretation of clinical measures and delivery of treatments.

Clinical Use of the Clinical Practice Guideline

Students selected a patient with a diagnosis of neck pain that they evaluated and treated

during their clinical experience for inclusion in this case series. Patients referred for post-operative neck conditions were excluded, as well as those with a history of neck surgery. All patients were seen in an out-patient setting, and each student was supervised by a licensed physical therapist serving as their clinical instructor. The students shared the CPG with their clinical instructor, and explained the rationale for the case study. Each case was summarized and shared with the student group and faculty member in written format, and in verbal format during a face-to-face meeting following the clinical experience. The students reflected on their experience of implementing the Neck Pain CPG in the clinical setting.

Case Examination and Classification

Two patients fit the "neck pain with radiating pain" category, one patient the "neck pain with mobility deficits," and one patient the "neck pain with movement coordination impairments." The "neck pain with headache" category was not represented in this series. The examination and classification of each case is summarized below, and in Tables 1-4.

Case 1 - Neck pain with radiating symptoms

This patient was referred by his primary care physician for management of neck pain with paresthesia and pain radiating to the right thumb and index finger. Demographics of patient case 1 are noted in Table 1, including radiographic results and co-morbidities. His pain and disability levels were high as indicated in Table 4. Additional activity limitation included sleep limited to 1-hour periods due to the neck pain. He reported participation restriction in job tasks as a correctional officer due to his symptoms. Cervical posture was unremarkable, a mild increase in thoracic kyphosis and rounded shoulders were noted. No deficits were found in upper extremity range of motion, or with dermatome and myotome testing.

Cervical range of motion was measured in sitting using a standard goniometer. Flexion and extension were within normal limits (flexion 40°, extension 50-70°)[9] (within normal limits); however, extension increased radicular symptoms distally into the right upper extremity. Right side bending measured 40°, and left 45°. Right and left rotation were 62° and 75°, respectively. Right rotation and left side bending increased radicular symptoms. Palpation revealed tenderness of the C4-6 central cervical region, as well as the right upper trapezius and deltoid muscles.

Additional examination included upper limb tension tests, Spurling's test, and the distraction test. Results are detailed in Table 2. Valsalva test and joint mobility assessment were deferred due to the neurologic symptoms reproduced with active motion and Spurling's test. This patient was classified in the "neck pain with radiating symptoms" category based on radiating symptoms, and the positive Spurling's and distraction tests despite a lack of positive dermatomal, myotomal or reflex tests. Interventions were selected based on this diagnostic category.

Case 2 – Neck pain with radiating symptoms

This patient self-referred to physical therapy with complaints of left sided neck pain and paresthesia that radiated into the shoulder and rarely to the forearm. Symptoms occurred primarily while at her desk, resulting in participation restrictions with work tasks. She had been self-treating with a home electrical stimulator unit, ice, and heat; however, symptoms had not resolved. Her pain and disability were at a mild to moderate level as indicated by the visual analog scale (VAS) and Neck Disability Index (NDI) scores in Table 4. A mild forward head posture was noted, and a slight increase in thoracic kyphosis. No deficits were found in upper extremity range of motion, or dermatome and myotome testing.

Cervical range of motion for flexion and extension were within normal limits of 40° for flexion and 50-70° for extension.[9] Flexion was painfree, but extension reproduced pain at end range which resolved when returning to neutral. Right side bending was limited to 25° and did not reproduce symptoms, left side bending was painful at 45°. Rotation in both directions was within normal limits and did not reproduce symptoms. Palpation of the cervical spine revealed point tenderness and increased pain on the left side of the cervical musculature between C4 and C7. The patient stated that this pain was different than her usual pain. No pain was noted during palpation of the left upper trapezius and deltoid.

Additional tests included upper limb tension tests, Spurling's test, Valsalva test, mid to lower cervical segmental mobility tests (posterior to anterior springing C3 - T6), manual muscle testing of neck musculature, the craniocervical flexion test and the neck flexor muscle endurance test. See Table 2 for test results. This patient was classified in the "neck pain with radiating symptoms" category, based on radiating symptoms and a positive distraction test despite a lack of positive dermatomal, myotomal or reflex tests. Interventions were selected based on this diagnostic category.

Case 3 – Neck pain with mobility deficits

This patient was referred by her primary care physician for management of bilateral neck pain, right greater than left, that had been interfering with her ability to work, sleep, turn her head, and drive. Her pain and disability levels were high as indicated in Table 4. Activity limitations were noted with driving and sleeping, and she reported participation restrictions in her work activities as a restaurant owner. Forward head and rounded shoulder posture were noted. No deficits were found in upper extremity range of motion, or dermatome and myotome testing.

Cervical active range of motion was assessed with a standard goniometer in a seated position. Flexion was 42°, extension 38°, right side bending 33°, left side bending 35°, right rotation 21°, and left rotation 20°. She reported pain at end range with rotation and side bending bilaterally. Attempts at passive range of motion revealed an empty end feel with no change in motion. Observation of cervical retraction revealed limited flexion in the upper cervical spine. There was tenderness to palpation on her C4-7 spinous processes, right levator scapulae, bilateral middle scalene, bilateral upper trapezius, and bilateral sub-occipital musculature.

Additional tests included the cervical flexion rotation test, Spurling's test, distraction test, joint mobility assessment of the cervical and thoracic spine, Valsalva test and the craniocervical flexion test. Results are detailed in Table 2. The patient was classified in the "neck pain with mobility deficits" category, and interventions were selected based on this diagnostic category.

Case 4 – Neck pain with movement coordination impairments

This patient self-referred to physical therapy with complaints of neck stiffness, dizziness, and pressure about his face. He denied radiation into the upper extremities. Symptoms were exacerbated by sitting in a slouched posture at work and home, and occasionally with sustained pressure such as wearing a coat, resulting in limitations with these activities. The patient noted participation restrictions in playing with his children, and lifting items due to fear of exacerbating his symptoms. Symptoms had been present for 2 years following an alcohol related fall in which he struck his neck

Table 1. Demographics of the Four Patients

Case	Age (years)	Sex	Onset	Symptom Duration	Imaging	Occupation	Co-morbidities
1	65	M	Gradual (no incident)	1 ½ weeks	X-ray -age related spondylitic changes	Correctional officer	Arthritis, high cholesterol
2	42	F	Gradual (worse with desk work)	2 months	Not performed	Office/desk work	Not pertinent
3	38	F	Sudden (no incident)	2 weeks	Not performed	Self-employed restaurant owner	Anxiety, depression, low back pain
4	34	M	Sudden (fall/ contusion)	2 years	MRI and X-rays reported negative	Office/desk work (sales)	Not pertinent

Abbreviations: M, male; F, female; PMH, past medical history; MRI, magnetic resonance imaging

Table 2. Examination Findings of the Four Patients

Case	Cervical ROM	Muscle Strength/Function	Special Tests	Joint Mobility Assessment	Category
1	Decreased	Deferred	+ Spurling's + Distraction Valsalva – deferred + Median nerve upper limb tension	Deferred	Neck pain with radiating pain
2	Decreased	MMT Anterior flexors 5/5 Anterolateral flexors 5/5 Posterolateral extensors 5/5 Craniocervical Flexion Test 30 mm Hg hold x 10 seconds Neck Flexor Endurance - 60 seconds	Spurling's - neg + Distraction Valsalva - neg + Median nerve upper limb tension	Hypomobile C4-7 Normal mobility of C2-3 and upper thoracic spine	Neck pain with radiating pain
3	Decreased	MMT Anterior flexors 4/5 (pain limiting) Rhomboids 4-/5 Middle trapezius 4-/5 Lower trapezius 3+/5 Craniocervical Flexion Test - neg	Spurling's - neg Distraction - neg Valsalva - neg Cervical and Thoracic Mobility Tests + Cervical flex rot	Hypomobile AO joint sideglides Cervical and thoracic PA springing	Neck pain with mobility deficits
4	WNL	MMT Anterior flexors 4+/5 Anterolateral flexors 4+/5 Posterolateral extensors 5/5 Craniocervical Flexion Test - neg Neck Flexor Endurance – 40 seconds	Spurling's - neg Distraction - deferred Valsalva- neg Upper limb tension – neg + Joint position error	Normal mobility	Neck pain with movement coordination impairment

Abbreviations: ROM, range of motion; WNL, within normal limits; MMT, manual muscle test; mmHg, millimeters of mercury; neg, negative; +, positive; AO, atlanto-occipital; PA, posterior to anterior; rot, rotation

on a curb. He denied pain, but described his other symptoms at a high level, with disability rated low as detailed in Table 4. He had medical imaging as described in Table 1, and had received prior medical assessment and treatment at a concussion/ vestibular center, and a prior physical therapy episode of care focused on coordination exercises and joint mobilization of the neck without symptom resolution. Mild forward head and rounded shoulders were noted. Screening of upper extremity motion found no restrictions.

Range of motion of the cervical region including active and passive movements was full, with complaints of stiffness at end range. Motion of the neck did not reproduce his current symptoms of dizziness or facial pressure. Palpation was unremarkable about the cervical/scapular region.

Additional testing included upper limb tension tests, Spurling's test, Valsalva test, craniocervical flexion, and neck flexor endurance. See Table 2 for results. Reproduction of dizziness occurred with testing of the vestibulo-ocular reflex. Cervical joint position testing results were inconsistent, with mul-

Table 3. Interventions that Were Used for the Four Patients

Case	Biophysical Agents	Manual Therapy	Therapeutic Exercises	Patient Education
1	Moist Heat/IFC, Infrared/Laser Therapy	Soft Tissue Massage, Trigger Point, Manual Stretching, Manual Traction	Cervical stretching, Scapular strengthening	Postural, Work Adaptations
2	None	Soft Tissue Massage, Joint Mobilization, Manual Traction Median nerve glides	Postural exercise, Scapulo-thoracic strengthening	Posture Activity modification Workstation set up
3	Moist Heat/IFC	Joint Mobilization, Passive Range of Motion	Cervical stretching, Scapulo-thoracic strengthening Upper extremity strengthening	Importance of mobility with ADLs
4	None	Cervical SNAGs C3-7	Postural exercises Scapulo-thoracic strengthening Upper extremity strengthening, Cervical coordination exercise (head laser unit); Deep neck flexor endurance training, Functional exercise (lifts)	Return to regular non-provocative activities

Abbreviations: IFC, Interferential current; SNAG, sustained natural apophyseal glide; ADL, activities of daily living

Table 4. Episode of Physical Therapy Care and Outcomes

Case	Treatment Length	Number of Visits	Status at end of Clinical Experience	VAS Initial/Final (0-10 scale)	NDI (Initial/Final) (%)	Outcomes
1	8 weeks	17	Continued care with clinical instructor for treatment of elbow	6/0	80/18	Pain (0/10) and disability (18%) decreased, cervical motion was full, sleep disturbance resolved.
2	5 weeks	8	Discharged, goals met	4/0	12/4	Pain-free increases in cervical range of motion. Ability to manage any cervical symptoms while working with postural correction.
3	4 weeks	11	Discharged, goals met	6/0	64/8	Increased cervical motion. Increased scapular and cervical muscle strength. Pain-free driving and work tasks.
4	6 weeks	10	Continued care with clinical instructor	9/9*	20/20	Improvements in cervical strength. No change in symptoms. Able to return to functional lifting of 40 pounds. Deficits in cervical proprioception remained.

Abbreviations: VAS, Visual Analog Scale; NDI, Neck Disability Index
* = symptoms of pressure, dizziness and stiffness but denied pain

tiple instances of error above the 4.5° level when tested with a laser head light and paper target. This patient was classified as "neck pain with movement coordination impairments" and interventions were selected based on this diagnostic category.

Case Intervention and Outcomes

Interventions for each patient are summarized in Table 3, and a summary of the episode of care and outcomes in Table 4. Three of the 4 cases had positive outcomes, with resolution of pain, decreases in disability to the negligible/low range as measured with the Neck Disability Index[10] and improvements in impairments as noted. The patient with longstanding and more atypical presentation (Case 4) had no improvement in symptoms though some increased neck muscle strength was noted. He did experience improved function with successful resumption of lifting activities which he had been avoiding for the past two years due to fear of exacerbation of symptoms. This patient was subsequently transitioned to the clinical instructor, a McKenzie certified physical therapist, who modified the treatment plan.

Case 1

Interventions initially focused on pain management with moist heat and interferential current in addition to manual therapy including cervical distraction, soft tissue mobilization, trigger point release and manual stretching of cervical and scapular muscles. Home exercises and patient education in symptom management via activity modification were used. Treatment progressed to include mechanical traction, median nerve glides, and strengthening of cervical and scapular muscles. Outcomes related to the neck complaints included resolution of neck pain, full cervical motion, and improvement of activity limitations in sleep to 5 hours. Prior participation restrictions with work tasks were resolved. The patient experienced an unrelated occurrence of epicondylalgia during the final 2 weeks of his care that was managed by another physical therapist.

Case 2

Interventions included soft tissue mobilization, manual cervical distraction, posterior to anterior and side-glide mobilizations of C4-7. The patient was educated in postural correction, activity modification, and ergonomic workstation set-up. Treatment was progressed to include postural and scapular strengthening exercises and median nerve glides. The postural exercises were incorporated into her workday, and the scapular exercises were progressed over the duration of the episode of care. Outcomes included resolution of pain, full cervical motion and decreased NDI scores into the negligible range. The absence of pain resulted in resolution of participation restrictions with her work tasks. Mild reproduction of symptoms persisted with the median nerve tension test.

Case 3

Interventions in the clinic were focused on manual therapy including grade III side glide and posterior glides of the atlanto-occipital joint, side glide mobilizations C4-7 and posterior to anterior mobilizations of C4-T12, and passive range of motion of the cervical region. Interferential electrical stimulation in conjunction with moist heat were used for pain control. The patient was taught self-stretching for the upper trapezius and levator scapulae muscles. Postural correction exercises of cervical and scapular retraction were included in her home exercise program. As her program was progressed, active then resistive exercises of scapular musculature were added. Manual resisted exercises were incorporated using the D2 PNF technique of slow reversal hold. Following 4 weeks of treatment, she demonstrated improvement in cervical motion without pain, and improvement in strength by ½ to 1 grade in the anterior cervical flexors, rhomboids, and middle and lower trapezius muscles. The NDI score was reduced to the negligible range, and the patient reported an overall 98% improvement. She was able to return to all work tasks without restriction, and activity limitations with sleep and driving were resolved.

Case 4

Interventions focused on exercises for neck coordination, neck muscle endurance, and upper extremity and neck strengthening. Cervical isometrics were progressed to exercises in the neck flexor endurance test position. For the upper extremities and scapular stabilizers, free weights and resistance bands were used. Functional activities of lifting up to 40 lbs were incorporated into his program. A cervical mounted laser pointer with a target was used for coordination exercises including cervical rotation, flexion and extension. Cervical sustained natural apophyseal glides were incorporated at the levels of C3-7, without a change in his symptoms. Cervical retraction exercises were also added. Following 6 weeks of therapy the patient denied any changes in his symptoms of stiffness and dizziness. His VAS and NDI scores were unchanged, and he demonstrated continued deficits with joint position testing despite increases in cervical neck muscle strength. Participation restrictions related to lifting were resolved as he was able to perform lifting tasks without exacerbation of his symptoms.

DISCUSSION AND CONCLUSIONS

The Neck Pain CPG has been in existence since 2008, with updated revisions published in 2017.[2,3] There remains an absence of literature examining implementation of the guidelines, and the effect on patient outcomes. This study reviews the evaluation, treatment, and outcomes of 4 patients managed in accordance with the guidelines, and describes the experience of 4 student physical therapists who used the guidelines with one patient each during their clinical experience.

The Neck Pain CPG recommends use of an algometer for assessment of pain pressure threshold as an evaluative technique; however, this device was not available at any of the student's clinical settings. All 4 students used manual muscle testing for strength assessment of the neck and upper extremities of their patients with testing positions as described by Kendall.[11] Patients were classified into the diagnostic categories described in the guidelines, with Cases 1 and 2 fitting the criteria for "neck pain with radiating pain," Case 3 "neck pain with mobility deficits" and Case 4 "neck pain with movement coordination impairments." No patient with "neck pain with headache" category was evaluated and managed during this study.

Interventions were selected from those recommended in the clinical practice guidelines, with additional biophysical agents for pain management in 2 cases. The CPG did not offer guidance in the use of interferential current, an electrotherapy technique used by the student physical therapists for pain management of Cases 1 and 3, who presented with initially high pain scores of 6/10. Both of these patients were managed with active manual and exercise techniques in addition to the modalities, and both had complete resolution of their pain over the course of their treatment (8 and 4 weeks respectively). Manual traction was used with Cases 1 and 2, categorized as "neck pain with radiating pain" and mechanical traction was used with Case 1.

The CPG includes thoracic manipulation as a suggested intervention for the diagnostic categories of neck pain with mobility deficits and neck pain with radiating pain. None of the students used thrust manipulation to the thoracic spine despite having learned these techniques during the didactic portion of their education. Student exposure to thrust manipulation in the clinical portion of their education has been an identified concern. Boissonnault and Bryan[12] in 2005 reported that only 30% of clinical instructors reported training students in manipulation during their clinical experiences. More recently Sharma and Sabus[13] in a survey of students found that 50% reported using manipulation in their clinical experiences; however, this study was based on subjects from a single university and may not be reflective of student experiences across the United States. In a larger study of 460 students from 38 states Struessel et al[14] found that 34% of students in out-patient orthopaedic clinic settings did not use thrust joint manipulation despite determining it was indicated. Students who had a clinical instructor who did not perform manipulation were less likely to have the opportunity to perform thrust manipulation.

Three of the 4 patients had complete resolution of their neck pain and improvement in impairments and function. The symptoms in case 4 were difficult to classify per the recommendations of the guidelines and exhibited no improvement over the course of therapy. This patient, who did not respond positively to implementation of the Neck Pain CPG, had a chronic presentation of 2 years since onset, whereas the remaining 3 had symptoms of 2 months or less. A systematic review with meta-analysis on impairments in pro-

prioception found that those with chronic neck pain perform worse on proprioceptive testing than those without neck symptoms.[15] A similar review on the effect of proprioceptive training found a lack of quality studies, but the low level studies identified no benefit from this training.[16] Management of individuals with chronic symptoms can be more challenging than those with acute or subacute presentations. The atypical presentation of absence of pain, and complaints of pressure and dizziness in Case 4, presenting post neck contusion, may warrant further examination.

The use of clinical practice guidelines in the clinical setting has had limited attention in the literature. Horn et al[4] in a retrospective review of 298 patients, found that in the first 3 years following publication of the Neck Pain CPG only 11% of patients could be categorized as receiving guideline adherent care. In this study the students reported that 3 of the 4 clinical instructors were familiar with the Neck Pain CPG, however did not use them in their clinical practice. Two clinical instructors had additional certification (OCS and MDT). All four clinical instructors were receptive and appreciative of exposure to the Neck Pain CPG.

The Academy of Orthopaedic Physical Therapy began the development of CPGs in 2006, and the Neck Pain CPG was one of the first to be disseminated. There has been a steady increase in the number of available orthopaedic CPGs, with 14 published by the Academy, and 12 more in development.[17] The implementation of these clinical practice guidelines remains a challenge for our profession. In a recent systematic review of strategies to translate knowledge into practice the authors concluded that current initiatives are not always resulting in modification of treatment in the clinical setting.[18] In light of the length of time involved in the translation of information from research to practice, a focus on action is required for our profession.[19]

The impression of the 4 student physical therapists after using the Neck Pain CPG for management of their patients was overall positive. They felt the CPG were a good resource for examination and intervention ideas, and provided some structure and affirmation to their clinical judgements. They did note that clinical experience and expertise were important, and needed to be integrated into use of the guidelines. The students noted that the craniocervical flexion test was difficult to use in the clinical setting due to the length of time needed to perform this test.

With increasing numbers of clinical practice guidelines, the translation of that knowledge into clinical application is crucial. There is a need for additional research to demonstrate the application of, and outcomes with, use of CPGs. Students modeling use of the CPG in the clinical setting may result in increased awareness and use of the guidelines by clinical instructors and other practicing physical therapists.

REFERENCES

1. Haldeman S, Carroll L, Cassidey JD, Schubert J, Nygren A. The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders: Executive summary. *Spine*. 2008;33(4S):S5-S7.
2. Childs JD, Cleland JA, Elliott JM et al. Neck pain: clinical practice guidelines linked to the International Classification of Functioning, Disability and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2008;38:351-360.
3. Blanpied PR, Gross AR, Elliott JM, et al. Neck pain: revision 2017: clinical practice guidelines linked to the International Classification of Functioning, Disability and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2017;47(7):A1-A83.
4. Horn ME, Brennan, GP, George SZ, Harman JS, Bishop MD. Clinical outcomes, utilization, and charges in person with neck pain receiving guidelines adherent physical therapy. *Eval Health Prof*. 2016;39(4):421-434.
5. Maas MJ, van der Wees PJ, Braam C, et al. An innovative peer assessment approach to enhance guideline adherence in physical therapy: single-masked, cluster-randomized controlled trial. *Phys Ther*. 2015;95:600-612.
6. Rutten GM, Harting J, Bartholomew LK, Schlief A, Oostendorp RA. Evaluation of the theory-based Quality Improvement in Physical Therapy (QUIP) programme: a one-group, pretest post-test pilot study. *BMC Health Services Research*. 2013;13:194.
7. Bernhardsson S, Johansson K, Nilsen P, Öberg B, Larsson ME. Determinants of guideline use in primary care physical therapy: a cross-sectional survey of attitudes, knowledge, and behavior. *Phys Ther*. 2014;94:343-354.
8. Health Information Privacy. US Department of Health and Human Services. http://www.hhs.gov/hipaa/. Accessed May 23, 2019.
9. Norkin CC, White DJ. Measurement of Joint Motion: A Guide to Goniometry. 5th ed. Philadelphia, PA: FA Davis Co; 2016.
10. Vernon H. The Neck Disability Index: State of the art 1991-2008. *J Manip Physiol Ther*. 2008;31:491-502.
11. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. *Muscles: Testing and Function with Posture and Pain*. 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.
12. Boissonnault W, Bryan JM. Thrust joint manipulation clinical education opportunities for professional degree physical therapy students. *J Orthop Sports Phys Ther*. 2005;35:416-423.
13. Sharma NK, Sabus CH. Description of physical therapist student use of manipulation during clinical internships. *J Phys Ther Ed*. 2012;26:9-18.
14. Struessel TS, Carpenter KJ, May JR, Weitzenkamp DA, Sampey E, Mintken PE. Student perception of applying joint manipulation skills during physical therapist clinical education: identification of barriers. *J Phys Ther Ed*. 2012;26:19-29.
15. Stanton TR, Leake HB, Chalmers KJ, Moseley GL. Evidence of impaired proprioception in chronic, idiopathic neck pain: systematic review and meta-analysis. *Phys Ther*. 2016;96:876-887.
16. McCaskey MA, Schuster-Amft C, Wirth B, Suica Z, de Bruin ED. Effects of proprioceptive exercises on pain and function in chronic neck and low back pain rehabilitation: a systematic literature review. *BMC Musculoskel Disord*. 2014;15:382. doi:10.1186/1471-2474-15-382.
17. Clinical Practice Guidelines. Academy of Orthopaedic Physical Therapy. https://www.orthopt.org/content/practice/clinical-practice-guidelines. Accessed June 6, 2019.
18. Bérubé ME, Poitras S, Bastien M, Laliberté LA, Lacharité A, Gross DP. Strategies to translate knowledge related to common musculoskeletal conditions into physiotherapy practice: a systematic review. *Physiother*. 2018;104:1-8.
19. Li LC, van der Wees PJ. "Knowing is not enough; we must apply. Willing is not enough; we must do"[editorial]. *Phys Ther*. 2015;95:486-490.

Effectiveness of Painful Loading in Lateral Elbow Tendinopathy on Pain Outcomes: A Systematic Literature Review

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ABSTRACT

Background and Purpose: To determine if painful loading of tendinous conditions of the lateral elbow impacts outcomes to guide effective clinical practice. **Methods:** A systematic literature review examined randomized controlled trials from 1975 to October 2018 regarding conservative management of lateral elbow tendinopathy. An electronic search of PubMed, CINAHL, OVID Medline, and SportDiscus were performed and assessed for bias. **Findings:** Eighteen studies of fair to high quality evidence based on the PEDro scale were included. All articles including loading found it to be an effective intervention in reducing lateral epicondylalgia pain. **Clinical Relevance:** Loading, manipulation, and mobilizations with movement are supported in the management of lateral elbow tendinopathy. **Conclusion:** The results of this review are unable to support the use of painful loading as effective management of lateral epicondylalgia. Future studies are necessary due to the limited number of pain measures, heterogeneous populations, insufficient exercise prescriptions, and lack of pain classification.

Key Words: epiconylagia, manipulation, tennis elbow

INTRODUCTION

Lateral epicondylalgia (LE), often referred to as "tennis elbow," is a tendon-related pathology of the lateral elbow. Prevalence rates for LE vary; however, in a 2006 study the prevalence of LE was found to be 1.3%, with the highest rates being in the 45- to 54-year age group. Associations were also found between the presence of LE and current or past history of smoking, obesity, and repetitive or forceful movements of the arm.[1] In other literature, prevalence rates were similarly found to be 4 to 7 cases per 1000 patients, with the highest prevalence occurring in the 35 to 54 age range. The symptoms were found to last between 6 months and 2 years, with recovery occurring in 89% of cases.[2] This optimistic prognostic data is contrasted by the combination of a poorly understood etiology, high rates of recurrence, and the findings that LE may last up to 2 years.[3,4] Likewise, although the rate of recovery from LE was found to be relatively high, data suggest that the average length of sick leave due to epicondylalgia in manual workers was high at 16 days, with a prevalence rate higher than what is typically reported in the literature.[5]

Previously, due to its associated inflammatory processes, LE was classified as a tendinitis and referred to as "lateral epicondylitis". However, recent histological evidence suggests there is a degenerative component in the absence of inflammation; therefore, it is now referenced under the umbrella term of tendinopathy. The modification of terminology from "epicondylitis" to "epicondylalgia" reflects the pain dominant nature of LE, rather than a focus on a physiological process of inflammation that is limited in its ability to explain the condition.[6] Our understanding of the pathological changes of tendinopathy has evolved over time, marked most recently by the introduction of a new model of tendon pathology proposed by Cook and Purdam.[7] This model features 3 broad categories occurring on a continuum from reactive tendinopathy to tendon disrepair, and finally to tendon degeneration. The conceptualization of a continuous model of tendinopathy allows clinicians to prescribe interventions specific to the patient along that continuum with the intent to improve outcomes. The relationship between the stage of a tendon within this model and the presence of pain is variable, as evidenced by Malliaras and Cook in which they found an absence of pain in tendons with structural changes on imaging, as well as the presence of pain in normal tendons.[8] These findings, in combination with the work of Moseley and Butler and Rio et al exploring potential peripheral and central nervous system drivers of nociception, suggest the need for a reconceptualization of our understanding of pain as an outcome of tissue change; that pain is a multi-variable output of the brain involving many individual and contextual factors.[9,10]

Until present, there has been no gold standard established for conservative management of LE. Nonoperative management has included nonsteroidal anti-inflammatory drugs, physical therapy, braces/orthoses, shockwave therapy, and various types of injections.[11] With recent advancements in the understanding of pain as a complex process, clinicians have aimed to develop more effective interventions that align with this reconceptualization of pain.[10] This concept has been mirrored in literature findings linking higher rates of depression and anxiety in patients suffering from LE.[12]

Within this context, clinicians have begun to explore the concept of the pain experience during therapeutic exercise, and whether or not this carries positive or negative associations with outcomes. In a recent systematic review by Smith et al,[13] the authors concluded that painful exercises provided a small but statistically significant benefit over pain-free exercises in the management of chronic musculoskeletal conditions. There are several reasons as to why these results are unlikely to be replicated within the LE literature investigating pain. First, the overall quality of the included studies in this systematic review was moderate to low, limiting its internal validity. Secondly, many studies either failed to protect against bias via blinding, or suffered a high level of attrition.[14] Lastly, there are numerous differences between the lateral elbow and the low back, shoulder, Achilles, and heel that were included by Smith et al in regards to activities of daily living, psychosocial impacts, and various loading possibilities.[13]

The investigation of pain as an outcome measure is not limited solely to the use of a subjective rating scale. In this systematic review, the investigation of pain is broadened to include other validated measures such as pain-free grip strength, pressure algometry, graphic representation, and numeri-

cal, verbal, or visual analogue scales.[15-19] The association between pain during exercise and outcomes from LE is still unclear; therefore, the purpose of this review is to determine the relationship between painful loading of tendinous conditions of the lateral elbow and its impact on pain outcomes in order to guide effective clinical practice.

PARTICIPANTS AND METHODS

A search of the following databases was performed electronically: PubMed, CINAHL, OVID Medline, and SportDiscus. Studies were included from 1975 to October 2018. The search terms used are displayed in Table 1. Duplicate references were removed from Refworks. One group removed articles based on irrelevant titles, placed them into a separate folder, and a second group reviewed these articles to ensure relevant titles were not removed. Multiple reviewers screened articles by abstract to remove articles that did not fit inclusion/exclusion criteria noted below while also searching the reference lists of included studies to identify additional useful literature not previously identified through database searches. Figure 1 depicts the study selection process including the rationale for why articles were eliminated from analysis.

Inclusion and Exclusion Criteria

Participants

Studies included adult participants (age 18-65) with painful lateral elbow tendinopathy. Studies were included if tendon conditions were referred to with synonymous terminology (ie, tennis elbow, lateral epicondylitis), such that non-tendon related pathologies were ruled out (ie, nerve entrapment).

Interventions

Studies that explored any therapeutic loading of tendon conditions, regardless of pain were included. Studies were included if supplementary interventions/modalities were provided (ie, transcutaneous electrical nerve stimulation, manual therapy, etc), with the exception of medical interventions (ie, corticosteroid injections, surgery).

Outcomes

Studies that involved outcome measures related to pain were included in the search. Outcome measures were only included if they were valid and reliable.[20-25]

Study design

Randomized controlled trials were the only studies included, in an effort to minimize the potential for bias.

Table 1. Search Strategy

Loading	Tendinopathy	Controlled Trials
exercise*	elbow tend*	randomized controlled*
eccentric*	elbow pain	controlled clinical trial
concentric*	lateral epi*	randomized controlled*
loaded*	tennis elbow	placebo
resistance*	extensor carpi radialis	randomly
physiotherapy*		trial
physical therapy*		groups
rehabilitation*		
conservative management		

Wildcard, this means that words with different endings would be retrieved without having to type all of the different variations. For example, "elbow tend" would retrieve 'elbow tendinopathy', 'elbow tendonitis', 'elbow tendinosis' etc.

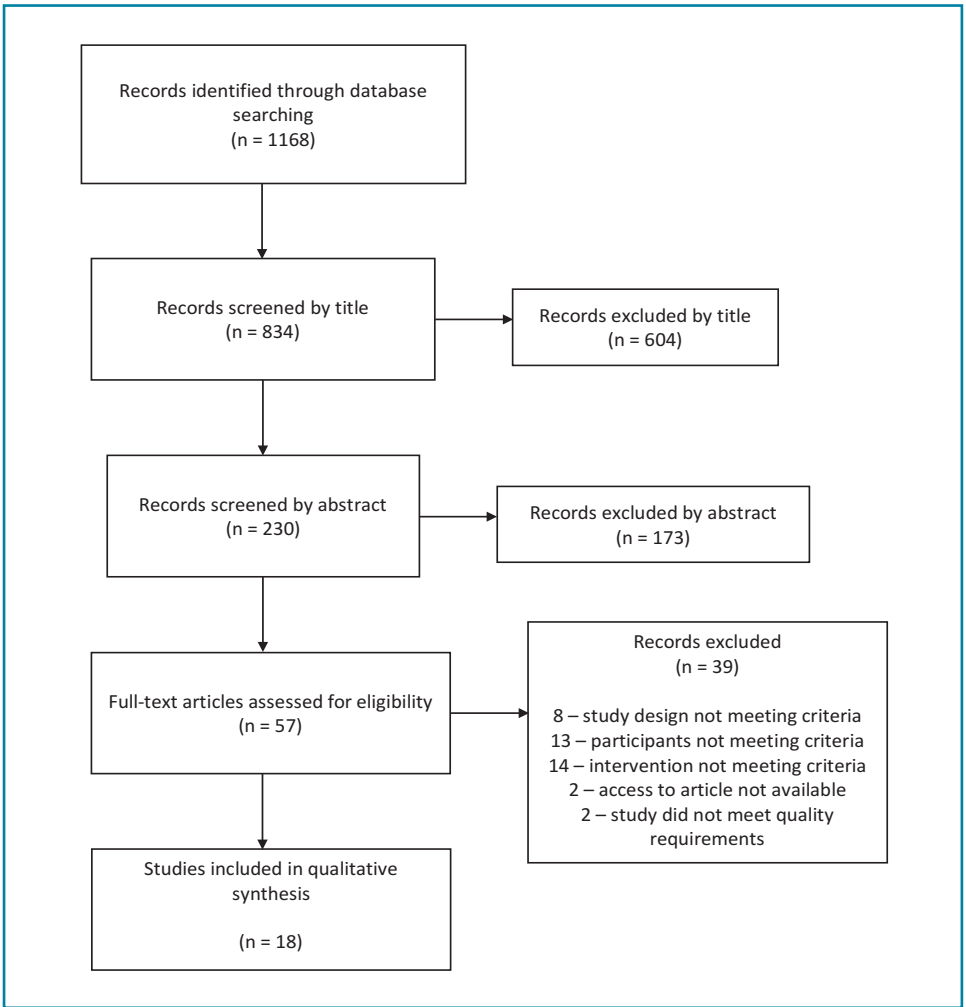

Figure 1. Study selection process.

Language

Studies were included with full texts in English or French. In order to minimize bias, multiple reviewers screened the search results through Refworks and removed duplicate titles and unrelated abstracts. The reviewers then collaborated to extract data that fit the inclusion and exclusion criteria previously identified.

Risk of bias assessment

Risk of bias was assessed via the PEDro scale, using 4/10 as the cut-off score. The PEDro scale has been validated in prior studies and is widely used in physical therapy research.[26] Each item was rated as yes (= 1), no (= 0), or unclear (= 0). An acceptable study was one that scored a minimum of 4 on the PEDro scale and had no fatal flaw, which was defined as: (1) drop-out greater than 50% and (2) statistically and clinically significant differences between groups at baseline indicating unsuccessful randomization.

Data synthesis

Based on the broad scope of interventions included, heterogeneity of exercise prescription parameters, and outcome measures were synthesized in the context of individual study's contextual factors.

RESULTS

The search generated a total of 1168 records, which was reduced to 834 once the duplicates were removed. The title and abstracts removal left 57 articles for full-text review. There were 39 full-text articles that were excluded due to study design, inclusion criteria, intervention criteria, access to the article, or the study rated as below 4/10 on the PEDro scale. After reviewing the full-texts articles, 18 articles met the inclusion criteria, were selected and reviewed (see Table 2 for articles reviewed).

DISCUSSION

Exercise Type

In regards to contraction type when treating LE, two articles directly compared concentric, eccentric, and isometric contractions. In a study by Martinez-Silvestrini et al, 3 groups consisting of conservative physical therapy management employing concentric strengthening, eccentric strengthening, as well as stretching exercises were compared. All groups improved in visual analog scale (VAS) and pain-free grip strength but there was no significant difference between groups at the end of the study.[27] In another study by Stasinopoulos, the effects of eccentric, eccentric-concentric training, and eccentric-concentric trainings combined with isometric contraction were compared, while all groups also performed static stretching exercises. The reported reduction in pain on VAS was significantly greater in the eccentric-concentric training combined with isometric group at weeks 4 and 8. There was no difference between the eccentric-concentric and the eccentric only training groups.[28] The findings of these two articles suggest that there is no difference in pain-related outcomes based on contraction type, although, an additional benefit could be seen when incorporating isometric exercises. These findings were recently mirrored in patellar tendinopathy literature where isometrics have demonstrated efficacy above that of isotonics in managing pain, at least in the short term.[11] A recent systematic review comparing the effects of contraction types on pain and function found that isometric exercises were more effective in managing pain in the short term, while heavy slow resistance and eccentrics may be more effective in pain management over the longer term.[29] Clinicians must be wary of the differences between the patellar tendon and lateral elbow, however, these findings provide guidance in the investigation of loading in lateral epicondylalgia in future research.

Thirteen out of the 18 studies included information related to dosage variables (ie, repetitions, set, frequency etc). Among these studies, there was considerable variability and inconsistency when prescribing dosing parameters, with only one study directly comparing a dosing parameter.[30] Regardless of dosage, it is shown that exercise is effective in reducing pain in LE; however, due to lack of comparison between dosing parameters, the optimal dosage is unclear. Comparison of dosage across studies presents a challenge, due to the increase in confounding variables between studies (ie, taping, ultrasound, stretching etc.), limiting our ability to develop recommendations. In the study by Lee et al, 3 groups consisting of 2, 3, and 6 days per week of general physical therapy were compared. At 3 weeks, the differences among the groups were not significant, although, all 3 groups showed a statistically significant decrease in pain on VAS. At 6 weeks, the pain scores of the 6 days per week group however, showed statistically significant difference compared to the other groups.[31] While all groups had significant decreases in pain, the 6 days per week group showed the most improvement. The VAS scores at 6-week post-test for the 2, 3, and 6 times per week groups were 5.7, 4.6, and 2.6, respectively. These findings, in which VAS scores were half as high for the higher frequency groups, suggest that there may be an importance when looking at dosage. It is unclear whether these differences are due to increased frequency or increased total volume performed by the 6 days per week group.

Only 4 of the 18 included articles allowed for mild pain during the exercise programs, while the remaining 14 articles either prohibited any pain during exercise or did not provide detail on the quantity of pain allowed. No studies allowed for pain provocation to exceed a mild discomfort, nor did any study compare painful loading to pain-free loading directly. The authors suggest that loading is effective in reducing pain in LE regardless of the presence of mild discomfort; however, due to a lack of comparison between painful and pain-free loading and the variability across studies regarding methodology, the optimal prescription of exercise related to pain while loading remains unknown. In regards to quantifying pain, there are multiple outcome measures that are used in the literature, and which have been deemed valid and reliable. Among the 18 articles selected, 15 of the 18 articles used the VAS, while 6 of the 18 used the pain-free grip scale, and 4 of the 18 used the point pressure threshold, with a limited number of articles overlapping in the use of multiple measures. The lack of congruous assessment of pain as an outcome measure, in combination with poor description of pain tolerance during exercise, raises concern regarding the value of the current literature in guiding clinical practice. Likewise, these inconsistent and seemingly incomplete study designs seem to undermine the importance of pain in clinical outcomes, contrary to recent work suggesting pain as an important component of a broad biopsychosocial understanding of patient management.[10,11,32,33] Due to complexity of pain as a process influenced by psychological, peripheral, and central mechanisms, future research should use multiple methods of assessing pain which further encapsulates these individual patient variations.

Manual Therapy

Seven articles examined manual therapy interventions in the treatment for lateral epicondylalgia. This included manipulation, mobilization with movement (MWM), transverse friction massage, and instrument-assisted soft tissue mobilization (IASTM) therapy. Manual therapy was part of a multimodal approach in all study designs.

Bissett et al studied a group receiving physical therapy (elbow MWM, therapeutic exercise, HEP, self-manipulation), a wait-and-see group and a corticosteroid injection group.[34] Both the wait-and-see group and injection group used twice as many analgesics for pain compared to the physical therapy group with MWM. The physical therapy group had a superior benefit to injection and wait-and-see after 6 weeks but not at 52 weeks. Joshi et al[35] studied the use of wrist manipulation for those with LE. When pain subsided, subjects

Table 2. Characteristics of Included Studies

References	Exercise Dosage	Outcome Measures
Bisset et al (2006)	- 8 treatments, 30 minutes over 6 weeks of exercise - No specific exercise included	(a) Severity of pain
Struijs et al (2004)	- Strengthening and stretching HEP 2x/day - Each exercise included 10 repetitions in 2-3 sets and performed 4-6x/day	(a) Pain-free grip strength (b) Pressure pain
Langen-Pieters et al (2003)	- Isometric exercises were done in wrist flexion, extension, radial deviation and ulnar deviation in first 2 weeks - Simple exercises with TB were used in weeks 3 and 4 - Combined movements, supination and pronation were done with TB and with resistance in weeks 5 and 6	(a) Pain-free grip strength (b) VAS
Viswas et al (2012)	- Eccentric strengthening: patient slowly lowered wrist into flexion for a count of 3, using contralateral hand to return the wrist to maximum extensions. 3 sets of 10 repetitions were performed during each treatment, with 1-minute rest interval between each set	(a) VAS
Sevier et al (2015)	- Eccentric strengthening exercises performed 2x/week for 2 pain-free sets of 15 repetitions each, increasing to 3 sets as tolerated	(a) Pain with activity
Joshi et al (2013)	- 2x/week, max 5 intervention sessions over the 3 weeks - Duration of treatment session was 15-20 minutes - No specific exercise included	(a) VAS
Emanet et al (2010)	- 3x/day for 20 repetitions - Strengthening exercises: performed with medium hard ball, 20-30 repetitions depending on pain level	(a) VAS - after activity, rest, and with resisted wrist extension (b) PPT (c) Pain-free grip strength
Agostinucci et al (2012)	- 6 weeks, 2x/day at least 4x/week - Resisted forearm supination 3x10 - Resisted wrist extension 3x10	(a) Pain with chair pick up test
Bhambhani et al (2016)	- Exercise prescription not included	(a) VAS
Choi et al (2017)	- Concentric exercises applied for 15 minutes 3x/week for 4 weeks (total of 12x)	(a) VAS
Eraslan et al (2017)	- Eccentric strengthening: patients slowly lowered wrist to flexion 30x - Patients were to continue exercise even when they experienced mild discomfort and to stop exercise if pain worsened - 3 sets of 10 repetitions with 1-minute rest interval between sets	(a) VAS
Ho et al (2007)	- Exercise prescription not included	(a) Mechanical-pain threshold (kg) (b) Pain-free grip strength (c) VAS
Lee et al (2018)	Stretching for 5 minutes (a) Group 1 - muscle eccentric contraction: 15x5 with break of 1 minute each set (b) Group 2 - push-up plus exercise using slings: 5x5 with a 1-minute break after each set	(a) VAS (b) PPT (UT) (c) PPT (WE) (d) Pain-free grip strength
Kachanathu et al (2017)	- Strengthening exercises: 3 sets of 10 repetitions with 1-minute rest in between sets → progress the exercise by increasing the load	(a) Pain-free grip strength
Lee et al (2014)	- Grip exercises: 3 sets of 10-15 repetitions with 1-minute rest	(a) VAS
Martinez-Silvestrini et al (2005)	Strengthening (concentric and eccentric) - Exercises performed 3 sets of 10 repetitions 1x/day with 2-5 minutes of rest between sets	(a) Pain-free grip strength (b) VAS
Stasinopoulus et al (2017)	- 3 sets of 15 repetitions of slow progressive exercises of the wrist extensors with 1-minute rest between each set	(a) VAS (b) Pain-free grip strength
Stergioulas (2007)	- 5 sets of 8 repetitions of slow progressive plyometric exercises of the wrist extensors each session with 1-minute rest between sets	(a) VAS

Abbreviations: HEP, home exercise program; VAS, visual analog scale; TB, TheraBand; PPT, pressure pain threshold; UT, upper trapezius; WE, wrist extensor

were instructed to do muscle stretching and strengthening exercises. Wrist manipulation was found to be effective in the reduction of pain at the moment, pain during the day, and lower score on 0-10 scale of inconvenience.[35] Non-thrust manipulation of the elbow complex had a significant improvement in pain scores on the VAS by the end of treatment.[36] All participants in this group had restrictions at the radial head. Langen-Pieters et al did find that non-thrust manipulation reduced pain as well. Evidence supports the use of thrust manipulation, non-thrust manipulation, and MWM in the management of LE for short-term pain reduction.[36]

Bhambhani et al compared kinesiotaping with a conventional physiotherapy group to a conventional physiotherapy only group, in which deep friction massage was part of the treatment for both groups. Both groups improved in pain and there was no significance between groups.[37] Strujis et al compared physical therapy (friction massage for 5-10 minutes, ultrasound, stretching and strengthening exercises) to bracing and found physical therapy was more effective in reducing pain (VAS) when compared to bracing after 6 weeks. At 26 and 52 weeks, no differences were present between all studied groups.[38] In a study by Viswas et al, a group receiving 10 minutes of deep transverse friction massage immediately followed by Mills' manipulation, showed a reduction in pain intensity after 4 weeks; however, the supervised exercise program showed greater improvement in comparison to those who received 10 minutes of deep transverse friction massage immediately followed by Mills' manipulation alone.[39] These studies do not support the use of transverse friction massage for LE.

Only one article studied the effects of IASTM therapy in the treatment of LE. A group receiving IASTM therapy 2 times weekly for 4 weeks, the program also included strengthening and stretching, showed significant improvements in pain with activity at 6 months and 12 months as compared to baseline measurements; 78.3% of subjects who received IASTM therapy resolved their symptoms.[40] As this outcome is no better than the wait and see approach, its use cannot be supported at this time.

Modalities

Cryotherapy

In the article by Agostinucci et al, the effects of exercise and cryotherapy were investigated in a randomized controlled trial. Participants were randomized into 4 groups consisting of a home exercise program (HEP) only, HEP + gel cold pack, HEP + Cryo-Max, and Cryo-Max only. This study showed significant improvements in pain levels for all 4 groups, but no significant difference was found among the groups. While the authors of this study suggest there is evidence for treating lateral epicondylitis with cryotherapy alone as noted by a 45% pain decrease with the use of the Cryo-Max, a high drop-out rate of 29% and the failure of the study to provide a control group really limit the findings.[41]

Taping

Two studies included kinesiotaping and its effect on pain levels in patients with LE. Eraslan et al compared 3 groups, one group who received kinesiotaping and usual physical therapy, another group received extracorporeal shock-wave therapy and usual physical therapy, and the control group received usual physical therapy. Usual physical therapy included cold pack and TENS five times a week for 15 sessions and a home exercise program consisting of stretching and eccentric strengthening. While all 3 groups showed significant improvements in VAS scores for pain at rest, inter-group comparison showed that the kinesiotaping group was most effective in reducing pain levels.[42] Similarly, in a second study by Bhambhani et al, kinesiotaping + physical therapy was found to have a greater reduction in pain levels compared to physical therapy alone.[37] These studies support the use of kinesiotape with physical therapy to provide patients with a short-term benefit for LE.

TENS and microcurrent therapy

Two studies tested the effects of TENS and microcurrent therapy. Choi et al compared a group receiving TENS while simultaneously performing wrist extension exercises to another group that received TENS prior to completing wrist extension exercises. While both groups showed significant improvements in VAS scores for pain, no difference was found between groups, indicating the timing of TENS delivery had no impact on pain intensity.[43] Ho et al compared a group of subjects receiving microcurrent therapy and exercise to another group receiving exercise only. Both groups had improvements in VAS scores, decreasing pain by 7.17% (microcurrent therapy) and 12.21% (exercise), but no between group differences were found.[44] Transcutaneous electrical nerve stimulation and microcurrent therapy cannot be recommended based on this evidence.

Laser therapy

Two studies included in the review looked at the effects of Gallium-Arsenide (GaAs) laser therapy on LE. Emanet et al compared a laser group to a placebo laser group over the course of 3 weeks consisting of 15 treatment sessions. While a significant reduction in resting pain was observed for both groups at 3 weeks and 12 weeks, no significant difference was found between the groups.[45] Stergioulas et al observed the effects of low-level laser therapy when combined with plyometric wrist exercises. The group receiving both laser and plyometric exercises had a significant decrease in pain at rest compared to the group receiving plyometric exercises and placebo laser treatment. This significant decrease in pain was observed after 8 weeks of treatment and also at the end of the 8-week follow-up period.[46] However, due to the limited number of studies and the conflicting results, more evidence is needed before a recommendation on laser therapy can be made.

Ultrasound

Only one study included in the review directly observed the effects of ultrasound on LE. Langen-Pieters et al used a protocol consisting of manipulation to the elbow, stretching, and strengthening exercises and compared it to a group receiving only ultrasound. Subjects from each group were treated twice a week for 6 weeks. Following assessments at 3 weeks and 6 weeks, significant improvements in pain reduction were found in both groups, however, the ultrasound group was significantly better in reducing pain when compared to the other protocol.[36] There were only 13 subjects used in this study so more evidence is needed before a recommendation can be made.

Stretching

One study by Martinez-Silvestrini et al looked at stretching alone in comparison to stretching with eccentric or concentric strength training. Stretching of the wrist extensors was performed twice a day for 3 repetitions of 30 seconds with a 30 second rest between repetitions. Following 6 weeks of stretching or stretching with strength training, significant improvements in pain intensity were made in all 3 groups, however, no significant differences were noted during inter-group comparisons. Since stretching was included in each group, it is difficult to make conclusions about its impact on pain intensity. Furthermore, all exercise sessions were performed at home which poses potential adherence issues, and no follow-up data

were collected.[27] Viswas et al compared the effectiveness of a supervised exercise program to Cyriax physiotherapy. In addition to eccentric training of the wrist extensors, static stretching of the extensor carpi radialis brevis was performed. The stretch was completed 3 times before and 3 times after the eccentric training and was held for 30 to 45 seconds. Following 4 weeks of treatment, both groups had significant improvement in pain.[39] More evidence is needed to make a recommendation.

Forearm band/brace

Struijs et al compared a brace only group, a physical therapy only group, and a brace and physical therapy group. Physical therapy consisted of ultrasound, friction massage, strengthening, and stretching. At 6 weeks, the physical therapy only group was superior to the other groups for pain intensity. However, at 26 weeks and 52 weeks follow-up, no significant differences were identified.[38] Kachanathu et al compared the use of a forearm band, elbow taping, and physical therapy. Both taping and band groups received physical therapy which included stretching, strengthening, and ultrasound. Following 4 weeks of treatment, all groups showed a significant improvement in pain-free grip strength, with the band group showing maximum improvement, followed by the taping group.[47] More evidence is needed to make a recommendation.

CONCLUSION

There are significant limitations in the ability to come to conclusions on the role of painful loading of lateral elbow tendinopathy due to the heterogeneity of populations included in this literature, the insufficient detail provided by authors regarding exercise parameters, and the lack of depth exploring the influence of the pain experience on pain outcomes. The majority of the literature included in this systematic review used a limited number of pain measures, often only using a VAS, hindering the ability to understand the role pain plays in managing this condition. It is the recommendation of the authors that future research address this issue by including multiple methods of assessing pain, eg, pressure algometry, two-point discrimination, etc in order to enhance the ability to subclassify patients based on pain characteristics; therefore, allowing clinicians the opportunity to tailor treatment specific to the patient presentation and improve outcomes.[48-50]

REFERENCES

1. Shiri R, Viikari-Juntura E, Varonen H, Heliovaara M. Prevalence and determinants of lateral and medial epicondylitis: A population study. *Am J Epidemiol*. 2006;164(11):1065-1074. Epub 2006 Sep 12
2. Vicenzino B, Wright A. Lateral epicondylalgia I: Epidemiology, pathophysiology, aetiology and natural history. *Phys Ther Rev*. 201423-34.
3. Murtagh JE. Tennis elbow. *Aust Fam Physician*. 1988;17(2):90-91, 94-95.
4. Kurppa K, Viikari-Juntura E, Kuosma E, Huuskonen M, Kivi P. Incidence of tenosynovitis or peritendinitis and epicondylitis in a meat-processing factory. *Scand J Work Environ Health*. 1991;17(1):32-37.
5. Ahmad Z, Siddiqui N, Malik SS, Abdus-Samee M, Tytherleigh-Strong G, Rushton N. Lateral epicondylitis: A review of pathology and management. *Bone Joint J*. 2013;95-B(9):1158-1164. doi: 10.1302/0301-620X.95B9.29285.
6. Waugh EJ. Lateral epicondylalgia or epicondylitis: What's in a name? *J Orthop Sports Phys Ther*. 2005;35(4):200-202.
7. Cook JL, Purdam CR. Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *Br J Sports Med*. 2009;43(6):409-416. doi: 10.1136/bjsm.2008.051193. Epub 2008 Sep 23.
8. Malliaras P, Cook J. Patellar tendons with normal imaging and pain: Change in imaging and pain status over a volleyball season. *Clin J Sport Med*. 2006;16(5):388-391.
9. Moseley GL, Butler DS. Fifteen years of explaining pain: The past, present, and future. *J Pain*. 2015;16(9):807-813. doi: 10.1016/j.jpain.2015.05.005. Epub 2015 Jun 5.
10. Rio E, Moseley L, Purdam C, et al. The pain of tendinopathy: Physiological or pathophysiological? *Sports Med*. 2014;44(1):9-23. doi: 10.1007/s40279-013-0096-z.
11. Lai WC, Erickson BJ, Mlynarek RA, Wang D. Chronic lateral epicondylitis: challenges and solutions. Open Access *J Sports Med*. 2018;9:243-251. doi: 10.2147/OAJSM.S160974. eCollection 2018.
12. Alizadehkhaiyat O, Fisher AC, Kemp GJ, Frostick SP. Pain, functional disability, and psychologic status in tennis elbow. *Clin J Pain*. 2007;23(6):482-489.
13. Smith BE, Hendrick P, Smith TO, et al. Should exercises be painful in the management of chronic musculoskeletal pain? A systematic review and meta-analysis. *Br J Sports Med*. 2017;51(23):1679-1687. doi: 10.1136/bjsports-2016-097383. Epub 2017 Jun 8.
14. Hjermstad MJ, Fayers PM, Haugen DF, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: A systematic literature review. *J Pain Symptom Manage*. 2011;41(6):1073-1093. doi: 10.1016/j.jpainsymman.2010.08.016.
15. Scott J, Huskisson EC. Graphic representation of pain. *Pain*. 1976;2(2):175-184.
16. Blanchette MA, Normand MC. Impairment assessment of lateral epicondylitis through electromyography and dynamometry. *J Can Chiropr Assoc*. 2011;55(2):96-106.
17. Stratford PW, Norman GR, McIntosh JM. Generalizability of grip strength measurements in patients with tennis elbow. *Phys Ther*. 1989;69(4):276-281.
18. Fischer AA. Pressure algometry over normal muscles. standard values, validity and reproducibility of pressure threshold. *Pain*. 1987;30(1):115-126.
19. Barbero M, Moresi F, Leoni D, Gatti R, Egloff M, Falla D. Test-retest reliability of pain extent and pain location using a novel method for pain drawing analysis. *Eur J Pain*. 2015;19(8):1129-1138. doi: 10.1002/ejp.636. Epub 2015 Jan 6.
20. Carlsson AM. Assessment of chronic pain. I. aspects of the reliability and validity of the visual analogue scale. *Pain*. 1983;16(1):87-101.
21. Nussbaum EL, Downes L. Reliability of clinical pressure-pain algometric measurements obtained on consecutive days. *Phys Ther*. 1998;78(2):160-169.
22. Pfingsten M, Baller M, Liebeck H, Strube J, Hildebrandt J, Schops P. Psychometric properties of the pain drawing and the Ransford technique in patients with chronic low back pain. *Schmerz*. 2003;17(5):332-340.
23. Price DD, Bush FM, Long S, Harkins SW. A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales. *Pain*. 1994;56(2):217-226.
24. Spahr N, Hodkinson D, Jolly K, Williams S, Howard M, Thacker M. Distinguishing between nociceptive and

neuropathic components in chronic low back pain using behavioural evaluation and sensory examination. *Musculoskelet Sci Pract*. 2017;27:40-48. doi: 10.1016/j.msksp.2016.12.006. Epub 2016 Dec 12.
25. De Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: A demographic study. *Aust J Physiother*. 2009;55(2):129-133.
26. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther*. 2003;83(8):713-721.
27. Martinez-Silvestrini JA, Newcomer KL, Gay RE, Schaefer MP, Kortebein P, Arendt KW. Chronic lateral epicondylitis: Comparative effectiveness of a home exercise program including stretching alone versus stretching supplemented with eccentric or concentric strengthening. *J Hand Ther*. 2005;18(4):411-419, quiz 420.
28. Stasinopoulos D, Stasinopoulos I. Comparison of effects of eccentric training, eccentric-concentric training, and eccentric-concentric training combined with isometric contraction in the treatment of lateral elbow tendinopathy. *J Hand Ther*. 2017;30(1):13-19. doi: 10.1016/j.jht.2016.09.001. Epub 2016 Nov 4.
29. Lim HY, Wong SH. Effects of isometric, eccentric, or heavy slow resistance exercises on pain and function in individuals with patellar tendinopathy: A systematic review. *Physiother Res Int*. 2018;23(4):e1721. doi:10.1002/pri.1721. Epub 2018 Jul 4.
30. Lee JH, Kim TH, Lim KB. Effects of eccentric control exercise for wrist extensor and shoulder stabilization exercise on the pain and functions of tennis elbow. *J Phys Ther Sci*. 2018;30(4):590-594. doi: 10.1589/jpts.30.590. Epub 2018 Apr 20.
31. Lee S, Ko Y, Lee W. Changes in pain, dysfunction, and grip strength of patients with acute lateral epicondylitis caused by frequency of physical therapy: A randomized controlled trial. *J Phys Ther Sci*. 2014;26(7):1037-1040. doi: 10.1589/jpts.26.1037. Epub 2014 Jul 30.
32. Gatchel,RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychol Bull*. 2007;133(4):581-624. doi:10.1037/0033-2909.133.4.581.
33. Booth J, Moseley GL, Schiltenwolf M, Cashin A, Davies M, Hübscher M. Exercise for chronic musculoskeletal pain: A biopsychosocial approach. *Musculoskel Care*. 2017;15(4):413-421. doi: 10.1002/msc.1191.
34. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ*. 2006;333(7575):939-939. Epub 2006 Sep 29.
35. Joshi S, Metgud S, Ebnezer C. Comparing the effects of manipulation of wrist and ultrasound, friction massage and exercises on lateral epicondylitis: A randomized clinical study. *Indian J Physiother Occup Ther*. 2013;7(3):205-209.
36. Langen-Pieters P, Weston P, Brantingham JW. A randomized, prospective pilot study comparing chiropractic care and ultrasound for the treatment of lateral epicondylitis. *Eur J Chiropract*. 2003;50(3):211-218.
37. Bhambhani S, Mitra M, Kaur A. Effectiveness of kinesiotaping along with conventional physiotherapy for patients with tennis elbow. *Indian J Physiother Occup Ther*. 2016;10(3):18-22.
38. Struijs PAA, Kerhoffs GM, Assendelft WJ, van Dijk CN. Conservative treatment of lateral epicondylitis: Brace versus physical therapy or a combination of both—a randomized clinical trial. *Am J Sports Med*. 2004;32(2):462-469.
39. Viswas R, Ramachandran R, Korde Anantkumar P. Comparison of effectiveness of supervised exercise program and Cyriax physiotherapy in patients with tennis elbow (lateral epicondylitis): A randomized clinical trial. *Sci World J*. 2012;2012:939645. doi: 10.1100/2012/939645.
40. Sevier TL, Stegink-Jansen CW. Astym treatment vs. eccentric exercise for lateral elbow tendinopathy: A randomized controlled clinical trial. *Peer J*. 2015;3:e967. doi: 10.7717/peerj.967. eCollection 2015.
41. Agostinucci J, McLinden J, Cherry E. The effect of cryotherapy and exercise on lateral epicondylitis: A controlled randomised study. *Int J Ther Rehabil*. 2012;19(11):641-650.
42. Eraslan L, Yuce D, Erbilici A, Baltaci G. Does kinesiotaping improve pain and functionality in patients with newly diagnosed lateral epicondylitis? *Knee Surg Sports Traumatol Arthrosc*. 2018;26(3):938-945. doi: 10.1007/s00167-017-4691-7. Epub 2017 Aug 24.
43. Choi Y, Kim M, Lee J. Effects of concentric contraction of the wrists and transcutaneous electrical nerve stimulation cycle on pain and muscle strength in lateral epicondylitis patients. *J Phys Ther Sci*. 2017;29(12):2081-2084. doi: 10.1589/jpts.29.2081. Epub 2017 Dec 7.
44. Ho L, Kwong WL, Cheing G. Effectiveness of microcurrent therapy in the management of lateral epicondylitis: A pilot study. *Hong Kong Physiother J*. 2007;25(1):14-20. doi: 10.1016/S1013-7025(08)0004-6.
45. Emanet SK, Altan LI, Yurtkuran M. Investigation of the effect of GaAs laser therapy on lateral epicondylitis. *Photomed Laser Surg*. 2010;28(3):397-403. doi: 10.1089/pho.2009.2555.
46. Stergioulas A. Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis. *Photomed Laser Surg*. 2007;25(3):205-213.
47. Kachanathu SJ, Miglani S, Grover D, Zakaria AR. Forearm band versus elbow taping: As a management of lateral epicondylitis. *J Musculosketel Res*. 2013;16(1):1-9. doi: 10.1142/S0218957713500036.
48. Ehrenbrusthoff K, Ryan CG, Gruneberg C, Martin DJ. A systematic review and meta-analysis of the reliability and validity of sensorimotor measurement instruments in people with chronic low back pain. *Musculoskelet Sci Pract*. 2018;35:73-83. doi: 10.1016/j.msksp.2018.02.007. Epub 2018 Mar 2.
49. Nishigami T, Mibu A, Osumi M, et al. Are tactile acuity and clinical symptoms related to differences in perceived body image in patients with chronic nonspecific lower back pain? *Man Ther*. 2015;20(1):63-67. doi: 10.1016/j.math.2014.06.010. Epub 2014 Jul 15.
50. Smidt N, van der Windt DA, Assendelft WJ, et al. Interobserver reproducibility of the assessment of severity of complaints, grip strength, and pressure pain threshold in patients with lateral epicondylitis. *Arch Phys Med Rehabil*. 2002;83(8):1145-1150.

Dry Needling and Intramuscular Electrical Stimulation for a Patient with Chronic Low Back Pain with Movement Coordination Deficits: A Case Report

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ABSTRACT

Background and Purpose: The clinical practice guidelines match the classification of chronic low back pain and movement coordination deficits (CLBPMC) with lumbopelvic stabilization exercise. The purpose of this case report is to describe a multimodal treatment for a patient with CLBPMC, which includes stabilization and dry needling with intramuscular electrical stimulation. **Methods:** Case description of a patient with a 9-year history of recurring low back pain despite manual therapy and stabilization interventions. **Findings:** Over the course of 4 visits, the patient reported a 50% reduction in pain and a decrease from 34% disability to 18% disability per the ODI. The patient was able to return to all work and recreational activities without limitation. **Clinical Relevance:** Based on the rapid improvements experienced by this patient, who was previously a non-responder to stabilization training, it is likely that dry needling with intra-muscular electrical stimulation may have enhanced multifidus strengthening in this case. **Conclusion:** Physical therapists may consider dry needling with electrical stimulation when strengthening the multifidus for patients with CLBPMC.

Key Words: stabilization training, treatment-based classification, trigger points

INTRODUCTION

The clinical practice guidelines (CPG) for the treatment of low back pain published by the Academy of Orthopaedic Physical Therapy of the American Physical Therapy Association (APTA) recommend an impairment-based classification for the diagnosis of low back pain by physical therapists.[1] This type of diagnosis is based on clinical findings versus imaging and shifts the focus away from pathoanatomic explanations for pain and towards items such as strength, muscle flexibility, joint mobility, and maladaptive pain behaviors. The impairment based-classification system is an adaptation of the treatment-based classification system (TBC) proposed by Delitto et al[2] in 1995. Evidence supports the efficacy of this approach, showing that patients matched to the appropriate treatment group within the TBC had statistically significant improvements in disability scores over those that received unmatched treatments.[3,4] Allocation to specific patient subgroups has also been shown to be reliable between therapists.[5]

Of particular interest to this case report is the classification of *chronic low back pain with movement coordination deficits*. Per the intervention portion of the CPG, this low back pain classification group is matched with a progressive course of lumbopelvic stabilization training.[1] Despite the existence of the CPG since 2012 and the TBC since 1995, the majority of studies investigating the use of lumbopelvic stabilization continue to use heterogenous populations in their study populations, instead of patients classified with movement coordination impairments.[6,7] Due to this, the evidence supporting the use of stabilization training within this subgroup is limited.

Dry needling (DN) is an intervention used by physical therapists that has been experiencing a surge in use over recent years. Multiple systematic reviews have been published regarding the use of DN for the treatment of low back pain.[8,9] Results of these systematic reviews and meta-analyses do not provide definitive evidence for the use of DN alone for the treatment of low back pain but do show that it is beneficial when used in combination with other therapy approaches, such as exercise.[10] No studies have investigated the use of DN in specific low back pain subgroups to date. However, there are multiple studies that show DN may cause immediate changes in contractility of the multifidus,[11-13] which one could hypothesize to be beneficial for those with decreased trunk strength, such as those with movement coordination impairments.

To date, there have been no studies that investigate the combination of DN with intramuscular electrical stimulation (IES) and stabilization training for patients that fall within the movement coordination deficits classification. The purpose of this case report is to describe the use of a multimodal treatment for a patient with chronic low back pain and movement coordination deficits (CLBPMC), which includes stabilization and DN with intra-muscular electrical stimulation.

CASE DESCRIPTION

The patient was a 30-year-old female political campaign advisor and volunteer fire fighter with a 9-year history of recurring low back pain that began after awkwardly lifting a heavy weight. Following initial onset, she had episodic low back pain that was occasionally associated with lateral left lower leg pain (L5 dermatomal distribution). The patient's primary aggravating factors included prolonged sitting and standing. The patient's primary occupation as a political advisor entailed significant hours at a desk and standing at public events. She also reported pain with end range motions that limited her ability to participate in yoga. She reported attending yoga 2 to 3 times a week as her schedule allowed. In addition to these limitations, her role as a volunteer firefighter required yearly training, where she reported limitations in her ability to carry heavy items, such as a fire hose. She was concerned that this would affect her ability to perform at full-capacity in a fire emergency.

The patient reported that she received physical therapy multiple times over the past several years for her low back pain with minimal changes in her symptoms. When asked to describe previous bouts of physical therapy, she described a general lumbopelvic stabilization approach with minimal use

of manual therapy techniques. She reported being adherent to a home exercise program for a time, but eventually discontinued these exercises when it was apparent the exercises were not helping.

PHYSICAL EXAMINATION

The physical examination included range of motion testing, strength testing, sensation testing, neurodynamic mobility testing, functional core strength testing, palpation/mobility testing, and special tests. The results of the physical examination can be found in Table 1.

Table 1. Physical Examination Findings for the Patient in this Case Report

Sensation	Light touch intact for L1-S2 dermatomes
Strength	Strong and painless resisted isometric contractions of L1-S2 myotomes
Range of Motion	(+) pain with sustained end range lumbar flexion and extension (-) changes with repeated motions (flexion/extension) (-) aberrant motions
Neurodynamic Mobility	(-) seated slump test (-) straight leg raise (both tested bilateral)
Functional Core Strength	Impaired (see below)
Palpation/Joint Mobility	Pain with unilateral and central posterior-anterior testing bilaterally L3-5 Hypermobility of the L3-5 segmental levels
Special Tests	(+) Active straight leg raise >91° (+) Prone instability test

The CPG describes chronic low back pain with movement coordination deficits based on subjective and objective examination findings. The subjective description of this classification is "chronic, recurring low back pain with associated (referred) lower extremity pain." Physical examination findings may consist of one or more of the following: low back/lower extremity pain that is worsened with sustained end-range movements or positions, lumbar hypermobility with segmental motion assessment, mobility deficits of the thorax and/or hip regions, diminished trunk or pelvic muscle strength or endurance, movement coordination impairments while performing community/work related recreational or work-related activities.[1]

Based on the guidelines put forth by the Academy of Orthopaedic Physical Therapy, APTA, this patient is consistent with a classification of low back pain with movement coordination deficits. In addition to the guidelines, this patient fits a previously proposed clinical prediction rule for patients with low back pain that respond well to stabilization training[14] This clinical prediction rule is considered positive if 3 or more of the following 4 items are positive/present: age <40, average straight leg raise >91°, (+) prone instability test, aberrant motion with range of motion testing. This prediction rule was not replicated in an attempted validation study, but it was likely underpowered.[15] Despite this, the rule may still offer a valuable framework to use as a guide when diagnosing those with movement coordination deficits.

The primary findings that led to this diagnosis were the subjective complaints of pain with prolonged positioning and end-range motions, as well as the objective findings of lumbar hypermobility, pain with sustained end range of motion testing, (+) prone instability test, anterior straight leg raise >91°, and core strength deficits. The functional core strength test used in this case was the ability to hold a quadruped position with contralateral upper and lower extremities extended ("bird dog" position) for 30 seconds with good form. The patient was unable to do so without substantial sway and momentary loss of balance. Although this has not been studied as an assessment technique, this exercise is a common component in many stabilization programs and is used as an assessment of "rotary stability" in the Functional Movement Screen.[16] By using the "bird dog" position as an assessment tool, it allows the therapist to set a baseline that can be used when prescribing the home exercise program. Additionally, patients are able to track their own progress as they are able to achieve longer hold times as strength improves.

In addition to the above findings that helped rule in the patient's diagnosis, competing diagnoses were effectively ruled out. Due to the presence of lower extremity pain associated with the patient's low back pain, the main competing diagnoses were low back pain with radiating pain and related (referred) lower extremity pain. As both neurodynamic mobility tests (slump, straight leg raise) were negative, the radiating pain diagnosis was ruled out. Timeframe and absence of centralization or peripheralization with repeated motion testing was used to rule out related (referred) lower extremity pain.[1] All red flag items were ruled out through a combination of subjective and objective examination.

The patient answered "no" to both screening questions from the Patient Health Questionnaire-2. This short survey has been shown to be a valid screening tool for depression.[17] Additional outcome measures used for detecting maladaptive pain behaviors or beliefs were not issued to this patient. The patient reported that she viewed exercise as a healthy activity and denied avoiding activity or exercise due to pain.

Visit 1 Treatment (Day 0)

Following the physical examination, the patient was educated on physical examination findings, most appropriate treatment plan, and positive prognosis. Based on the diagnosis of low back pain with movement coordination deficits, a treatment plan primarily consisting of lumbopelvic stabilization was selected.

As lumbopelvic manipulation has been shown to improve the contractility of deep lumbopelvic muscle stabilizers, a sidelying high-velocity low-amplitude (HVLA) lumbopelvic manipulation was performed.[18,19] The cited studies investigating changes in muscle function following spinal manipulation have used a supine lumbopelvic manipulation. Although not studied for its effects on muscle function specifically, the sidelying manipulation has been shown to provide equivalent changes in pain and disability for those who meet a clinical prediction rule.[20] This may lead one to believe that these two manipulation techniques operate by a similar mechanism and would therefore cause similar changes in muscle contractility. Following the HVLA manipulation, lumbar flexion was performed again without any change in symptoms in low back or lower extremity. The patient also reattempted the "bird dog" position, which continued to be difficult

and she was unable to maintain the position without significant sway and loss of balance.

Based on a lack of response to joint manipulation, dry needling was performed in an effort to assist with multifidi recruitment. Needles were inserted on either side of the L3-5 vertebrae (6 total) deep enough to contact the ipsilateral lamina. No pistoning of the needle was used with this patient. Following insertion of the needles (.30 x 60 mm), electric stimulation was applied to each side via inserted needles until a small pulsing was visible in the paraspinal muscles (Figure 1). Electric stimulation was applied using an ITO ES-130 3 Channel Electro Simulation Unit at an intensity of 4 and frequency of 1 Hz. This was done to stimulate the multifidi, as multifidus strength and contractility have been shown to play a major role in low back pain.[21,22] Needles were left in place with intramuscular stimulation for 5 minutes. As no guidelines have been established regarding the length of time needles should be left in place, this length of time was based on previous clinical experience and practicality.

Following the removal of needles and cessation of electric stimulation, the patient was reassessed. At this time, lumbar flexion was full (palms to floor) without pain and the patient was able to perform the bird dog exercise with 30-second holds without significant sway. She did report fatigue in the low back paraspinals by the end of the exercise but denied pain. She was given bird dogs, side bridges, and prone hip extensions as an initial home exercise.

Visit 2 (Day 8)

The patient returned to clinic reporting a 1- to 2-day period following the initial session that she was pain-free. She reported a current pain level of 3/10 on the Numerical Pain Rating Scale (NPRS). She went on to say that she was having significant fatigue when performing the bird dog exercise at home but was not experiencing pain during her home program.

Treatment during the second visit consisted of DN and IES in the same fashion as the first visit. Additionally, the patient's home program was reviewed and dosage was increased slightly. Details regarding the contents of each visit are displayed in Table 2.

Visit 3 (Day 15)

The patient returned to clinic reporting a 3- to 4-day pain-free period after the second session of therapy. She reported a current pain level of 2/10 on the NPRS. She reported continued fatigue with bird dog exercises but was tolerating longer holds and felt as though she could maintain form more consistently. At this visit, side bridges were progressed to full side planks and dosage was updated for the remainder of her home program.

Visit 4 (Day 30)

The patient returned to clinic reporting that she had just returned from camping. She was able to hike, carry a pack, and participate in yoga without limitations or significant pain. She reported a current pain level of 2/10 on the NPRS. On this day, DN was not performed due to a lack of functional limitation. Instead, self-treatment techniques were reviewed in order to assist in the event of a future recurrence. Once again, the patient's home program was reviewed and updated to remain challenging. The patient scored a 9/50 (18%) on the Oswestry Disability Index (ODI) and a 5+ (quite a bit better) on the Global Rate of Change scale (GROC). The patient was discharged to an independent home exercise program.

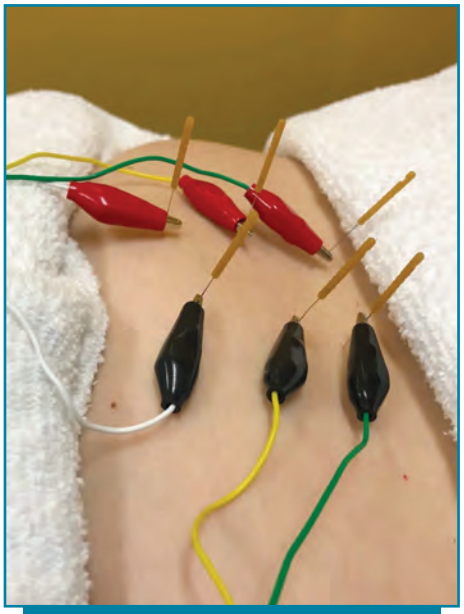

Figure 1. Dry needling L3-5 with intramuscular electrical stimulation.

DISCUSSION

This case report describes a patient with chronic low back pain that was previously a non-responder to a traditional stabilization treatment plan. Subjective complaints and findings per the physical examination led to a diagnosis of low back pain with movement coordination deficits.[1] This presentation generally calls for lumbopelvic stabilization training. Based on this patient's lack of response to previous physical therapy with this approach, DN and IES were used to assist with stabilization training.

The minimal clinically important difference (MCID) for the ODI is published as 10 on a scale of 0-100.[23] This episode of care was considered to be successful having exceeded the MCID (-16) for the ODI and having achieved a 5+ on the GROC, which corresponds with a subjective patient response of "quite a bit better." Additionally, the patient reported a change in pain equal to the MCID for the NPRS (2 points).[24] Beyond the outcome measure scores provided, the patient reported a full return to yoga and firefighter training without limitation due to back pain.

There is no definitive timeframe by which patients with this diagnosis generally respond to stabilization programs but considering the chronic nature of this patient's condition and her previous lack of success with physical therapy, the results achieved within 4 weeks during this episode of care were likely at an accelerated pace. It is unlikely that DN directly affected the patient's rate of muscle hypertrophy, but it may have assisted in the rate at which she gained motor control.

A recent study shows that there is a subset of patients that show an improvement in multifidi contraction and nociceptive sensitivity one week following DN.[13] This subset of patients showed a larger improvement on the ODI than patients who did not exhibit these physical responses to DN. As the necessary examination items (pain pressure threshold algometry, ultrasound imaging) were not performed post-DN to confirm that this patient experienced these physical changes, the authors are unable to determine if the patient falls into this subgroup. However, this does provide support for a potential mechanism by which the patient achieved these results. An additional study showed improved multifidus contraction following DN in healthy adults.[11] Although it cannot be assumed that this mechanism is present in those with back pain, this does lend further support towards this mechanism of improvement.

Two published studies discuss the use of DN combined with IES for the treatment of back pain.[25,26] The case study pertains to a patient with low back pain, while the case series describes the episode of care for two patients with thoracic spine pain. All 3 patients from both studies show clinically meaningful changes in pain and disability, in addition to improvements in pain-free range of motion. Each of these case examples use multi-modal approaches, which include DN

Table 2. Content of Treatment Sessions and Home Program with Relevant Patient-Reported Outcomes

Visit	Manual Therapy	Home Exercise (2x/day)	Patient-Reported Outcome
1 (Day 0)	Lumbopelvic HVLA Dry needling and electric stimulation to L3-5 multifidi	Bird dogs: 10 sec holds, 10 repetitions per side Side bridges: 20 sec holds, 5 repetitions per side Prone hip extensions: 5 sec holds, 2 sets of 10 per side	NPRS 4/10 ODI 34/100
2 (Day 8)	Dry needling and electric stimulation to L3-5 multifidi	Bird dogs: 10 sec holds, 10 repetitions per side; 10 elbow to knee touches per side (alternating) Side bridges: 30 sec holds, 5 repetitions per side Prone hip extensions: 5 sec holds, 2 sets of 10 per side	NPRS 3/10
3 (Day 15)	Dry needling and electric stimulation to L3-5 multifidi	Bird dogs: 20 sec holds, 5 repetitions per side; 10 elbow to knee touches per side (alternating) Side planks: 30 sec holds, 5 repetitions per side Prone hip extensions: 5 sec holds, 2 sets of 10 per side	NPRS 2/10
4 (Day 30)	Instrument assisted soft tissue mobilization with instructions on how partner could perform at home	Bird dogs: 20 sec holds, 5 repetitions per side; 10 elbow to knee touches per side (alternating) Side planks: 45 sec holds, 5 repetitions per side Prone hip extensions: 5 sec holds, 2 sets of 10 per side	NPRS 2/10 ODI 18/100 GROC 5+

Abbreviations: HVLA, high-velocity, low amplitude; NPRS, Numerical Pain Rating Scale; ODI, Oswestry Disability Index; GROC, Global Rate of Change Scale

with IES and exercise. The authors did not classify any of these patients into impairment-based subgroups and speculated that improvements in patients were due to treatment of myofascial trigger points, versus changes in contractility of deep trunk stabilizers. However, it is possible that enhanced muscle contractility is responsible for these patients' successful outcomes. It should also be noted that all 3 of the above examples presented with acute back pain in contrast to the chronic nature of the patient's symptoms in this case study.

Although no high-level evidence exists pertaining to electric stimulation in combination with DN for the treatment of low back pain, electric stimulation is widely used for improving the contractility of inhibited musculature, most commonly the quadriceps during postoperative knee rehabilitation.[27,28] It is possible that IES may help to decrease inhibition in deep spinal stabilizers, such as the multifidi.

There are several limitations to this study being a single case report with no control group, which limit our ability to determine the effects of DN or IES. It could be argued that stabilization training alone was responsible for the decrease in symptoms experienced by the patient; however, the patient's history of ineffective prior therapy episodes of care leads us to believe that the interventions used in this episode were more effective than stabilization training alone would have been. Additionally, this case study describes a tissue-based explanation for the patient's improvements. Considering the importance of the biopsychosocial pain model, it is possible that the therapist's emphasis on movement and positive prognosis were more responsible for the positive results achieved in this study than any specific manual or exercise-based interventions. Although maladaptive pain behaviors were not detected during the subjective examination, it is possible that outcome measures assessing specific pain behaviors such as catastrophizing and fear-avoidance may have better determined the presence of these behaviors. Long-term follow-up is also needed to determine lasting effects of treatment.

CLINICAL APPLICATIONS

Although it is beyond the scope of this case report to definitively determine the specific mechanism by which DN affects local musculature, it does point to a potential treatment for those affected by low back pain associated with movement coordination deficits. Clinicians may consider using DN to facilitate training of the multifidus in patients with low back pain associated with movement coordination deficits.

REFERENCES

1. Delitto A, George SZ, Van MC LR, et al. Low back pain. *J Orthop Sports Phys Ther*. 2012;42(4):A1-57. doi: 10.2519/jospt.2012.42.4.A1. Epub 2012 Mar 30.
2. Delitto A, Erhard RE, Bowling RW. A treatment-based classification approach to low back syndrome: identifying and staging patients for conservative treatment. *Phys Ther*. 1995;75(6):470-485; discussion 485-489.
3. Brennan GP, Fritz JM, Hunter SJ, Thackeray A, Delitto A, Erhard RE. Identifying subgroups of patients with acute/subacute "nonspecific" low back pain: results of a randomized clinical trial. *Spine (Phila Pa 1976)*. 2006;31(6):623-631.
4. Fritz JM, Delitto A, Erhard RE. Comparison of classification-based physical therapy with therapy based on clinical practice guidelines for patients with acute low back pain: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2003;28(13):1363-1371; discussion 1372.
5. Fritz JM, Brennan GP, Clifford SN, Hunter SJ, Thackeray A. An examination of the reliability of a classification algorithm for subgrouping patients with

low back pain. *Spine (Phila Pa 1976)*. 2006;31(1):77-82.
6. Brumitt J, Matheson JW, Meira EP. Core stabilization exercise prescription, part 2: a systematic review of motor control and general (global) exercise rehabilitation approaches for patients with low back pain. *Sports Health*. 2013;5(6):510-513. doi: 10.1177/1941738113502634.
7. Gomes-Neto M, Lopes JM, Conceicao CS, et al. Stabilization exercise compared to general exercises or manual therapy for the management of low back pain: A systematic review and meta-analysis. *Phys Ther Sport*. 2017;23:136-142. doi: 10.1016/j.ptsp.2016.08.004. Epub 2016 Aug 18.
8. Hu HT, Gao H, Ma RJ, Zhao XF, Tian HF, Li L. Is dry needling effective for low back pain?: A systematic review and PRISMA-compliant meta-analysis. *Medicine (Baltimore)*. 2018;97(26):e11225. doi: 10.1097/MD.0000000000011225.
9. Liu L, Huang QM, Liu QG, et al. Evidence for dry needling in the management of myofascial trigger points associated with low back pain: a systematic review and meta-analysis. *Arch Phys Med Rehabil*. 2018;99(1):152.e2. doi: 10.1016/j.apmr.2017.06.008. Epub 2017 Jul 8.
10. Furlan AD, van Tulder M, Cherkin D, et al. Acupuncture and dry-needling for low back pain: an updated systematic review within the framework of the Cochrane collaboration. *Spine (Phila Pa 1976)*. 2005;30(8):944-963.
11. Dar G, Hicks GE. The immediate effect of dry needling on multifidus muscles' function in healthy individuals. *J Back Musculoskelet Rehabil*. 2016;29(2):273-278.
12. Koppenhaver SL, Walker MJ, Rettig C, et al. The association between dry needling-induced twitch response and change in pain and muscle function in patients with low back pain: a quasi-experimental study. *Physiotherapy*. 2017;103(2):131-137. doi: 10.1016/j.physio.2016.05.002. Epub 2016 May 20.
13. Koppenhaver SL, Walker MJ, Su J, et al. Changes in lumbar multifidus muscle function and nociceptive sensitivity in low back pain patient responders versus non-responders after dry needling treatment. *Man Ther*. 2015;20(6):769-776. doi: 10.1016/j.math.2015.03.003. Epub 2015 Mar 13.
14. Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil*. 2005;86:1753-1762.
15. Rabin A, Shashua A, Pizem K, Dickstein R, Dar G. A clinical prediction rule to identify patients with low back pain who are likely to experience short-term success following lumbar stabilization exercises: a randomized controlled validation study. *J Orthop Sports Phys Ther*. 2014;44(1):-B13. doi: 10.2519/jospt.2014.4888. Epub 2013 Nov 21.
16. Kraus K, Schutz E, Taylor WR, Doyscher R. Efficacy of the functional movement screen: a review. *J Strength Cond Res*. 2014;28:3571-3584. doi: 10.1519/JSC.0000000000000556.
17. Kroenke K, Spitzer RL, Williams JB. The Patient Health Questionnaire-2: validity of a two-item depression screener. *Med Care*. 2003;41(11):1284-1292.
18. Koppenhaver SL, Fritz JM, Hebert JJ, et al. Association between changes in abdominal and lumbar multifidus muscle thickness and clinical improvement after spinal manipulation. *J Orthop Sports Phys Ther*. 2011;41(16):389-399. doi: 10.2519/jospt.2011.3632. Epub 2011 Apr 6.
19. Raney NH, Teyhen DS, Childs JD. Observed changes in lateral abdominal muscle thickness after spinal manipulation: a case series using rehabilitative ultrasound imaging. *J Orthop Sports Phys Ther*. 2007;37(8):472-429.
20. Cleland JA, Fritz JM, Kulig K, et al. Comparison of the effectiveness of three manual physical therapy techniques in a subgroup of patients with low back pain who satisfy a clinical prediction rule: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2009;34(25):2720-2729. doi: 10.1097/BRS.0b013e3181b48809.
21. Russo M, Deckers K, Eldabe S, et al. Muscle control and non-specific chronic low back pain. *Neuromodulation*. 2018;21(1):1-9. doi: 10.1111/ner.12738.
22. Ranger TA, Cicuttini FM, Jensen TS, et al. Are the size and composition of the paraspinal muscles associated with low back pain? A systematic review. *Spine J*. 2017;17(11):1729-1748. doi: S1529-9430(17)30320-0.
23. Hagg O, Fritzell P, Nordwall A, Swedish Lumbar Spine Study Group. The clinical importance of changes in outcome scores after treatment for chronic low back pain. *Eur Spine J*. 2003;12(1):12-20. Epub 2002 Oct 24.
24. Farrar JT, Young JP,Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*. 2001;94(2):149-158.
25. Rainey CE. The use of trigger point dry needling and intramuscular electrical stimulation for a subject with chronic low back pain: a case report. *Int J Sports Phys Ther*. 2013;8(2):145-161.
26. Rock JM, Rainey CE. Treatment of nonspecific thoracic spine pain with trigger point dry needling and intramuscular electrical stimulation: a case series. *Int J Sports Phys Ther*. 2014;9(5):699-711.
27. Stevens-Lapsley JE, Balter JE, Wolfe P, Eckhoff DG, Kohrt WM. Early neuromuscular electrical stimulation to improve quadriceps muscle strength after total knee arthroplasty: a randomized controlled trial. *Phys Ther*. 2012;92(2):210-226. doi: 10.2522/ptj.20110124. Epub 2011 Nov 17.
28. Knee Pain and Mobility Impairments: Meniscal and Articular Cartilage Lesions Revision 2018: Using the Evidence to Guide Physical Therapist Practice. *J Orthop Sports Phys Ther*. 2018;48(2):123-124. doi: 10.2519/jospt.2018.0503.

Physical Therapy Management Following Popliteal Tendon Release After Total Knee Arthroplasty: A Case Report

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ABSTRACT

Background and Purpose: The purpose of this case report is to describe the medical and physical therapy management of a patient status post total knee arthroplasty (TKA) with persistent pain and functional limitation who was found to have popliteal tendon dysfunction and underwent a popliteal tendon release. **Case Description:** The patient presented for consultation and evaluation 36 weeks status post right TKA, 10 weeks status post ultrasound guided popliteal injection on the right knee, and 4 weeks status post arthroscopic popliteal release on the right knee. The patient was unable to return to work or resume her normal activity levels because of impairments of persistent pain, weakness, and stiffness. **Methods and Outcomes or Findings:** Following the popliteal tendon release, the patient was evaluated for a home exercise and graded activity program to improve impairments and functional limitations of gait and stair climbing. In addition, manual therapy and pain neuroscience education was provided to decrease sensitization. At the 8-week follow-up, the patient reported she could return to work part-time with improved pain, strength, stiffness, and function as demonstrated by functional assessment outcome measures. **Discussion:** The patient elected physical therapy consultation following popliteal tendon release post TKA for specific strengthening and education. The program included graded activity and reassurance to return to a pain-free optimal level of activity. The patient's pain and sensitization were addressed through pain neuroscience education while using exercise and manual therapy to target impairments in range of motion, strength, and functional limitations. This provided a synergistic approach for this patient's unique presentation to improve her symptoms and level of function. **Conclusion and Clinical Relevance:** This case report highlights the potential of popliteal tendon dysfunction resulting in persistent pain following a TKA. This case report can help guide the clinician in the management of a patient with popliteal tendon dysfunction in which successful outcome of pain relief and function with the usual treatment protocol post TKA was not achieved.

Key Words: gait disorder, persistent pain, stiffness

INTRODUCTION

Persistent pain following a total knee arthroplasty (TKA) is observed in up to 20% of individuals 3-24 months postsurgery.[1] The causes of long-term pain following a TKA are multifactorial and can be related to loosening of the prosthesis, infection, osteolysis, musculotendinous dysfunction, and psychological factors.[2] In some cases, popliteal tendon dysfunction may be a cause of persistent knee pain post TKA.[2-7] The popliteus muscle originates on the lateral condyle of the femur and inserts on the posterior medial surface of the tibia. The muscle acts as a knee flexor and internal rotator of the tibia in an open chain to assist initiation of flexion from full extension, and can also act as a dynamic stabilizer in joint movements in the transverse and frontal plane.[8]

Popliteal tendon release may be performed intraoperatively during a TKA or postoperatively as part of a separate arthroscopic surgery. Intraoperatively during a TKA, surgeons consider knee varus, valgus, or neutral joint alignment, component selection, and procedure among other factors to decide on soft tissue release.[9-12] Outcomes for popliteal tendon release vary. Kessman et al[13] reported that a senior surgeon was unable to identify differences in knee stability between knees with transected popliteal tendons and knees with non-transected popliteal tendons during the TKA procedures. Ghosh et al[14] found that isolated popliteal tendon release or injury (cadaveric study) did not lead to abnormal laxity within the knee following a posterior stabilized TKA. In contrast, Cottino et al[15] found that during a TKA, release of the popliteal tendon created instability in both the medial and lateral aspects of the knee. De Simone et al[16] found that complete laceration or resection of the popliteal tendon during TKA resulted in lower International Knee Scores.

Postoperatively, if a patient complains of pain following a TKA and the physician suspects popliteus tendon dysfunction, a separate popliteal tendon release procedure may be used to address the symptoms.[3-7] Pain or impingement can be due to the tendon being disrupted by an osteophyte or potentially from the lateral component of the prosthesis[4] or it can also occur with well-fit components.[17] This surgery aims to release the tendon that is causing the mechanical dysfunction and pain.

There are numerous studies demonstrating the use of physical therapy interventions in reducing pain and improving a patient's functional ability post TKA.[18-24] However, the literature for physical therapy following popliteal tendon release after a TKA is sparse. The purpose of this case report is to describe post TKA popliteal tendon dysfunction, including medical and physical therapy management of persistent pain and functional deficits following a popliteal tendon release procedure.

CASE DESCRIPTION

History

The patient was a 62-year-old female (BMI of 20) with a history of bilateral knee pain and a diagnosis of osteoarthritis. The patient is a physical therapist who contributed to the development of the case report. Premorbid, the patient led an active lifestyle as a world traveler, avid hiker, and skier. The patient also engaged in heavy physical activity, including lifting bales of hay and shoveling stables for her horses. For several months prior to her TKA surgery, she experienced significant limitations in walking, working, performing home maintenance, and enjoying leisure activities. She had more frequent and increased bilateral knee pain, increased use of medication, and multiple episodes of her knees giving out. After years of conservative treatment including exercise, nonsteroidal anti-inflammatory medication (NSAIDs),

and multiple injections for bilateral knee pain, she elected to have bilateral TKA.

The patient underwent TKA to her right and left knees 36 and 32 weeks, respectively prior to an initial physical therapy evaluation. The same surgeon performed both procedures with a posterior stabilizing approach. From the inception of the first TKA, the patient reported participating in outpatient physical therapy to regain function and decrease pain. Physical therapy consisted of pain and edema management, graded exercise, manual therapy, gait training, range of motion, and strengthening for both knees following a standard protocol.[18,19] After approximately 9 weeks of physical therapy on the right and 4 weeks on the left, the left knee was improving, while the right knee was making limited progress. To assess pain intensity, the Numeric Pain Rating Scale (NPRS) was used. The NPRS is a patient reported scaled score from 0-10, with 0 being "no pain" and 10 being "the worst pain imaginable."[25] The patient's specific symptoms in the right lower extremity included persistent catching and sharp posterior lateral knee pain (2/10 NPRS) at baseline and exacerbated with various movements. Symptoms were reproduced during knee flexion in the initial swing phase of gait (5/10), lateral side stepping (5/10), and with every step descending the stairs (7/10). The patient also reported most notable reproduction of sharp pain with active right leg abduction with the knee slightly flexed in side lying on the left hip (8/10). Due to the patient's ongoing difficulty with her right knee, she searched the medical literature and hypothesized that her problem may be related to popliteal dysfunction.[2-7]

A follow-up with her surgeon and review of postoperative images revealed no adverse reactions and a well-fit and stable prosthesis. After discussing the potential of popliteal tendon dysfunction and impingement, the plan of care was to monitor the situation with a wait-and-see approach and continue with conservative treatment. At the request of the patient, physical therapy, home exercise volume and intensity was decreased with the intent of limiting irritation to the suspected tendon dysfunction. The goal was to prevent further exacerbation of pain and stiffness while maintaining the knee range of motion (ROM) that had been attained. The plan included limiting weight-bearing activity and use of a straight cane on the contralateral side. All activities and exercises were performed between 0 (or painfree) and 5/10 levels of pain on the NPRS. No appreciable improvement was achieved and eventual increase in right knee pain (7/10) at baseline and stiffness particularly over the posterior lateral knee occurred over this period.

Westermann et al[4] have proposed that if a symptomatic patient has relief of symptoms with an ultrasound guided injection to the popliteus, it may confirm that the popliteal tendon release procedure can be beneficial to the patient. Hence, after multiple bouts of conservative treatment yielded little or no improvement in pain or level of function, the patient requested an injection and an elective popliteal tendon release to help her find relief. The surgeon agreed and at 28 weeks post TKA, the patient underwent an ultrasound-guided injection (10 mg of Kenalog mixed with 3cc of 0.25% bupivacaine) to the right popliteus. The patient reported immediate relief from her posterior lateral right knee symptoms. Unfortunately, the duration of symptom relief was limited and her persistent symptoms slowly returned within 7 days post injection (6/10).

Secondary to the immediate but limited right posterior knee pain relief, the patient underwent an arthroscopic surgical release of the right popliteus tendon 6 weeks post injection. During the procedure, the surgeon completely transected the popliteal tendon with a biter, and per the surgical report the patient had significant joint capsule scarring. Within 48 to 72 hours of the right popliteal tendon release procedure, the posterior lateral knee symptoms (including the sharp pain and catching with specific movement) was significantly reduced (2/10).

EXAMINATION

The patient presented to the clinic for physical therapy consultation and evaluation 36 weeks status post right TKA, 10 weeks status post ultrasound guided popliteal injection on the right knee, and 4 weeks status post arthroscopic popliteal release on the right knee. Since the popliteal tendon release procedure, the patient had been performing a home program of gentle range of motion cycling and walking to tolerance. The sharp posterior lateral pain on the right knee resolved. The patient continued to experience stiffness and mild anterior and lateral knee pain with higher levels of pain (4/10) and stiffness associated with higher levels of activity. The patient's greatest concern was her inability to descend stairs and return to work. She reported apprehension with stair navigation due to the stiffness, weakness and anticipation of pain, and insecurity with being able to appropriately guard and transfer patients. Her activity tolerance was limited to approximately 5,000 steps a day. She could complete all activities of daily living (ADLs); however, most of these tasks could not be performed without knee pain. The patient's short-term goals were to perform all household tasks, traverse stairs with less difficulty, and return to work. Her long-term goals included shoveling stables, lifting hay bales, and moderate levels of hiking and skiing.

The physical examination consisted of a screen of the lumbar spine, hips, knees, and ankles, as well as gait assessment, special tests, and tests of function. The screening examination consisted of ROM of hips, knees, and spine. Repeated lumbar active ROM in standing did not reproduce symptoms in her lower back or either lower extremity. Passive hip ROM was pain-free and symmetrical, and special tests for the hips were negative bilaterally (Flexion Adduction Internal Rotation [FADIR] and Scour Tests). Palpation to the right knee revealed slightly warmer temperature than the left, and the patient reported mild pain when moderate pressure was applied to the anterior and lateral knee. The patient's posterior right knee had restricted skin mobility and tenderness most prominent in the lateral popliteal space. Muscle atrophy of the quadriceps was noted comparing right to left, and circumferential measurements as well as other remarkable examination findings are listed in Table 1. Patellar mobility was painfree and symmetrical bilaterally.

Functional tests were performed to assess strength and balance, results are in Table 1. The 30-second chair rise test was administered without the use of the upper extremities for assistance. The test is performed by counting the number of repeated repetitions to and from sitting in a chair to standing with full hip and knee extension for 30 seconds.[26] Single leg heel raises were assessed with bilateral finger touch support and conclusion of the test was an inability to perform with full ankle plantar flexion ROM. Balance was assessed with single leg stance with the contralateral hip and knee in 90° of flexion and her hands on the hips. For single leg stance, the time was recorded at the first loss of balance outside of the base of support. The patient's ability to ascend and descend stairs was assessed on a flight of 11 steps. The patient was asked to perform the test as safely and quickly as possible with no handrail and only going one step at a time. The patient reported lateral right knee pain with descending the stairs. The Lower Extremity Functional Scale was administered as an outcome measure to obtain information about

Table 1. Examination Findings and Follow-up Outcomes

	Initial Physical Therapy Visit		Follow-up Physical Therapy Visit 8 Weeks Post Initial Visit (12 weeks post popliteal release)		Age-based Normative Values* or MCID
	Right	Left	Right	Left	
Lower Extremity Circumferential Measurements: 10 cm above the mid patella	38.5cm	40cm	40.5cm	41cm	
mid patella	36.5cm	36cm	37cm	37cm	
15 cm below the mid patella	34cm	34cm	34.5cm	34cm	
Knee Passive ROM Flexion (supine)	115°	120°	120°	120°	
Knee Passive ROM Extension (supine)	0° (neutral)	4° past neutral	2° past neutral	4° past neutral	
Timed 30 Second Chair Rise	16 repetitions (performed double leg)		28 repetitions		Norm: 16 repetitions[26]
Single Leg Stance	7 seconds	15 seconds	22 seconds	30 seconds	Norm: 27 seconds[27]
Single Leg Heel Raise	5 repetitions	5 repetitions	10 repetitions	11 repetitions	Norm: 2.7 repetitions[28]
Stair Ascend, 11 stairs (sec/stair)	5.13 (0.47)		3.15 (.29)		Norm: Ascend 0.65 seconds per stair[29]
Stair Descend, 11 stairs (sec/stair)	4.93 (.45)		3.30 (.3)		Norm: Descend 1.4 seconds per stair[29]
LEFS	44/80		68/80		MCID=9[30]

Abbreviations: ROM, range of motion; WNL, within normal limits; MMT, manual muscle test; mmHg, millimeters of mercury; neg, negative; +, positive; AO, atlanto-occipital; PA, posterior to anterior; rot, rotation

the patient's self-assessment of her functional ability. These findings and results can be found in Table 1.

Gait was observed over a distance of 50 feet for 6 trials. At trial 1, the patient had an antalgic gait with decreased time in right single leg stance as well as lack of heel strike with the right foot during initial contact. The therapist asked the patient to focus on arm swing, trunk rotation, and hip movement, while increasing gait speed to as fast as she felt comfortable. This was an attempt to change the context of walking by distracting her from the expectation of knee pain during ambulation. The change of focus allowed for an increased pace, increased stride length, and increased heel strike. The patient reported she immediately "felt better" and was encouraged by this rapid within-session response.

During a squat assessment, the patient could flex her knee past 90° with an extreme forward trunk lean. The patient reported this movement caused pain within the knees bilaterally. She could squat to approximately 70° of knee flexion with less forward trunk flexion and perform multiple repetitions without exacerbation of her knee pain. The patient performed the squat with no excessive knee valgus or varus.

EVALUATION

The patient presented to therapy with extensive history of knee pain, knee surgeries, and reduced function. With the suspected popliteal dysfunction addressed surgically, her current primary concern was anterior and lateral right knee pain and stiffness. In conjunction with these symptoms, she also has anticipation of discomfort with various movements, which limited her return to work and other physical activities.

Intra-session improvements with gait and stairs were demonstrated and reported after intervention of exercise, manual therapy, reassurance and education, which are positive prognostic factors. Additionally, she was motivated to improve with a high prior level of function, and specific goals related to caring for her horses, hiking and working, which can also benefit the patient in recovery.

It was determined that she would benefit from a specific exercise and graded activity program to address her impairments with the goal of reaching the patient's ideal level of function. She would also benefit from reassurance and education to increase her confidence and graded return to exercise.

INTERVENTION

The plan of care included an 8-week home program consisting of exercises and graded activity to improve her pain, strength, functional ability, and tolerance to activ-

ity. After 8 weeks, a second assessment was conducted. The home program consisted of lower extremity strengthening and balance exercises to incorporate with her daily activities to progress toward her desired level of function. Exercise instruction was demonstrated and performed by the patient during the session, and written instructions were provided to promote adherence. A summary of the home program is presented in Table 2. The patient was instructed to perform the exercises 3 times per week with sets of 3 to 4. The patient was instructed to work through a painfree ROM and stop once fatigued. The number of repetitions were expected to vary with each exercise, and the patient was instructed to increase repetitions with regards to pain and functional performance as she was able. Booth et al[31] provide general guidelines for exercise prescriptions for people with chronic musculoskeletal pain. The recommendations for this patient were to focus on increasing endurance, strength, and function rather than on pain with exercise. The patient was also educated on a walking and graded activity program to increase her tolerance to activity without exacerbation of pain and stiffness. The therapist asked her to incorporate this graded activity approach into her walking program, ADLs, and other activities such as yoga and biking.

Manual therapy was used to improve stiffness and decrease pain. The physical therapist performed soft tissue mobilizations to the popliteal and posterior lateral region of the right knee. The patient reported improved symptoms (0/10) and was instructed in how to perform this technique with assistance from a family member if she found it difficult to perform independently. In addition, the patient was provided education in pain neuroscience including a booklet by Louw.[32] Pain neuroscience education (PNE) has shown effectiveness in decreasing pain, improving function, and reducing the psychological factors involved with chronic musculoskeletal pain.[33,34] Specifically, PNE can decrease fear of movement and sensitivity to pain in those undergoing a TKA.[35] The patient was introduced to pain neuroscience in the context of her knee symptoms and experiences. Metaphors used included a voltage meter with "room for activity" and "less room for activity" when nerves are sensitized. Various examples were used to explain this phenomenon and the patient was able to articulate that her nervous system had been protecting her from perceived threats such as walking and other physical activities. Recently Louw et al[36] has introduced a proposed PNE approach to manual therapy, which was also used with this patient.

OUTCOMES

Eight weeks after the initial evaluation, a follow-up re-evaluation was conducted to assess the patient's progress as noted in Table 1. The patient reported she could return to work part-time as a physical therapist and tolerate up to 12,000 steps a day measured by her phone activity counter. She reported 0/10 knee pain at rest, and her knee stiffness had vastly improved. She reported that ADLs were painfree and she could complete barn work such as lifting bales of hay and shoveling stables. The patient also reported biking up to an hour a day in intermittent bouts, and she returned to yoga and gardening. Although her right knee improved, she still got some pain (1/10) or stiffness at the end of a long day. The patient reported that physical therapy consultation gave her courage to methodically increase her day-to-day activity while working on strength, ROM, functional tasks, and symptom modulation. She was able to return to a level of function she had not been able to achieve in years. The patient demonstrated an improved performance in all functional tests, including the 30-second chair rise, single leg balance, single leg heel raise, and stair ascend and descend. Her gait was non-antalgic with increased stride, pace, and heel contact bilaterally. Her LEFS score improved from a score of 44/80 to 69/80. The patient was encouraged to continue to participate in her home program with the addition of a side step squat and high knee marching exercise. The patient was also encouraged to continue to participate in her other exercises and activities such as yoga, biking, and hiking to tolerance. The patient was discharged from physical therapy care.

DISCUSSION

In patients with persistent pain post TKA, symptoms may be caused by the popliteal tendon being disrupted by an osteophyte or the lateral component of the TKA prosthesis.[4] To alleviate these symptoms, the use of a popliteal tendon release to address postoperative pain has been described by several authors.[3-7] Westerman et al[4] describes how the tendon can snap or become impinged on the components producing mechanical symptoms. This is consistent with our patient's mechanical lateral and posterior lateral knee symptoms with associated "catching" and "sharp" pain. Our patient followed a similar path as proposed by Westerman et al.[4] After conservative treatment did not improve her symptoms and an ultrasound guided injection did not relieve her symptoms, the patient underwent an arthroscopic release of the popliteal tendon.

In other reports of popliteal dysfunction and management, Martin et al[3] reported the patients having diffuse posterior lateral knee pain exacerbated with palpation, but reported no significant pain with ambulation. While Soejima et al[5] reported persistent posterior lateral pain with greater than 90° of knee flexion. In alignment with our findings, both report their patients having relief of symptoms after undergoing a popliteal tendon release. Martin et al[3] also proposed a clinical technique to assess popliteal tendon dysfunction in patients post TKA. Martin et al[3] suggested testing for reproduction of symptoms in sidelying with the operative limb up; the patient performs gravity resisted hip abduction with knee extension, then subsequently flexes the knee while holding the hip in abduction.[3] The therapist was unable to examine the patient with this assessment prior to her popliteal tendon release. However, she retrospectively reported that this movement caused her extreme discomfort and reproduction of symptoms.

This case report describes a multimodal plan of care and the factors that led to this patient's improvement in pain and function cannot be specifically determined. It appears that dysfunction of the popliteal tendon caused the patient's catching and sharp posterior lateral pain of the knee. These symptoms are consistent with popliteal dysfunction and were alleviated post release. However, the patient's persistent pain, impairments and inability to return to function appeared exacerbated by her apprehension with specific movements and a presentation similar to central sensitization, which can be attributed to months of discomfort. While the authors did not specifically measure fear with a functional outcome measure such and the Fear Avoidance Belief Questiona or Tampa Scale of Kineseophobia, the patient expressed hesitancy and anticipation of pain and with specific movements during gait and descending stairs. Patients with fear avoidance, hyperalgesia, and a history of failed interventions (medical/surgical/therapeutic) have a greater likelihood of central sensitization.[37-39] Addressing her sensitization through pain neuroscience education, graded exercise, and manual therapy provided a synergistic approach to this patient's unique concerns and presentation. Persistent pain, even in the presence of a discrete cause, in this case,

Table 2. Summary of Exercise Program

Movement	Notes
Heel Raises	• Use the counter to support with your upper extremities • Use as little of upper extremity for support as possible while still achieving full range of motion • Decrease use of upper extremity as tolerated
Squats	• To a tolerable depth • Focus on equal weight bearing going through each lower extremity
Single Leg Eccentric Step Down	• Use the last step of your stairs with upper extremities for support as needed • Slow and controlled step-down portion without dynamic valgus moment at the knee • Do not allow contralateral pelvis to drop • Decrease use of upper extremity support as tolerated

suspected popliteal dysfunction, should be addressed from a neuro-behavioral perspective in combination with an appropriate exercise prescription. Reassurance by the physical therapist regarding activity allowed her to exercise with more confidence.

There were several limitations in this case report that should be considered. There were two face-to-face visits between the physical therapist and patient over the 8-week period. Additional visits in physical therapy may have allowed for a more structured exercise progression. The exercise volume is unknown, as exercise logs were not used. This case report is unable to identify the impact of factors such as natural progression through phases of healing, specifically, how time was a factor in her recovery. It is also not known if the popliteal tendon release would have been successful as a placebo procedure, as this is not a controlled study. An additional limitation to the case was not being able to assess the patient prior to the release procedure.

CONCLUSION AND CLINICAL APPLICATION

Persistent pain following a TKA can be challenging to manage. To our knowledge, there has been no literature discussing the physical therapy management of a patient with a popliteal tendon release post TKA. This case report highlights the potential of popliteal tendon dysfunction resulting in persistent pain following a TKA. This report can help guide the clinician in the management of a patient with popliteal tendon dysfunction in which successful outcomes of pain relief and function with the usual treatment protocol post TKA were not achieved.

DISCLOSURE

The patient in this case report is a home health care physical therapist who after years of limited improvement in symptoms and function sought the guidance of additional medical and physical therapy providers. The patient's background as a health care professional led to a well-documented report of history and treatment interventions implemented before the authors met the patient. The patient being a physical therapist also lends itself to her self-efficacy and understanding of a home exercise program in terms of compliance and prescription without additional follow-ups.

REFERENCES

1. Lewis G, Rice D, McNair P, Kluger M. Predictors of persistent pain after total knee arthroplasty: a systematic review and meta-analysis. *Br J Anaesth*. 2015;114(4):551-561. doi:10.1093/bja/aeu441.
2. Alves WM, Migon EZ, Zabeu JL. Pain following a total knee arthroplasty-a systematic approach. *Rev Bras Ortop*. 2010;45(5):384-391. doi:10.1016/S2255-4971(15)30424-9.
3. Martin JR, Fout A, Stoeckl AC, Dennis DA. diagnosing and treating popliteal tendinopathy after total knee arthroplasty. *Reconstructive Review*. 2017;7(1). doi:10.15438/rr.7.1.172.
4. Westermann RW, Daniel JW, Callaghan JJ, Amendola A. Arthroscopic management of popliteal tendon dysfunction in total knee arthroplasty. *Arthrosc Tech*. 2015;4(5):e565-e568. doi:10.1016/j.eats.2015.06.006.
5. Soejima T, Katouda M, Tabuchi K, et al. Arthroscopic treatment of popliteal tendon impingement following total knee arthroplasty: a case report. *J Clin Case Reports*. 2016;06(01). doi:10.4172/2165-7920.1000689.
6. Barnes CL, Scott RD. Popliteus tendon dysfunction following total knee arthroplasty. *J Arthroplasty*. 1995;10(4):543-545.
7. Allardyce TJ, Scuderi GR, Insall JN. Arthroscopic treatment of popliteus tendon dysfunction following total knee arthroplasty. *J Arthroplasty*. 1997;12(3):353-355.
8. Nyland J, Lachman N, Kocabey Y, Brosky J, Altun R, Caborn D. Anatomy, function, and rehabilitation of the popliteus musculotendinous complex. *J Orthop Sports Phys Ther* [serial online]. 2005;35(3):165-179
9. Meloni MC, Hoedemaeker RW, Violante B, Mazzola C. Soft tissue balancing in total knee arthroplasty. *Joints*. 2014;2(1):37-40.
10. Peters CL, Severson E, Crofoot C, Allen B, Erickson J. Popliteus tendon release in the varus or neutral knee: prevalence and potential etiology. *J Bone Joint Surg Am*. 2008;90(Suppl 4):40-46. doi:10.2106/jbjs.h.00687.
11. Tsubosaka M, Muratsu H, Takayama K, Miya H, Kuroda R, Matsumoto T. Comparison of intraoperative soft tissue balance between cruciate-retaining and posterior-stabilized total knee arthroplasty performed by a newly developed medial preserving gap technique. *J Arthroplasty*. 2018;33(3):729-734. doi:10.1016/j.arth.2017.09.070.
12. Kazakin A, Nandi S, Bono J. Diagnosis and treatment of intraoperative popliteus tendon impingement. *J*

Knee Surg. 2014;27(6):485-488. doi:10.1055/s-0034-1367729.
13. Kesman TJ, Kaufman KR, Trousdale RT. Popliteus tendon resection during total knee arthroplasty: an observational report. *Clin Orthop Rel Res*. 2011;469(1):76-81. doi:10.1007/s11999-010-1525-z.
14. Ghosh K., Hunt N., Blain A. Isolated popliteus tendon injury does not lead to abnormal laxity in posterior-stabilized total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc*. 2015; 23:1763–1769.
15. Cottino U, Bruzzone M, Rosso F, Dettoni F, Bonasia DE, Rossi R. The role of the popliteus tendon in total knee arthroplasty: a cadaveric study. *Joints*. 2015;3(1):15-19. doi:10.11138/jts/2015.3.1.015.
16. De Simone V, Demey G, Magnussen RA, Lustig S, Servien E, Neyret P. Iatrogenic popliteus tendon injury during total knee arthroplasty results in decreased knee function two to three years postoperatively. *Int Orthop*. 2012;36(10):2061-2065. doi:10.1007/s00264-012-1631-5.
17. Bonnin MP, de Kok A, Verstraete M, Van Hoof T, Van der Straten C, Saffarini M, Victor J. Popliteus impingement after TKA may occur with well-sized prostheses. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(6):1720-1730. doi:10.1007/s00167-016-4330-8.
18. Mistry JB, Elmallah RDK, Bhave A, et al. Rehabilitative guidelines after total knee arthroplasty: a review. *J Knee Surg*. 2016;29:201-17.
19. American Physical Therapy Association. Total Knee Arthroplasty Clinical Summary. October 25, 2011. http://www.ptnow.org/clinical-summaries-detail/total-knee-arthroplasty-tka. Accessed May 31, 2019.
20. Moffet H, Collet JP, Shapiro SH, Paradis G, Marquis F, Roy L. Effectiveness of intensive rehabilitation on functional ability and quality of life after first total knee arthroplasty: a single-blind randomized controlled trial. *Arch Phys Med Rehabil*. 2004;85(4):546–556.
21. Petterson SC, Mizner RL, Stevens JE, et al. Improved function from progressive strengthening interventions after total knee arthroplasty: a randomized clinical trial with an imbedded prospective cohort. *Arthritis Rheum*. 2009;61(2):174–183.
22. Minns Lowe CJ, Barker KL, Dewey M, Sackley CM. Effectiveness of physiotherapy exercise after knee arthroplasty for osteoarthritis: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2007;335(7624):812.
23. Feng J, Novikov D, Anoushiravani A, Schwarzkopf R. Total knee arthroplasty: improving outcomes with a multidisciplinary approach. *J Multidiscip Healthc*. 2018;11:63-73. doi:10.2147/jmdh.s140550.
24. Topp R, Swank AM, Quesada PM, Nyland J, Malkani A. The effect of prehabilitation exercise on strength and functioning after total knee arthroplasty. *PM&R*. 2009;1(8):729-735. doi:10.1016/j.pmrj.2009.06.003.
25. Jensen MP, McFarland CA. Increasing the reliability and validity of pain intensity measurement in chronic pain patients. *Pain*. 1993;55:195–203.
26. Mckay MJ, Baldwin JN, Ferreira P, Simic M, Vanicek N, Burns J. Reference values for developing responsive functional outcome measures across the lifespan. *Neurology*. 2017;88(16):1512-1519. doi:10.1212/wnl.0000000000003847
27. Bohannon RW. Single limb stance times. *Topics Geriatr Rehabil*. 2006;22(1):70-77. doi:10.1097/00013614-200601000-00010.
28. Daniels L, Worthingham C, Hislop HJ, Montgomery J. *Muscle Testing Techniques of Manual Examination*. Philadelphia, PA: W.B. Saunders; 2007.
29. Nightingale EJ, Pourkazemi F, Hiller CE. Systematic review of timed stair tests. *J Rehabil Res Develop*. 2014;51(3):335-350. doi:10.1682/jrrd.2013.06.0148
30. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): Scale Development, Measurement Properties, and Clinical Application. *Phys Ther*. 1999;79(4):371-383. doi:10.1093/ptj/79.4.371.
31. Booth J, Moseley GL, Schiltenwolf M, Cashin A, Davies M, Hübscher M. Exercise for chronic muscu- loskeletal pain: A biopsychosocial approach. *Musculoskeletal Care*. 2017;15:413–421. https://doi.org/10.1002/msc.1191
32. Louw A. *Why Do I Hurt?: A Patient Book about the Neuroscience of Pain*. Minneapolis, MN: Orthopedic Physical Therapy Products; 2013.
33. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. *Physiother Theory Pract*. 2016;32(5):332-355. doi:10.1080/09593985.2016.1194646.
34. Rufa A, Beissner K, Dolphin M. The use of pain neuroscience education in older adults with chronic back and/or lower extremity pain. *Physiother Theory Pract*. 2019;35(7):603-613. doi:10.1080/09593985.2018.1456586.
35. Louw A, Zimney K, Reed J, Landers M, Puentedura EJ. Immediate preoperative outcomes of pain neuroscience education for patients undergoing total knee arthroplasty: A case series. *Physiother Theory Pract*. 2019;35(6):543-553. doi:10.1080/09593985.2018.1455120
36. Louw A, Nijs J, Puentedura EJ. A clinical perspective on a pain neuroscience education approach to manual therapy. *J Man Manip Ther*. 2017;25(3):160-168.
37. Hilton S, Vandyken C. The puzzle of pelvic pain - a rehabilitation framework for balancing tissue dysfunction and central sensitization, I. *J Women's Health Phys Ther*. 2011;35(3):103-113.
38. Kolski MC, O'Connor A, Van Der Laan K, Lee K, Kozlowski AJ, Deutch A. Validation of a pain mechanism classification system (PMCS) in physical therapy practice. *J Man Manip Ther*. 2016;24(4):192-199.
39. Nijs J et al. LBP: Guidelines for the Clinical Classification of Predominant Neuropathic, Nociceptive, or Central Sensitization Pain. *Pain Physician*. 2015;18:E333-E343.

Patients Presenting with Temporomandibular Disorder: An Analysis of 674 Patient Evaluations by a Dentist

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ABSTRACT

Background/Purpose: It is generally accepted that the etiology of temporomandibular joint disorders (TMD) is multifactorial and is related to a number of dental and medical conditions. The purpose of the study was to retrospectively evaluate standardized patient data suffering from temporomandibular disorder (TMD), in order to seek out trends and correlations with demographics and symptoms. **Methods:** A retrospective review of material on file for 674 patients who presented with TMD was performed. Patients were examined and treated by one orofacial pain/TMD specialist in one clinic to reduce interpretive bias. The accumulated data was correlated to find underlying trends. **Results:** Of the 674 patients presenting to this clinic, 561 (83.2%) were female and 113 (16.8%) were male. Temporomandibular joint (TMJ) sounds, such as clicking or popping, are one of the most common signs. The most common symptom among patients was pain in the musculature surrounding the temporomandibular joint (TMJ) and associated TMJ pain in 525 (77.9%). Pain was almost evenly distributed between bilateral and unilateral pain, as well as distributed evenly between right and left sides when unilateral pain presented. The largest group of patients by age was 151 (22.4%) in the third decade of life, while the next highest was 114 (16.9%) were in the fifth decade of life. The most common group by occupation was that of professionals (white collar workers) (29.4%). **Conclusion:** The study reiterates that pain associated with TMD is more commonly found in females. There may also be a link between an older population pool, who are in the fifth decade of life, and increased occurrences of patients with TMD.

Key Words: dentistry, pain, temporomandibular joint

INTRODUCTION

Temporomandibular disorders (TMD) are complex and characterized by a variety of clinical presentations including auricular pain, tenderness of the masticatory musculature and TMJ, limited opening of the mouth, and clicking or popping sounds originating in the TMJ.[1,2] Chronic facial pain affects nearly 10 million adults in the United States, including 7 million people who have pain centered on the temporomandibular joints and its associated muscles of mastication.[1,3,4] Pain is described by patients as being a generally mild, dull ache, but can be sharp and severe upon jaw function.[5] The causes of TMD are often complicated and poorly defined, making interpretation, differential diagnosis and treatment plans difficult to determine, unless the multifaceted signs and symptoms are examined along with a patient's social and psychological data.[1,5,6] While chronic facial pain and TMD are very common, the systematic evaluation of substantial patient populations with TMD has been relatively sporadic.

The purpose of the study was to retrospectively evaluate standardized patient data of a large patient pool suffering from TMD, in order to seek out trends and correlations with demographics and clinical presentations. This would help in an understanding of the manifestation of symptoms.

METHODS

A retrospective review of records from one clinic in Louisville, Kentucky for 674 patients who presented with TMD was performed. To reduce the interpretive bias, only records reviewed were for patients examined and treated by one orofacial pain/TMD specialist Dr. Carmine Esposito. Demographic information and signs and symptoms of TMD were recorded. Patient information analyzed included age, gender, and occupation. The accumulated data was then correlated to find underlying trends.

Results

Out of 674 patients, 561 (83.2%) were female and 113 (16.8%) were male (Figure 1). The age distribution for females was from 5 to 78 years old, and from 9 to 76 years old for males. The largest group of patients by age was 151 (22.4%) in the third decade of life, while the next highest was 114 (16.9%) were in the fifth decade of life (Figure 2).

Occupation was recorded for all patients, and this information was then correlated with gender (see Figure 1). The largest occupational group were professionals (white collar workers) with 154 women and 44 men (29.4% of patients). The next largest group of occupations were clerical: 97 women and 9 men (15.7% of patients) and homemakers: 95 women and 6 men (15.0% of patients). Those occupations with the fewest occurrences of TMD were retired (4.9%) and unemployed (2.1%).

The most common symptom among patients was pain in the musculature surrounding the TMJ and associated TMJ pain in 525 (77.9%). Headache was the next most common symptom with 487 (72.2%), followed by clicking or popping of the TMJ seen in 341 (50.6%) patients.

Nearly one-third of all patients (223) presented with pain in the neck musculature equilibrium problems (16.2%), difficulty swallowing (12.0%), and less common was earache (7.3%). Complaints involving the TMJ included clicking or popping, pain in 81.5% of patients, followed by limited functional mobility in 12.6% of patients.

There was an almost even distribution between patients with bilateral (51.4%) and unilateral pain (48.6%), as well as between right and left sides when unilateral pain was described by the patient. The most common site of muscle pain presentation was that of the masseter area in 58.7% of patients, followed by the lateral pterygoid area in 56.4% of patients.

Moderate to severe pain just posterior to the TMJ was found on the right side in 50.9% of patients, and the left side in 45.8% of patients presenting with TMJ pain. Separation of the incisal edges of the anterior teeth in patients presenting with TMD ranged from 12 mm to 61 mm. The

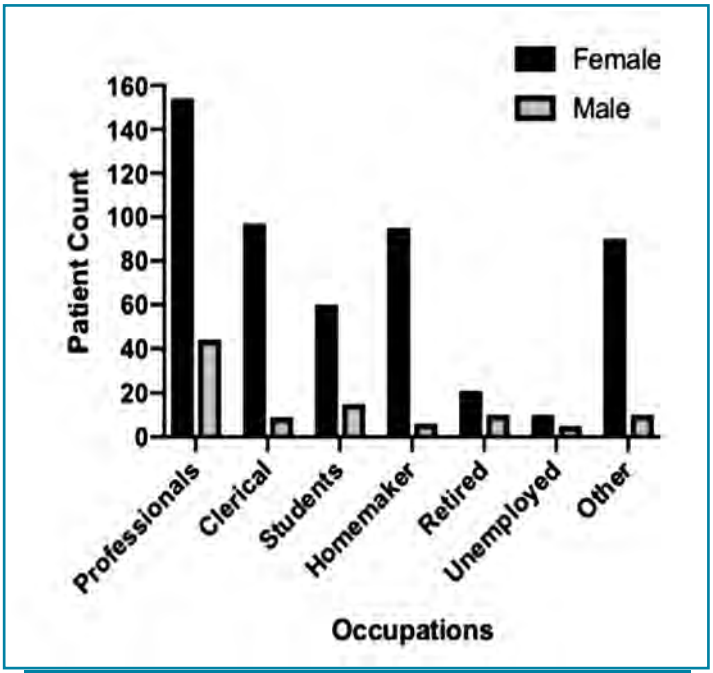

Figure 1. Distribution by gender and occupation for the patients (N=674).

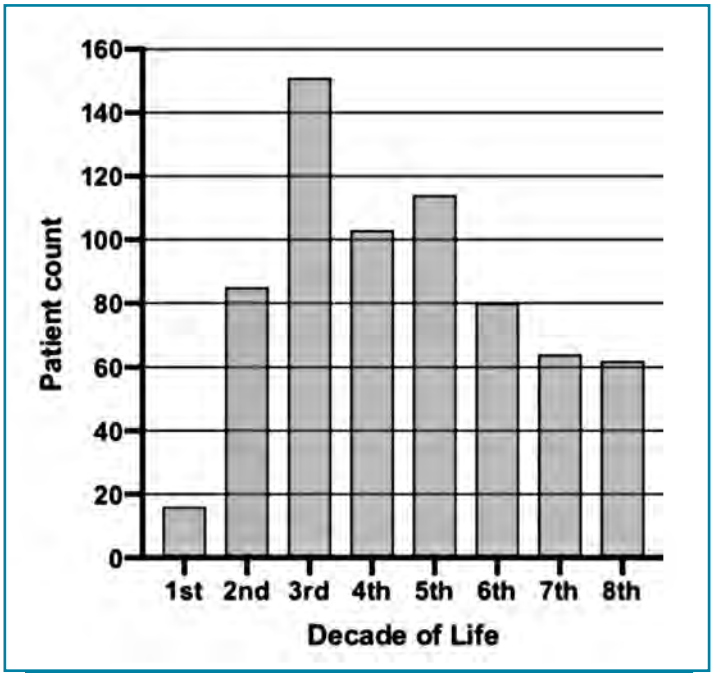

Figure 2. Distribution by age of the patients with temporomandibular disorder (N=674).

literature suggests this range to be 40 mm to 55 mm.[7]

DISCUSSION

Temporomandibular disorders comprise a group of disorders that affect the temporomandibular joint (TMJ), the masticatory muscles, or both. Temporomandibular disorders involve musculoskeletal pain, disturbances in the mandibular movement patterns, and/or impairment in functional movement. Pain is the main characteristic feature of most TMDs and also the main reason for patients to seek treatment.[8] The etiology of temporomandibular disorders has been accepted to be multifactorial, few of which includes skeletal malformations, past injuries, and inappropriate dental treatment. Occlusion, even though controversial, has been known as predisposition factor for TMDs which includes, the intercuspal position than 2 mm, extreme anterior open bite, overjet greater that 6–7 mm, 5 or more missing posterior teeth.[9]

Management goals for patients with TMD should be done by a team approach which includes patient education and self-care, cognitive behavioral intervention, pharmacotherapy, physical medicine, occlusal therapy, and potentially surgery as needed. The aim for patients with TMD is to decrease pain, restore function and return the patient to normal daily activities that do not aggravate their TMD symptoms.

The results of the current study of patients with TMD are relatively consistent with previous studies in the literature.[10] This study reiterates that the incidents of pain associated with TMD in females in the third decade of life is more common than in men of similar professional demographics.[11,12] Previous studies have shown that headache, frequent and moderate or severe, is significantly associated with TMD pain. In most cases, the onset of headache preceded TMD pain.[13] Our study showed that the headache was the next most common symptom followed by clicking or popping of the TMJ.

After tabulation and correlation, no clear and definitive relationship was found between specific signs and symptoms or demographic features studied. With correlation coefficients below an absolute value of .15 in all cases, no direct link could be made between discomfort in the muscles of mastication and the presence of demographic factors nor signs and symptoms of patients presenting with TMD.

An area that was inconsistent with previous studies was a spike in patients who are in the fifth decade of life. Usually, age distribution presents as a "bell curve" with the highest incidence in the third decade of life. However, this extra peak seen in the fifth decade of life may be due to an increasing older population pool, which could be associated with increased occurrence of TMD in this age group in the future.

However, further studies would be warranted to determine if the number of patients presenting at this age is actually proportional to the whole population at this age in the Louisville area. This would determine whether the same percentage of a population at a particular age presents with TMD, rather than just an increase in the number of patients.

REFERENCES

1. Gauer RL, Semidey MJ. Diagnosis and treatment of temporomandibular disorders. *Am Fam Physician*. 2015;91(6):378-386.
2. Mohl ND, Dixon DC. Current status of diagnostic procedures for temporomandibular. *J Am Dental Assoc*. 1994;125(1):56-64.
3. Manfredini D, Chiappe G, Boscow M. Research diagnostic criteria for temporomandibular disorders (RDC/TMD) axis I diagnosis in an Italian patient population. *J Rehabil*. 2006;33(8):551-558.
4. National Institute of Dental and Craniofacial Research. TMJ (Temporomandibular Joint & Muscle Disorders). NIH Publication No. 063487. http://www.nidcr.nih.gov/OralHealth/topics/TMJ/TMJDisorders.htm. Accessed August 12, 2020.

5. Murphy MK, MacBarb RF, Wong ME, Athanasiou KA. Temporomandibular disorders: a review of etiology, clinical management, and tissue engineering strategies. *Int J Oral Maxillofac Implants*. 2013;(6):e393-414. doi: 10.11607/jomi.te20.
6. Shaffer SM, Brismee JM, Sizer PS, Courtney CA. Temporomandibular disorders. Part 1: anatomy and examination/diagnosis. *J Man Manip Ther*. 2014;(1):2-12. doi: 10.1179/2042618613Y.0000000060.
7. Zawawi KH, Al-Badawi EA, Lobo S, Melis M, Mehta NR. An index for the measurement of normal maximum mouth opening. *J Can Dent Assoc*. 2003;69(11):737–741.
8. Tjakkes GH, Reinders J, Tenvergert EM, Stegenga B. TMD pain: the effect on health related quality of life and the influence of pain duration. *Health Qual Life Outcomes.* 2010 May 2;8:46. doi: 10.1186/1477-7525-8-46.
9. Atsu SS, Ayhan-Ardic F. Temporomandibular disorders seen in rheumatology practices: a review. *Rheumatol Int*. 2006;26:781–787. doi: 10.1007/s00296-006-0110-y.
10. Farman AG, Esposito CJ, Veal SJ. Myofascial pain-dysfunction syndrome: analysis of 164 cases. *Quintessence Int Dent Dig*. 1982;13(12):1279-1285.
11. Bagis B, Ayaz EA, Turgut S, Durkan R, Ozcan M. Gender difference in prevalence of signs and symptoms of temporomandibular joint disorders: a retrospective study on 243 consecutive patients. *Int J Med Sci*. 2012;9(7):539-544. doi: 10.7150/ijms.4474.
12. Østensjø V, Moen K, Storesund T, Rosen A. Prevalence of painful temporomandibular disorders and correlation to lifestyle factors among adolescents in Norway. *Pain Res Manag*. 2017;2017:2164825. doi: 10.1155/2017/2164825. Epub 2017 May 30.
13. Nilsson IM, List T, Drangsholt M. Headache, co-morbid pains, associated with TMD pain in adolescents. *J Dent Res*. 2013;92(9):802-807. doi: 10.1177/0022034513496255. Epub 2013 Jun 27.

Applying the Clinical Practice Guidelines and the Literature on Ankle Instability: A Case Series

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ABSTRACT

Background and Purpose: Ankle sprains account for 80% of most ankle injuries and 77% of these ankle sprains are lateral ankle injuries.[1] Due to the high prevalence of ankle sprains and resultant ankle instability, it is important to select effective clinical measures and appropriate interventions to properly manage these injuries. The purpose of this study was to examine the clinical application of the Ankle Clinical Practice Guidelines and current evidence in a case series for individuals with a history of chronic ankle instability. **Methods:** Four individuals with a history of ankle sprains aged 22 to 25 years old participated in an exercise program for 4 weeks. A pretest/posttest design was used including the Cumberland Ankle Instability Tool, the Quick Foot and Ankle Ability Measure, and 3 functional hop tests. **Findings:** All 4 individuals demonstrated an increase in their Cumberland Ankle Instability Tool score. All individuals were able to decrease their time on the 6-meter Hop Test and the Figure-of-8 Hop Test. **Clinical Relevance:** Use of these patient-reported Outcome measures and objective tests did not show clinical significance except for the 6-Meter Hop Test. The 6-Meter Hop test would be beneficial for clinicians to use as it is an ideal way to document functional improvement. **Conclusion:** When considering the Ankle Clinical Practice Guidelines and the outcome of 4 individuals with varied levels of ankle instability, the authors found mixed results in terms of completing a home exercise program that focused on balance and proprioception. The clinical application of the clinical practice guidelines should continue to be explored in future studies to demonstrate their effectiveness for examination and intervention of patients with ankle instability.

Key Words: Cumberland Ankle Instability Tool, functional hop tests, Quick Foot and Ankle Ability Measure

INTRODUCTION

Ankle sprains account for 80% of most ankle injuries and 77% of these ankle sprains are lateral ankle injuries.[1] Chan et al[2] state that acute ankle sprains account for 10% of all emergency room visits with an incidence of 30,000 ankle sprains per day. The authors note that 80% make a full recovery with conservative treatment, while the remainder will develop chronic ankle instability. Tanen et al[3] define chronic ankle instability as a history of recurrent sprains and a sensation of "giving way." Based on the literature, there is a strong correlation between individuals with a history of ankle sprains and chronic ankle instability. Due to the high prevalence of ankle injuries, it is important to have an effective evaluation and appropriate management of patients with these injuries.

One of the ways to identify the best examination techniques and interventions for the treatment of ankle instability is by reviewing the best evidence in the literature. The Academy of Orthopaedics have developed Clinical Practice Guidelines (CPGs) on ankle stability and movement coordination impairments.[4] Experts were chosen to develop the CPG to determine best practice based on the current evidence. The CPG was created in 2013 in order to provide recommendations for physical therapists to implement evidence-based practice for the diagnosis and treatment of ankle injuries.

In the current study, an exploration of the CPG application is considered using the guidelines to treat chronic or acute ankle instability with two purposes in mind. The first purpose is to consider the evidence that has emerged since the CPG was published, specifically articles from 2013-2018. Articles prior to 2013 were not a focus of this study since this evidence would have been included in the creation of the guidelines. The second purpose is to combine new and old evidence from the CPG related to diagnostic tools, clinical tests and measures, and intervention techniques. The application and effectiveness of this research will be examined by applying these principles to 4 participants in a case series format.

REVIEW OF CURRENT EVIDENCE RELATED TO CLINICAL TESTS AND MEASURES

From the CPG, two outcome measures were selected for use in this case series. These two outcome measures were chosen by the authors because the evidence from the CPG and since the CPG was published supports their use to determine ankle instability and functional impairments that exist after ankle injury. The first of these self-report outcome measures is the Cumberland Ankle Instability Tool, which is used to determine if a person is experiencing ankle instability or not. The CPG stated that a score of less than 28 indicated ankle instability, and the authors of the CPG determined that this outcome tool is a valid and reliable way to diagnose ankle instability.[4] A research study by Vuuberg et al[5] supported the findings from the CPG by showing significant correlation with self-reported ankle instability. The authors concluded that the Cumberland Ankle Instability Tool does not have a floor or ceiling effect. The minimal clinically important difference (MCID) of the Cumberland Ankle Instability Tool is a change of 3 points or greater.[6] The MCID is defined as the minimal level of change required in response to an intervention before the outcome would be considered worthwhile in terms of patient function or quality of life.[7]

The second self-report outcome measure that was used in this study is the Quick-Foot and Ankle Ability Measure (FAAM). The FAAM had evidence in the CPG that gave it a level I rating. A 2016 study by Hoch et al[8] determined that the FAAM was too time consuming for clinical purposes, thus they developed the Quick-FAAM. The Quick-FAAM includes functional and recreational activities, which may include walking up and down hills, walking on uneven ground, stepping up and down curbs, and the ability to participate in sports. After analyzing the data, the authors determined that the Quick-FAAM "demonstrated favorable internal consistency as well as convergent validity based on moderate-to-strong relationships with

the original foot and ankle ability measure, global ratings of function, activities of daily living, sport, and short form-12 Physical Component Summary score."[8] The MCID of the Quick-FAAM was found to be a change of greater than 6.5%.[9]

Tests and measures chosen from the CPG in this case series include the Side Hop Test and the Figure-of-8 Hop Test. Original research cited in the CPG suggests that these tests have the ability to differentiate between the affected ankle and the unaffected ankle. The Side Hop and Figure-of-8 Hop Test received level II evidence and newer evidence confirms the usefulness of these tests. Linens et al[10] reviewed the studies completed by Caffrey et al[11] and Hertel et al[12] and concluded that these two tests had cutoff scores that were useful in determining patients who would benefit from rehabilitation. The researchers reported the cutoff scores for the Side Hop Test as >12.87 seconds and for Figure-of-8 Hop Test >17.35 seconds.[10] The minimal detectable change (MDC) defined as the amount of change that just exceeds the standard error of measurement of an instrument,[7] for the Side Hop Test was found to be 5.82 seconds, and for the Figure-of-8 Test as 4.59 seconds.[11] In addition to these two tests, the 6-Meter Hop Test was used. A study by Cho et al[13] the 6-Meter Hop Test was shown to be reliable at detecting ankle instability. The 6-Meter Hop Test has a cut off score of 87.7% limb symmetry index and an MDC of .233 seconds for males and .211 seconds for females.[14,15] Based on the CPG and more recent evidence, the authors of the current study selected the Side Hop Test, 6-Meter Hop Test, and the Figure-of-8 Hop Test as appropriate tests and measures for this case series to determine if patients with functional ankle instability improve with rehabilitation.

REVIEW OF CURRENT EVIDENCE RELATED TO INTERVENTION

The intervention section of the CPG contains a comprehensive list of interventions that have been researched in regards to acute lateral ankle sprains. A literature search was conducted to review literature from 2013-2018 to consider more recent evidence since the CPG was published. Interventions of focus include electrotherapy, low level laser therapy, early weight bearing with support, manual therapy, therapeutic exercise, and balance/proprioception exercises. Electrotherapy and low level laser therapy was chosen secondary to the authors of the CPG reporting a grade of "D," conflicting evidence, on their effectiveness based on the evidence. A literature search was performed for the additional interventions to review recent evidence on the efficacy of these techniques which were highly rated in the CPG.

In regard to the use of electrical stimulation for ankle injuries, the CPG states there is moderate evidence both to support its use and also evidence reported that supports its ineffectiveness.[4] There was one study that was cited in support of electrical stimulation which was completed in 1972.[16] Upon further investigation, a systematic review published in 2015 suggests that electrical stimulation is not effective in treating acute ankle sprains. Feger et al.[17] conclude that there is high-quality evidence against the use of electrical stimulation for pain reduction, swelling, and improvement in functional impairment. The article identified 4 randomized control trials that examined the use of neuromuscular electrical stimulation and high-voltage pulsed electrical stimulation. The ankle instability CPG was updated in 2013, so this systematic review was not included.[4] This systematic review provides information to further suggest against the use of electrical stimulation in the treatment of ankle sprains.

In terms of low level laser therapy evidence the CPG authors note there is mixed evidence for this population. One of the studies that was cited in the CPG was completed in 1989 and found that there was rapid reduction in pain and faster return to work; however, an additional 1988 study reported that low level laser was ineffective.[4] In contrast to this suggestion, De Moraes et al[18] in a randomized controlled trial state that low level laser was effective. The researchers found that the group that was treated with the active light-emitting diode showed statistically decreased pain compared to the placebo group. The authors found that the levels of edema were decreased on the third and sixth days in the light-emitting diode treatment group. From these results, the researchers concluded that using their testing dosage, light-emitting diode is effective for pain and edema reduction in the acute phase of ankle sprains.[18] This research, which was conducted following the publication of the CPG, helps to provide more evidence in support of the use of laser therapy. However, a limitation of this study is potential bias since the publisher of this journal is a manufacturer of lasers.

Early weight bearing with support received a grade of A by the CPG authors. Current research continues to support the CPG findings. A systematic review by Peterson et al[19] concluded that long term non-weight bearing should be avoided following nonsurgical treatment of lateral ankle sprains. A below the knee cast helps to reduce swelling and pain during the early inflammatory phases of healing. For ankle sprains of grade III, a short period of nonweight bearing with a cast below the knee could be beneficial for a maximum of 10 days. Later during the proliferative phase and remodeling phase, immobilization would be detrimental for the healing process. Following this phase, the ankle is best to be protected from further inversion injury using a semi-rigid ankle brace. The authors report that prolonged immobilization has a detrimental effect on muscles, ligaments, and joint surfaces. This research supports the statements in the CPG related to the importance of early weight bearing.

Manual therapy is an additional intervention technique discussed in the CPG. The CPG identified that mobilizations with movement were an appropriate treatment approach to use in the progressive loading phase of treatment but was not mentioned for use in the acute phase. A 2017 case series was conducted by Hudson et al[20] on the effect of the Mulligan mobilization with movement (MWM) when used to treat acute ankle sprains. The mobilization was done at the distal fibula or 2 to 3 inches proximal if it was modified. The treatment was administered for a total of 9 days and patients reported a decrease in pain, decrease in disability, and an increase in function. The authors reported an immediate decrease in pain following the first treatment with MWM. This evidence indicates that the use of MWM is beneficial in both the acute and the progressive loading phases of ankle sprains.

Many other manual therapy techniques can be beneficial in treatment of ankle sprains. A randomized controlled trial was conducted later in 2013 that compared the effectiveness of manual therapy and exercise to a home exercise program alone in the treatment of inversion ankle sprains. From this study,[21] the researchers concluded there were improvements on both the activities of daily living and sports subscale of the FAAM, improvements of the Lower Extremity Functional Scale, and improvements on the Numeric Pain Rating Scale that were greater in the group who received manual therapy at both 4 weeks and 6 months. The manual therapy that was received by these individuals included mobilizations at the proximal and distal tibiofibular joint, subtalar joint, and the talocrural joint.[21] This research further supports the information that is included in the CPG by providing evidence in support of using mobilizations in the treatment of

ankle sprains in both the acute and progressive loading phases.

There is a significant amount of evidence on therapeutic exercise as an intervention for ankle sprains. In 2010, Bleakley et al[22] reported a significant increase in lower extremity function for those who received exercise in combination with early progressive weight bearing. Early progressive weight bearing is also highly recommended within the CPG. As for the subacute/chronic stage, evidence by Hall et al[23] suggests that TheraBand® and proprioceptive neuromuscular facilitation techniques are both effective treatments to improve strength, pain, and how patients perceive their instability. These two different therapeutic exercise techniques were compared to a control group who did not receive any exercise. Both proprioceptive neuromuscular facilitation and resistance band groups had improvements in strength and in pain levels but there were no improvements in the control group.[23] This research provides further support for the CPG recommendation in the use of therapeutic exercise in the progressive loading phase for reduction in pain and increases in strength in chronic ankle instability.

The CPG intervention section provides useful information about proprioception and balance training. Overall, the CPG reports that this type of training helps to improve postural sway and functional ankle instability.[4] In a systematic review, Doherty et al[24] concluded that with the addition of balance and proprioceptive training, there was a reduction in repeat ankle sprain incidence and subjective instability, improved postural control, and decreased incidence of "giving way" episodes. Another study by Lasarou et al[25] concluded that balance and proprioception interventions were very effective in improving ankle range of motion (ROM) and functional performance in individuals with ankle instability. Both of these studies support the CPGs recommendation for including balance and proprioceptive training in the treatment for ankle instability.

Research Summary

The CPG was used as a guide to implement selected examination and intervention techniques in the individuals within this case series. Based on the CPG review and additional studies through a literature search, clinical tests and measures, and interventions that are best supported by the evidence were applied to the individuals in this case series. The Side Hop Test, 6-Meter Hop Test, and Figure-of-8 Hop Test were used to determine the individual's functional abilities and potential need for rehabilitation. Following examination, the Quick-FAAM and the Cumberland Ankle Instability Tool were used as the outcome tools to measure functional progress. Cut off scores for the Cumberland Ankle Instability Tool were used to identify ankle instability. Intervention for the treatment of the individuals' lateral ankle sprain included a focus on therapeutic exercise, particularly on balance and proprioception due to the chronic nature of the individual's injury. The goal was to combine the new evidence obtained through this literature review and the CPG in order to determine the effectiveness of these guidelines in a clinical setting.

CASE PRESENTATIONS

Case 1

Examination: A 25-year-old female presented to clinic with a history of chronic right ankle instability. She had a history of multiple sprains over the last 5 years with the most recent episode 2 weeks prior to examination. Tenderness was located over the anterior talofibular ligament with palpation; however, no pain was described. No swelling or ecchymosis was observed. The individual reported that her ankles "felt weak," however, this did not limit her activity level. Prior treatment included strengthening ankle musculature with TheraBand and use of a brace. She was in good health with no significant past medical history. Examination of the ankle revealed active motion within normal limits and equal bilaterally. Laxity noted 3/4 (0 = no mobility, 3 = normal mobility, 6 = complete instability) on the right and 2/4 on the left with an anterior drawer test.[26,27] Manual muscle testing revealed 5/5 strength in anterior tibialis and peroneal longus and brevis with 4/5 strength in posterior tibialis on the right.[28] The individual was able to perform 8 heel raises on the right. During the examination, the patient performed the Side Hop Test, 6-Meter Hop Test, and the Figure-of-8 Hop Test (Table 1).

Management and Outcome: At the start of treatment, the individual completed the Cumberland Ankle Instability and Quick-FAAM outcome measures (Table 2). Based on the cut off score for the Cumberland Ankle Instability Tool, her score was consistent with a diagnosis of ankle instability. The individual performed a home program of therapeutic exercises instructed by the physical therapist. An emphasis on balance and proprioceptive activities was provided with a goal of performing the exercises 5 times per week for 4 weeks. This was recorded on a chart (Table 3). Additionally, she was instructed in transverse friction massage to the anterior talofibular ligament to be performed once per day for 15 minutes. The individual was able to perform the home program independently. Upon return for the follow-up visit, she reported no difficulty with performing the exercises and had less tenderness with palpation of the anterior talofibular ligament. Overall, she reported her ankle felt stronger when performing sport activities including volleyball. At this time, a Cumberland Ankle Instability and Quick-FAAM was completed again. She was re-tested on the Side Hop Test, 6-Meter Hop, and Figure-of-8 Hop Test (see Tables 1 and 2). Over a 4-week period, she participated in a total of 8 exercise sessions.

Case 2

Examination: A 24-year-old male presented to the clinic with a prior ankle sprain 5 months ago. He reported only one episode of injury to his right ankle and denied any pain or tenderness with palpation in the ankle. No laxity was noted with an anterior drawer test. Ankle ROM was within normal limits bilaterally. Manual muscle test revealed 5/5 strength in anterior tibialis, posterior tibialis, peroneus longus, and peroneus brevis. He was able to perform 18 heel raises on the right and 23 on the left. Prior home exercises included pain-free ankle ROM and heel raises. The individual did not receive any prior physical therapy intervention. His past medical history was unremarkable. During the examination, he performed the Side Hop Test, the 6-Meter Test, and the Figure-of-8 Hop Test.

Management and Outcome: At the start of treatment, he completed the Cumberland Ankle Instability and Quick-FAAM outcome measures. Based on the cut off score for the Cumberland Ankle Instability Tool, his score was consistent with a diagnosis of ankle instability. The individual performed a home program of therapeutic exercises, with an emphasis on balance and proprioceptive activities with a goal of performing the exercises 5 times per week for 4 weeks. He was instructed by the physical therapist on proper performance of the exercises and demonstrated correct performance of the exercises. The individual was given a list of the home exercise program and a chart to document each time he performed the prescribed exercises. He was able to perform the home program independently. Upon return for the follow-up visit, he reported no dif-

Table 1. Pre and Post Data from Functional Hop Tests for the Four Individuals in this Case Series

	6-Meter Hop Test		Figure-of-8 Hop Test		Side Hop Test	
Patient 1	18.25 sec	12.06 sec	21.55 sec	19.28 sec	22.0 sec	22.65 sec
Patient 2	9.125 sec	5.45 sec	12.9 sec	11.56 sec	9.2 sec	8.67 sec
Patient 3	5.39 sec	3.34 sec	15.0 sec	12.3 sec	9.33 sec	7.94 sec
Patient 4	4.44 sec	3.27 sec	13.45 sec	10.63 sec	11.3 sec	8.4 sec

Table 2. Self-Report Outcome Tool Scores for the Four Individuals in this Case Series

	Cumberland Ankle Instability Tool		Quick-Foot and Ankle Mobility Measure Hop Test	
	Pre	Post	Pre	Post
Patient 1	17/30	18/30	39/48 (81%)	34/48 (70%)
Patient 2	25/30	27/30	30/32 (92%)	32/32 (100%)
Patient 3	23/30	24/30	48/48 (100%)	44/48 (91%)
Patient 4	16/30	26/30	36/44 (81%)	N/A

Table 3. Description of the Initial Home Exercise Program for the Four Individuals in this Case Series

Initial Home Exercise Program
BOSU ball single leg balance 30 seconds 3 – 5 times
BAPS board clockwise and counterclockwise in standing 3 sets
Single leg heel raises 10 reps/5 sets
Marching on trampoline 5 – 15 minutes based on patient tolerance

ficulty with performing the exercises. He stated he had slightly more confidence in his ankle and felt he could perform single leg squats with less difficulty. At the follow-up appointment, he completed the Cumberland Ankle Instability and Quick-FAAM. Over a 4-week period, he participated in a total of 16 exercise sessions.

Case 3

Examination: A 23-year-old male presented to clinic with chronic left ankle instability. He had a history of 5 to 7 ankle sprains over the last 5 years. The most recent ankle sprain was 3 months ago. There was no current complaints of pain or edema. No tenderness with palpation of the lateral ligaments of the left ankle. Ankle ROM was within normal limits bilaterally. Manual muscle testing revealed 5/5 strength in anterior tibialis, posterior tibialis, peroneus longus, and brevis. The individual was able to perform 23 repetitions of heel raises on the left and 25 on the right. Anterior drawer test revealed 2/4 laxity bilaterally. He had no formal treatment for his prior ankle sprains and was in good health with no significant past medical history. During the examination, he performed the Side Hop Test, 6-Meter Hop Test, and the Figure-of-8 Hop Test.

Management and Outcome: At the start of treatment, he completed the Cumberland Ankle Instability and Quick-FAAM outcome measures. Based on the cut off score for the Cumberland Ankle Instability Tool, his score was consistent with a diagnosis of ankle instability. He performed a home program of therapeutic exercises, with an emphasis on balance and proprioceptive activities with a goal of performing the exercises 5 times per week for 4 weeks. He was instructed by the physical therapist on proper performance of the exercises and demonstrated correct performance of the exercises. The individual was given a list of the home exercise program and a chart to document each time he performed the prescribed exercises. He was able to perform the home program independently. Upon return for the follow-up visit, he reported no difficulty with performing the exercises. He stated his ankle was feeling better until he landed on a player's foot playing volleyball and "rolled" his left ankle again 5 days later. He denied any edema following the reinjury. He stated he was able to continue his exercise program; however, complained of "popping" in his ankle with exercise. At the follow-up appointment, the Cumberland Ankle Instability and Quick-FAAM were completed again. He was re-tested on the Side Hop Test, 6-Meter Hop Test, and Figure-of-8 Hop Test. Over a 4-week period, he participated in a total of 17 days of exercise sessions.

Case 4

Examination: A 22-year-old female presented to clinic with a prior history of left ankle instability. She reports 3 prior ankle sprains with the most recent 1.5 years ago and denied any pain in her ankle. Ankle ROM was within normal limits bilaterally. Manual muscle testing revealed 5/5 strength in anterior tibialis, posterior tibialis, peroneus longus, and brevis. She was able to perform 20 heel raises on the left and 25 heel raises on the right. The anterior drawer test revealed 2/4 laxity bilaterally. She did not report any prior formal treatment for the ankle sprains. The individual's past medical history was unremarkable. During the examination, she performed the Side Hop Test, 6-Meter Hop Test, and the Figure-of-8 Hop Test.

Management and Outcome: At the start of treatment, she completed the Cumberland Ankle Instability and Quick-FAAM outcome measures. Based upon the cut off score for the Cumberland Ankle Instability Tool, her score was consistent with a diagnosis of ankle instability. She performed a home program of therapeutic exercises, with an emphasis on balance and proprioceptive activities with a goal of performing the exercises 5 times per week for 4 weeks. The physical therapist instructed her on proper performance of the exercises and demonstrated correct perfor-

mance of the exercises. She was given a list of the home exercise program and a chart to document each time she performed the prescribed exercises. She was able to perform the home program independently. Upon return for the follow-up visit, she reported no difficulty with performing the exercises; however, compliance in performing the exercises was difficult. At the follow-up appointment, she completed the Cumberland Ankle Instability and Quick-FAAM again. The individual was re-tested on the Side Hop Test, 6-Meter Hop Test, and Figure-of-8 Hop Test. Over a 4-week period, she participated in a total of 14 exercise sessions.

DISCUSSION

The purpose of this case series was to determine if the evidence in the Clinical Practice Guidelines and most recent evidence were applicable in a clinical setting. After analyzing the data from the 4 individual cases, multiple observations were noted.

Cumberland Ankle Instability

All the individuals in the study scored lower than a 28 on the Cumberland Ankle Instability Tool indicating that they did have ankle instability at the initial evaluation. It is also important to note that none of the individuals scored higher than 28 on their posttreatment scores indicating that each individual still had some degree of ankle instability. It was observed that all 4 cases had an increase in their score from pre- to posttesting. However, only one individual, Case 4 as described above, had a clinically significant change of 10 points. As mentioned in the research section on outcome tools, the MCID for the Cumberland Ankle Instability Tool is ≥ a 3-point change.[6] Case 1 and 3 had one-point improvements and Case 2 had a two-point increase; however, these were not clinically significant for the Cumberland Ankle Instability Tool.

Quick-Foot and Ankle Ability Measure

The second outcome tool we used was the Quick-FAAM. It was noted that Case 4 did not complete the Quick-FAAM in its entirety. Therefore, her score was unreliable and was not included in the data analysis. Two of the remaining 3 individuals, Cases 1 and 3, showed a decrease in their pre and post scores of 11% and 9%, respectively. These percentages demonstrate a decrease in the individual's ability to perform the tasks included in the Quick-FAAM because the MDC is greater than 6.5%.[10] One individual, Case 2, showed an increase in his score by 8%, indicating an increase in his ability to perform the tasks on the Quick-FAAM.

Functional Examination Techniques

For the 6-Meter Hop Test, all 4 individuals decreased their time. All of the differences in time were greater than the reported MDC of 0.233 seconds for males, and 0.211 seconds for females.[16] Therefore, the results show that participation in proprioception and balance exercises, as recommended by the Ankle Stability Clinical Practice Guidelines improves the individual's ability to perform the 6-Meter Hop Test with improved ankle stability. The second functional hop test used was the Figure-of-8 Test. Case 1 had an improvement in her time of 2.27 seconds. Case 2 showed an improvement of 1.34 seconds. Case 3 exhibited an improvement of 2.70 seconds. Finally, Case 4 showed improvement of 2.82 seconds. Overall, the times varied when it came to completing the test. The fastest completion time was noted to be 13.45 seconds during the pretest and 10.63 seconds for the posttest. Interestingly, these scores were achieved by the same individual. After analyzing the data, all 4 individuals experienced a decrease in their overall time. However, based on the MDC of 4.59 seconds, these results show that the individuals did not have a significant increase in their overall function.[10] It was also noted that higher pretest level of function (shorter completion times) seems to coincide with higher posttest function. Lastly, the Side Hop Test was analyzed. According to the previous research, the MDC for the Side Hop Test is 5.82 seconds.[10] When comparing the MDC to the differences in individual's completion time, some interesting results are yielded. Of the 4 individuals, Case 1 experienced a 0.15 second increase in her overall time. The other 3 individuals all experienced a decrease in their completion time. Case 2 had a difference of 0.53 seconds. Case 3 exhibited a difference of 1.39 seconds and Case 4 showed a 2.90 second change in her time. The differences in times were all less than the MDC. As a result, these times were not indicative of a significant improvement in overall function on the affected ankle. As a side note, Case 1 performed the worst on all three functional hop tests by a significant amount of time. It is hypothesized that this participant performed the worst on the functional tests because her injury was rather acute occurring only two weeks prior to initiation of treatment sessions. She also had the most complaints about ankle pain, as well as ankle limitations at the beginning of the treatment sessions.

There were a number of limitations to this case series that include the following: all of the individuals that were recruited for the case series had chronic ankle instability; however, one individual had an acute re-injury two weeks prior to the study. During the initial research of the Ankle Stability Clinical Practice Guidelines, the majority of the evidence was for acute ankle sprains, making it difficult to apply certain aspects of the Clinical Practice Guidelines to the individuals of the case series. The next limitation of the case series was that due to circumstances of the study, the individuals were instructed to complete a home exercise program 5 times per week for 4 weeks and increase their exercises on their own, making it difficult to assess whether their responses and reporting were accurate or not. Participant adherence was difficult to determine and exercises were not completed all 20 days that were recommended (ranging from 8-17 days). The third limitation was that one of the individuals did not fill out the Quick-FAAM completely creating an inaccurate representation of the function and ability of their ankle. The other limitation with Quick-FAAM was that the individuals had very high scores prior to treatment, resulting in a possible ceiling effect for the individuals. The last limitation is that the uninvolved ankle was not assessed during completion of the anterior drawer test or the other functional tests, which made it difficult to compare the affected ankle to the unaffected ankle for laxity and function.

Further research should be completed in order to apply the Ankle Stability Clinical Practice Guidelines throughout a typical physical therapy plan of care in those with acute or chronic ankle sprains to determine the effectiveness of the CPG application.

CONCLUSION

In conclusion, this case series examined the benefits of balance and proprioceptive exercise training on individuals with a history ankle instability. Prior to beginning treatment, all individuals completed 2 outcome measures, 3 functional tests, and the anterior drawer test. These tests and measures were chosen based on evidence from the Clinical Practice Guidelines and current evidence. The following tests and measures showed mixed results for individuals with ankle instability: Cumberland Ankle Instability Tool was not clinically significant, the Quick-FAAM showed mixed results, 6-Meter Hop Test showed clinically significant improvement, Figure-of-8 Test showed improvement but was not clinically significant, and

the Side Hop Test showed improvement but was not clinically significant. Overall, mixed results were found for the completion of a home exercise program that focused on balance and proprioceptive exercises for individuals with a history of ankle instability. The clinical application of the CPGs should continue to be researched in future studies to demonstrate their effectiveness for examination and intervention of patients with ankle instability.

REFERENCES

1. Al-Mohrej OA, Al-Kenani NS. Acute ankle sprain: conservative or surgical approach? *EFORT Open Rev*. 2016;1:34-44.
2. Chan KW, Ding BC, Mroczek KJ. Acute and chronic lateral ankle instability in the athlete. *Bull NYU Hosp Jt Dis*. 2011;69:17-26.
3. Tanen L, Docherty CL, Van Der Pol B, Simon J, Schrader J. Prevalence of chronic ankle instability in high school and division I athletes. *Foot Ankle Spec*. 2014;7(1):37-44. doi: 10.1177/1938640013509670. Epub 2013 Nov 27.
4. Martin RL, Davenport TE, Paulseth S, et al. CPG: Ankle stability and movement coordination impairments: ankle ligament sprains. *J Orthop Sports Phys Ther*. 2013;43(9):A1-A40. doi: 10.2519/jospt.2013.0305.
5. Vuurberg G, Kluit L, Niek van Dijk C. The Cumberland Ankle Instability Tool (CAIT) in the Dutch population with and without complaints of ankle instability. *Knee Surg Sports Traumatol Arthrosc*. 2018;26:882-891.
6. Wright CJ, Linens SW, Cain MS. Establishing the minimal clinical important difference and minimal detectable change for the Cumberland Ankle Instability Tool. *Arch Phys Med Rehabil*. 2017;98(9):1806-1811. doi: 10.1016/j.apmr.2017.01.003. Epub 2017 Jan 27.
7. Jewell DV. *Guide to Evidence-Based Physical Therapist Practice*. 3rd ed. Burlington, MA: Jones & Bartlett Publishers; 2015.
8. Hoch M, Hoch J, Houston M. Development of the quick-FAAM: a preliminary shortened version of the foot and ankle ability measure for chronic ankle instability. *Int J Athl Ther Train*. 2016;21(4):45-50.
9. Hoch JA, Powden CJ, Hoch MC. Reliability, minimal detectable change, and responsiveness of the quick-FAAM. *Phys Ther Sport*. 2018;32:269-272. doi: 10.1016/j.ptsp.2018.04.004. Epub 2018 Apr 9.
10. Linens S, Ross S, Arnold B, Gayle R, Pidcoe P. Postural-stability tests that identify individuals with chronic ankle instability. *J Athl Train*. 2014;49(1):15-23. doi: 10.4085/1062-6050-48.6.09. Epub 2013 Dec 30.
11. Caffrey E, Docherty CL, Schrader J, Klossner J. The ability of 4 single-limb hopping tests to detect functional performance deficits in individuals with functional ankle instability. *J Orthop Sports Phys Ther*. 2009;39(11):799-806. doi: 10.2519/jospt.2009.3042.
12. Hertel J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. *J Athl Train*. 2002;37(4):364–375.
13. Cho BK, Park JK. Correlation between joint-position sense, peroneal strength, postural control, and functional performance ability in patients with chronic lateral ankle instability. *Foot Ankle Int*. 2019;40(8):961-968. doi: 10.1177/1071100719846114. Epub 2019 Apr 25.
14. Logerstedt D, Grindem H, Lynch A, et al. Single-legged hop tests as predictors of self-reported knee function after anterior cruciate ligament reconstruction. *Am J Sports Med*. 2012;40(10):2348-2356. doi: 10.1177/0363546512457551. Epub 2012 Aug 27.
15. Munro A, Herrington L. Between session reliability of four hop tests and the agility T-Test. *J Strength Cond Res*. 2011;25(5):1470-1477. doi: 10.1519/JSC.0b013e3181d83335.
16. Wilson DH. Treatment of soft-tissue injuries by pulsed electrical energy. *Br Med J*. 1972;2(5808):269–270. doi: 10.1136/bmj.2.5808.269.
17. Feger MA, Goetschius J, Love H, Saliba SA, Hertel J. Electrical stimulation as a treatment intervention to improve function, edema, or pain following acute lateral ankle sprains: A systematic review. *Phys Ther Sport*. 2015;16(4):361-369. doi: 10.1016/j.ptsp.2015.01.001. Epub 2015 Jan 26.
18. De Moraes Prisnti B, Novello GF, de Souza Moreira Prianti T, et al. Evaluation of the therapeutic effects of led on the initial phase of ankle sprains treatment: a randomized placebo-controlled clinical trial. *Lasers Med Sci*. 2018;33(5):1031-1038. doi: 10.1007/s10103-018-2460-6. Epub 2018 Feb 8.
19. Petersen W, Rembitzki IV, Koppenburg AG, et al. Treatment of acute ankle ligament injuries: a systematic review. *Arch Orthop Trauma Surg*. 2013;133(8):1129–1141. doi: 10.1007/s00402-013-1742-5. Epub 2013 May 28.
20. Hudson R, Baker RT, May J, et al. Novel treatment of lateral ankle sprains using the mulligan concept: an exploratory case series analysis. *J Man Manip Ther*. 2017;25(5):251-259. doi: 10.1080/10669817.2017.1332557. Epub 2017 May 29.
21. Cleland JA, Mintken P, McDevitt A, et al. Manual physical therapy and exercise versus supervised home exercise in the management of patients with inversion ankle sprain: a multicenter randomized clinical trial. *J Orthop Sports Phys Ther*. 2013;43(7):443-455. doi: 10.2519/jospt.2013.4792. Epub 2013 Apr 29.
22. Bleakley CM, Oconnor SR, Tully MA, et al. Effect of accelerated rehabilitation on function after ankle sprain: randomised controlled trial. *BMJ*. 2010;340:c1964. doi:10.1136/bmj.c1964.
23. Hall EA, Docherty CL, Simon J, Kingma JJ, Klossner JC Strength-training protocols to improve deficits in participants with chronic ankle instability: a randomized controlled trial. *J Athl Train*. 2015;50(1):36-44. doi: 10.4085/1062-6050-49.3.71. Epub 2014 Nov 3.
24. Doherty C, Bleakley C, Delahunt E, Holden S. Treatment and prevention of acute and recurrent ankle sprain: an overview of systematic reviews with meta-analysis. *Br J Sports Med*. 2017;51:113-125. doi: 10.1136/bjsports-2016-096178. Epub 2016 Oct 8.
25. Lazarou L, Kofotolis N, Pafis G, Kellis E. Effects of two proprioceptive training programs on ankle range of motion, pain, functional and balance performance in individuals with ankle sprains. *J Back Musculoskelet Rehabil*. 2018;31:437-446. doi: 10.3233/BMR-170836.
26. Bekkering GE, Effects on the process of

care of an active strategy to implement clinical guidelines on physiotherapy for low back pain: a cluster randomized controlled trial. *Qual Saf Health Care*. 2005;14(2):107-112. doi: 10.1136/qshc.2003.009357.
27. Van der Wees PJ, Hendriks EJ, Jansen MJ, Beers HV, De Bie RA, Dekker J. Adherence to physiotherapy clinical guideline acute ankle injury and determinants of adherence: a cohort study. *BMC Muscul Dis*. 2007;8(1):45. doi: 10.1186/1471-2474-8-45.
28. Croy T, Koppenhaver S, Saliba S, Hertel J. Anterior talocrural joint laxity: diagnostic accuracy of the anterior drawer test of the ankle. *J Orthop Sports Phys Ther*. 2013;43(12):911-919. doi: 10.2519/jospt.2013.4679. Epub 2013 Oct 30.
29. Kaltenborn FM. *Manual Mobilization of the Extremity Joints*. 5th ed. Minneapolis, MN: OPTP; 1999.
30. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. *Muscles Testing and Function with Posture and Pain*. 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.

President's Message

Rick Wickstrom, PT, DPT, CPE, CME

We are facing new challenges and uncertainties in the wake of COVID-19. After record-setting "in-person" attendance at CSM 2020, our new normal will be a "virtual" CSM experience in 2021. On the same day that APTA made this announcement, a friend shared this healing message of comfort with me:

> *Be aware of opportunities presenting in your life and trust that they are appearing for a good reason. Take up these opportunities with trust and faith that they are for your betterment and will help you to achieve long-term success.*

This prompted me to consider embracing these challenges as opportunities in our mission to empower members to excel in occupational health. We can accomplish more by working together with a common vision to optimize movement, musculoskeletal health, and work participation from hire to retire:

- Our Practice Committee led by Lorena Payne (Chair) has nearly completed our evidence-based Work Rehab Clinical Practice Guideline. There will soon be an opportunity for OHSIG members to provide peer review feedback of this foundational document. If this interests you, please connect with Lorena Payne (lpettet@aol.com) by email.
- Our Research Committee led by Marc Campo (Chair) is forging ahead with our strategic initiative to create an advanced educational credential to qualify and promote occupational health professionals with advanced competencies. This will be a COVID-friendly virtual learning experience that combines an independent study course (ISC) with a peer review component for credentialing. There are opportunities for OHSIG members to serve on the steering subcommittee, as well as authors to create our educational modules. If this interests you, please email a description of your background to Rick Wickstrom (rwickstrom@orthopt.com) or Marc Campo (mcampo@mercy.edu).
- Our Membership Committee led by Caroline Furtak (Chair) is launching our strategic initiative to establish OHSIG members to serve as state key contacts for payment policy inquiries and make presentations related to occupational health practice. If this interests you, please send an email to our OHSIG Vice President, Steve Allison (sallisondpt@fcexpt.com) or Caroline Furtak (ckfurtak@gmail.com).
- Our Membership Committee led by Cory Blickenstaff (Chair) and Peter McMenamin (Vice Chair) is meeting on a regular basis to reshape our Current Concepts document on "The Role of the Physical Therapist in Occupational Health". We look forward to publishing this work product in the next edition of *OPTP.*
- Our Nominating Committee members Katie McBee (Chair), Michelle Despres, and Jeff Paddock are doing a great job of inspiring new leaders as well as supporting the above initiatives.

We invite OHSIG members to participate in our initiatives as well as discussions on our Occupational Health SIG Facebook Page. Let us know your needs, or simply share your story about how your practice is taking the opportunity to innovate in response to COVID-19. We are better together!

President's Message

Laurel Daniels Abbruzzese, PT, EdD

PASIG 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*

Greetings PASIG members!

I am writing this letter in August 2020, and the COVID-19 Pandemic is still ever-present in our daily lives. Although businesses have started to open this summer, performing artists need audiences, and packed audiences would still pose too great a risk to the health of our communities. Performers who continue to train during this extended "off-season" are doing so in their homes or masked in smaller cohorts. It will be important for performing arts physical therapists to be mindful of new injury risks and limited access to care given these new circumstances. We will also want to be on the lookout for post-viral syndrome,[1] including signs of fatigue and difficulty concentrating. Our PASIG Artist Screening Chair, Mandy Blackmon, notes that despite a great need, many schools and companies will not be conducting large screening events this year due to social distancing precautions. She plans on prioritizing the cardiovascular and aerobic capacity components of her screens for dancers in Atlanta. Our Columbia Dance Research team is planning a virtual adolescent dancer screen, including standardized self-report measures such as the Eating Attitudes Test© (EAT-26)[2] and the Dance Functional Outcome Survey (DFOS).[3] We will also expand our weekly electronic injury surveillance, using a modified Oslo Sports Trauma Research Centre questionnaire on health problems for dancers.[4]

As a PASIG, we have been taking advantage of the Zoom movement and connecting more frequently in virtual spaces. On June 14th, we had a great turnout for our virtual PASIG Membership Meeting, including breakout sessions for Research, Public Relations, and Education. We welcome Sarah Edery-Altas and Katrina Lee, our new Independent Study Course (ISC) Task-Force Co-Chairs. They will lead our efforts to create a new ISC and create educational content with the Education Committee, led by Rosie Canizares. The first topic on the docket is "Aerial Performing Arts."

"Injuries in circus arts" was also the topic of our July citation blast by Emily Scherb, PT, DPT. If there is a topic of interest that you would like to read more about, or if you would like to contribute a PASIG blast or article, please contact our Research Chair, Mark Romanick.

On August 2nd, we hosted an informal Q&A for new grads that are seeking resources and advice for careers working with performing artists. A big thank you to Janice Ying, Dawn Muci, Mandy Blackmon, Andrea Lasner, Anna Saunders, and Rosie Canizares for sharing your wisdom with our PASIG new grads, and thank you to Ryann Lewis for moderating the event.

Tiffany Marulli is still easing into her new role as Fellowship Advisory Panel Chair. She will be facilitating the joint needs of our 4 performing arts fellowship programs. One of the most frequent questions that I received when I was in that role was from current DPT students wanting to know how a fellowship is different from a residency program. I offer this excerpt from the ABPTRFE credentialing handbook:

"[A clinical fellowship is a…] post-professional planned learning experience in a focused advanced area of clinical practice. Similar to the medical model, a clinical fellowship is a structured educational experience (both didactic and clinical) for physical therapists which combines opportunities for ongoing clinical mentoring with a theoretical basis for advanced practice and scientific inquiry in a defined area of sub-specialization beyond that of a defined specialty area of clinical practice. A fellowship candidate has either completed a residency program in a related specialty area or is a board-certified specialist in the related area of specialty. Fellowship training is not appropriate for new physical therapy graduates."

— The Credentialing Handbook, 2012

If you are planning a career path that includes a performing arts fellowship, your first step is to obtain board certification (OCS or SCS) or complete a residency. More information about the performing arts fellowship options can be found at: https://accreditation.abptrfe.org/#/directory?f-accredited=true&f-candidate=false&f-developing=false&f-fellowship=true&f-residency=false

AOPT SIG | PERFORMING ARTS
ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY, APTA

The PASIG leadership team is committed to recruiting and engaging a diverse membership, so this summer we had a PASIG logo contest to reflect the diversity of artists that we treat. Thank you to Victoria Lu, SPT, for creating the winning submission.

Thank you to our membership chair, Jessica Waters, for leading this effort and for researching PASIG swag options for our members. We know that many of you are eager to show off your PASIG pride.

This past spring and summer, Dawn Muci and her Public Relations Committee have been ramping up the Public Relations for Performing Arts abstract submissions to CSM 2021. This year the PASIG is prepared to offer two student scholarships, one for entry-

level DPT students and one for performing arts fellows. Our website has been updated to make it easier to apply online once your abstract has been accepted [https://www.orthopt.org/scholarship-application-pasig.php]. The deadline to apply is November 30th. Applications will be reviewed by the scholarship committee, led by Anna Saunders. Recipients will be notified in December.

On August 7th, APTA announced that CSM will be held virtually. We are disappointed to not be able to see our PASIG members in person in Orlando for CSM but know that this plan will help to keep us all healthy and safe. We look forward to hearing more details about the virtual format from APTA and hope that more PASIG members will be able to participate in this new format.

REFERENCES

1. Healthline. Fauci warns about 'Post-Viral' Syndrome after COVID-19. https://www.healthline.com/health-news/fauci-warns-about-post-viral-syndrome-after-covid-19. Accessed August 8, 2020.
2. Eating Attitudes Test – 26 item. https://www.psychology-tools.com/test/eat-26. Accessed August 17, 2020.
3. Bronner S, Urbano IR. Dance Functional Outcome Survey: Development and Preliminary Analyses. *Sports Med Int Open*. 2018;2(6):E191-E199. doi: 10.1055/a-0729-3000. eCollection 2018 Nov.
4. Kenny SJ, Palacios-Derflingher L, Whittaker JL, Emery CA. The influence of injury definition on injury burden in preprofessional ballet and contemporary dancers. *J Orthop Sports Phys Ther*. 2018;48(3):185-193. doi: 10.2519/jospt.2018.7542. Epub 2017 Dec 13.

IMPORTANT

Specialist Certification Application Deadlines Extended

The American Board of Physical Therapy Specialties has extended the specialist certification application deadlines for the 2021 certification exam cycle by three months, and has added an option for an initial partial payment of the application fee (excluding reapplicants). The application extension and/or partial payment option is automatically extended to all applicants.

The application deadlines are Oct. 1 for Cardiovascular & Pulmonary, Clinical Electrophysiology, Oncology, and Women's Health, and Oct. 31 for Geriatrics, Neurology, Orthopaedics, Pediatrics, and Sports. Access the online application and candidate materials. For more information, contact the Specialist Certification Program at 800-999-2782, ext. 8520, or spec-cert@apta.org.

Hello AOPT Foot and Ankle SIG members! The FASIG shared the last newsletter at the beginning of a national quarantine. Throughout this past spring and summer, we adjusted to many new ways of teaching, learning, and practicing. Online interaction became a familiar mode of connecting and communicating for many of us. We have now learned the positives, and negatives, of staying connected while at a distance. We write this newsletter at a time when things begin to "open up." But the fall will bring the return to school for our children, young and old, and our planning for this remains on all of our minds. I am afraid that some FASIG initiatives remain a bit "paused" in these uncertain times, but others have progressed, and some new ones have emerged. Included below is a summary of some of the activities the FASIG is engaged in and we welcome everyone's insight and participation if you would like to be involved. Please reach out directly to anyone on the FASIG leadership.

One exciting and rewarding initiative that has unfortunately been paused is our annual work with the American Orthopaedic Foot and Ankle Society (AOFAS). The AOFAS annual meeting was planned for September in San Antonio which required a last-minute move to an online format that accommodated only a limited set of topics and talks. Our ongoing work to collaborate on rehabilitation focused content was postponed, with hopes to include it in a later virtual program. Although disappointing, we look forward to this ongoing collaboration and continuing to work to develop foot and ankle programming across the patient care spectrum.

The FASIG would like to recognize the wonderful contribution of Dr. Kimberly Veirs, MPT, PhD, ATC, who submitted the manuscript titled, *"Multi-Segment Assessment of Ankle and Foot Kinematics during Relevé Barefoot Demi-Pointe and En Pointe"* that was published in the last edition of *OP.* Thank you Dr. Veirs for your commitment to disseminate foot and ankle content for the AOPT membership.

- We continue to work on our foot and ankle fellowship initiative. Working closely with the American Board of Physical Therapy Residency and Fellowship Education (ABPTRFE) we are in the final stages of distributing a *Practice Analysis Survey*. The survey was reviewed at the ABPTRFE's August meeting and in working closely with the AOPT office, the survey is now adapted for release using an online survey tool. Many thanks to the practice analysis coordinators, project consultants, and the entire task force working on this. The information gathered during the last quarter of 2020 will inform the training of our future of foot and ankle specialists.
- The FASIG Practice Committee together with guidance from the AOPT Public Relations Committee has created infographics to share information about common foot and ankle pathologies. These will be shared across the AOPT as a resource for members. Versions may also be developed to inform patients about common conditions and what to expect when seeking treatment. A special thanks to the FASIG Practice Chair, Megan Peach, DPT, OCS, CSCS, who is coordinating this effort.
- A new initiative during our time working virtually was the development of an "author spotlight" webinar that we hope to continue to develop. Our thanks to Dr. Ruth Chimenti, DPT, PhD, from the University of Iowa for sharing her insight on the paper "Local Anesthetic Injection Resolves Movement Pain, Motor Dysfunction, and Pain Catastrophizing in Individuals with Chronic Achilles Tendinopathy: A Nonrandomized Clinical Trial" published in the *Journal of Orthopaedic and Sports Physical Therapy* in May 2020. This is an exciting new initiative that our Research Chair will continue to grow so watch for new research and author interviews to be highlighted.
- Make sure to check out our quarterly newsletters posted to our website (listed below) if you did not catch them in your email! Dr. Jennifer Zellers at Washington University works closely with a great group of student FASIG members to develop these newsletters. They include summaries of our SIG activity, member spotlights, and a citation blast for hot-off-the press foot and ankle research.

We wish everyone in the AOPT and the FASIG well and look forward to how the remainder of 2020 and the start of 2021 might unfold. At the writing of this message, we have also just been informed that our national Combined Sections Meeting (CSM) 2021 will be held virtually. We now have ample planning time to put our collective experience with online learning, teaching, and practicing to work.

The FASIG Leadership
https://www.orthopt.org/content/special-interest-groups/foot-ankle

President's Message

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

Greetings, all. I hope this report finds you well and safe. We know how this time of uncertainty is reflected in our patients who suffer from chronic pain. To address this concern, we collaborated with past Pain SIG present Carolyn McManus, MPT, MA, to develop and present a Stress Management Webinar entitled, Mindfulness as Medicine: Practical Strategies for Stressful Times. Carolyn presented the webinar on July 9, 2020. All who attended provided positive feedback. The Academy and the Pain SIG would like to sincerely thank Carolyn for her time and dedication in developing and presenting this successful webinar.

The Pain SIG has had two very productive leadership business meetings over the summer. We are working on many projects. One such project is the development and documentation of officer roles and responsibility. Such a project will help define and organize the roles of officers and the nominating committee in the future.

Another exciting project we are working on is the development and crafting of our Pain SIG logo. We are presently gathering quotes and ideas for this endeavor. If you have ideas or would want to work on this committee, please reach out to me.

We would like to thank Michelle Finnegan, PT, DPT, OCS, MTC, CMTPT, CCTT, FAAOMPT, for her leadership as Membership Committee Chair. She will be stepping down from this role. Thank you Dr. Finnegan for all your hard work. The position of Membership Chair is not an elected position. The SIG will be looking for a member to fill this position.

Officer Reports

Vice President: Mark Shepherd, PT, DPT, OCS, FAAOMPT

- Dr. Shepherd continues to work on the Pain Education Manual. The most recent meeting was held on June 5, 2020. To date, progress on the manual continues with the plan of Phase II being completed by the end of August 2020. Progressing forward the committee will move on to the final Phase III to have a final product by CSM 2021 and ACAPT "sponsorship" by October 2021 to help bid to CAPTE for elements to be added to entry-level requirements.

Nominating Chair: Brett Neilson PT, DPT, OCS, FAAOMPT

- The AOPT elections are in November. Dr. Neilson has worked hard on obtaining historical information from past elections and reaching out to past candidates to see if they might be interested in running again for a position. The two positions that will be slated will be Vice President and Nominating Committee.

Research Chair: Dana Dailey, PT, PhD

- Dr. Dailey has developed a survey that is ready to be sent out to members. It will poll topics, methods of delivery, podcast, video interview between two people, and Blog with a demonstration. The results of the survey will be reflected in the revision and development of our strategic plan. The survey is ready to launch. Keep your eyes open for the survey in your inbox. We have provided the link below.
- Dr. Dailey is also working on reaching out to members who would like to help in this effort of reorganizing the Research format of delivery.

Practice Committee Chair: Craig Wassinger, PT, PhD

- Dr. Wassinger is also working on the Pain Education Manual and Clinical Guideline. They have completed 4 out of the 5 systematic reviews. Dr. Wassinger is also involved in the 2021 CSM presentation of Pain Education for DPT Curriculum.

Public Relations Committee Chair: Derrick Sueki, PT, PhD, DPT, GCPT

- Dr. Sueki is working on defining the Public Relations (PR) Chair's role and responsibility. He is the representative from the Pain SIG to the AOPT Public Relations Committee. Additionally, the SIG PR committee will be responsible for the creation and maintenance of a private Facebook page and creating a Pain website. We are looking for interested members to join this growing committee.
- Dr. Sueki is also the Committee Chair of the Pain Specialization Work Group. The Pain Specialization Work Group has its survey ready. It will be will be sent out to members in the near future. The question being asked is, "What does it take to be a pain specialist?" The other half of Pain Specialization is residency.

Residency and Fellowship Chair: Katie McBee, DPT, OCS

- Dr. McBee has been working on Residency vs Fellowship. What will be needed in the future will be to find candidates and institutions for residency. She is working in collaboration with other programs.

In closing, the Pain SIG would like to thank the AOPT office personnel and President, Joseph M Donnelly, PT, DHSc, for their continued support and guidance.

Moving forward, this is an exciting time to be a member of the Pain SIG. Grassroots efforts are being developed and directed by our SIG members in Education, Specialization, Residency/Fellowship, Research, Membership, Public Relations, and logo initiatives. We presently have multiple opportunities for SIG involvement such as Membership Committee Chair position, Public Relations Committee member, Logo Development Committee, and Research Committee positions. Please contact me or any other Pain SIG leader to volunteer to help with our initiatives and please fill out our survey so we can continue to meet the needs of our members.

AOPT PAIN SIG SURVEY
https://www.surveymonkey.com/r/DQFNWHV

Imaging News & Updates

Charles Hazle, PT, PhD

Joint Effort by APTA, AIUM and Inteleos

In recent months, you may have heard of a developing 3-way relationship between the APTA, the American Institute for Ultrasound in Medicine (AIUM), and Inteleos. If you are unfamiliar with these organizations, AIUM is a multidisciplinary organization that recognizes physical therapists as among those professionals capable of achieving expertise in ultrasound. The AIUM is self-described as "…dedicated to advancing its mission by providing education, fostering best practices, and facilitating research" relating to the use of ultrasound. Inteleos is the main organization containing the American Registry for Diagnostic Medical Sonography® (ARDMS®) and the Alliance for Physician Certification & Advancement™ (APCA™). Of particular interest to physical therapists, Inteleos offers the individual credential of Registered in Musculoskeletal Sonography or perhaps better known as the RMSK®, which is a prestigious individual credential indicating a very high level of educational achievement and performance using ultrasound. At present, approximately 30 physical therapists are among those who have earned the RMSK. These organizations have been working together in recent years to establish joint benefit to all 3 entities with the Imaging SIG being a significant contributor to facilitating this effort. In particular, the goal is to establish a pathway for physical therapists to be educated in the use of ultrasound in a structured and comprehensive approach such that qualification for the RMSK credential is more attainable.

In August 2020, the 3 organizations agreed on language to describe their combined efforts:

"The American Physical Therapy Association (APTA), the American Institute of Ultrasound in Medicine (AIUM) and Inteleos are committed to a collaborative effort to support the education, performance, certification, and accreditation of physical therapists and their practices in the field of musculoskeletal ultrasound. The creation of a structured pathway of education and training will provide physical therapists with quality opportunities to advance their proficiency, and successful completion of the pathway can result in the earning of the Registered in Musculoskeletal® (RMSK®) sonography certification, and improving their practice's eligibility for AIUM Practice Accreditation. The combined effort of APTA, AIUM and Inteleos will help bridge the gap for physical therapists on their pursuit of individual competency and practice accreditation."

The APTA Executive Vice President, Bill Boissonnault commented, "This statement reflects the next step in a collaborative effort that dates back to 2017. The organizations are committed to promoting quality musculoskeletal ultrasound education and training for physical therapists. Establishment of a structured pathway in musculoskeletal ultrasound will hopefully lead to similar efforts in other physical therapist practice areas."

Glynis V. Harvey, Chief Executive Officer of AIUM, states, "This alignment of resources provides the practitioner with the proficiency tools to perform safe, effective, and affordable medical imaging that improves patient care."

"Inteleos is pleased to partner with AIUM and APTA to better serve the physical therapy community and enable providers to receive an independent validation of their knowledge, skills and abilities" says Dale Cyr, Chief Executive Officer of Inteleos.

Unfortunately, all "hands-on" ultrasound education has effectively ceased because of COVID-19 transmission concerns. Our hope is, however, that once safety allows a return of direct ultrasound training, physical therapy education in ultrasound can be facilitated more easily than in the past in preparation for earning the RMSK. Further announcements of the educational tracks available for physical therapists will be forthcoming. We plan to have information on the AOPT website Imaging SIG pages, in addition to directly linking relevant information provided by AIUM and Inteleos. The goal of the Imaging SIG is to encourage physical therapists to be in an accessible and achievable curriculum toward preparation to earn the RMSK. Our overall goal of imaging referral being within the scope of physical therapist practice will be supported by more physical therapists having earned the RMSK. Additionally, advocacy and reimbursement efforts will be aided by greater strength in the numbers of qualified physical therapists in ultrasound imaging.

Combined Sections Meeting 2021—Virtual Conference

We will be adapting Imaging SIG activities to the virtual format required for CSM. More information will be forthcoming on all aspects of this. Described here are what we are confident we can adapt, but with some details pending.

The Imaging SIG educational session has an approach of pairing advocacy and evidence. The number of jurisdictions in which physical therapists now have imaging referral privileges continues to gradually grow. Evidence of prudent and appropriate use of imaging referral by physical therapists is likewise accumulating. As such, we have an opportunity to present this evidence and combine that with descriptions of the efforts within these states of their legislative efforts. Opposition to physical therapist referral privileges for imaging usually adheres to the excessive cost and overuse themes although those are not supported by the evidence. This session will offer contradictory and current evidence to those notions. The combination of this evidence and the narratives of the state leaders involved will help offer preparation to those in jurisdictions considering initiatives for imaging referral privileges. Please encourage your state leaders to participate in this session.

The educational session is entitled "Advances in Imaging Referral: Generating a New Pulse in Autonomous Physical Therapist Practice" and will include presentations by Aaron Keil, PT, DPT, OCS; Evan Nelson PT, DPT, PhD; Stephen Kareha, PT, DPT, ATC, PhD; Kip Schick PT, DPT, MBA; and Michelle Collie, PT, DPT and will be moderated by Imaging SIG Vice President, Marie Corkery, PT, DPT, MHS.

We also hope to have a manuscript of this session evolve as an advocacy tool available for jurisdictions seeking legislative initiatives for imaging referral. Perhaps with the combined efforts of the presenters and APTA central staff, we can produce a document that state leaders may find helpful.

If you have a presentation accepted for CSM, regardless of format, please let the Imaging SIG know so that any and all sessions relating to imaging can be promoted and SIG members encouraged to attend virtually.

Similarly, if you have a presentation accepted and would like to apply for the Imaging SIG Scholarship or if you know of someone who may be deserving, please investigate applying for that scholarship at https://www.orthopt.org/content/special-interest-groups/imaging/imaging-sig-scholarship. The deadline for applications is November 1. This will be the 4th year for the scholarship, which was established to encourage and support physical therapy research in imaging.

We are likely to have an Imaging SIG member meeting at some point during the duration of CSM, but the details of this are unknown at the time of this writing. More details will be coming.

Elections 2020

By the time you receive this (circa October), the Imaging SIG elections will be upon us. During November, Imaging SIG members will be voting on candidates for Vice President and the Nominating Committee. Both of these are 3-year terms. The newly elected individuals will assume office immediately after Combined Sections Meeting following the election.

The Vice President serves in the role of Education Chair. While including responsibilities oriented toward programming at CSM and other conferences, the Vice President is also in charge of other educational initiatives within the SIG and with outreach.

The Nominating Committee position is a rotating 3-year term with the last year of the term being committee chairperson. This is a great opportunity for someone seeking a greater role in the SIG in the future.

In November 2021, elections will be held for President and Nominating Committee.

Clinical Practice Guideline Input Methodology Established

As a product of meetings held at CSM in Denver in February 2020, the Imaging SIG has begun to offer input on diagnostic imaging procedures for the AOPT's clinical practice guideline (CPG) development. Content experts will offer input related to imaging in the early stages of CPG formulation and then again at the review stage. The overarching goal here is to assure there is consistent mention of imaging in the diagnostic process where indicated. Much of this focus on when imaging is particularly relevant in the diagnostic process is as suggested by the American College of Radiology Appropriateness Criteria. This input to the CPGs is being coordinated by Jim Dauber who serves as the liaison between the Imaging SIG and the AOPT Practice Committee.

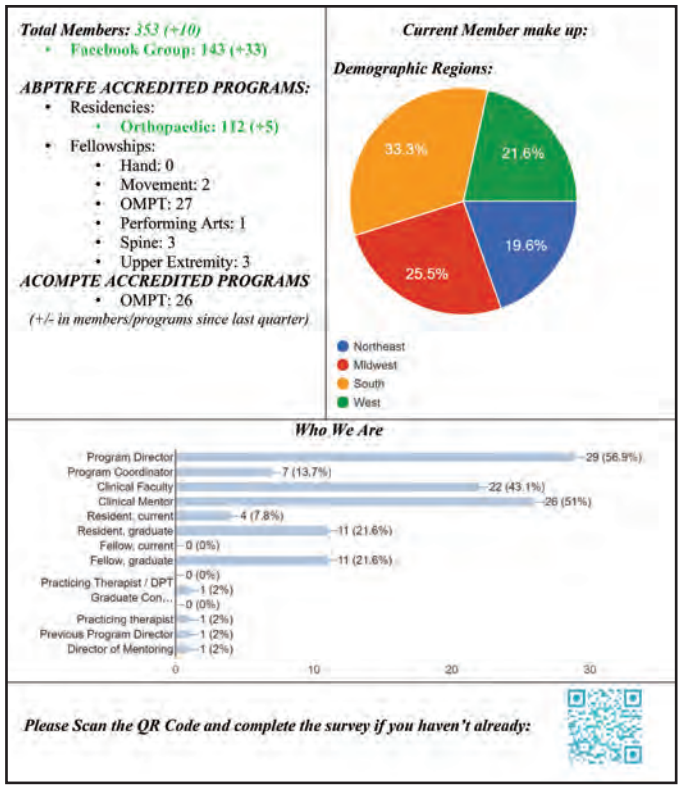
Strategic Plan Updates

As of this writing, the new strategic plan for the Imaging Special Interest Group will be published and available on the AOPT's website, SIG pages. This new strategic plan was developed by members throughout summer and was initiated to be consistent with AOPT's new strategic plan. First, volunteers were solicited from among the SIG members by mass email. Then an "idea development" phase occurred as those volunteers provided input for proposed SIG initiatives. The initiatives were then prioritized by the members and the language of the final items was adjusted for consistency. The overall approach in the development of this strategic plan was to establish goals that were more within short-term reach and could be determined as accomplished or steps toward accomplishment were made.

Education Initiatives

We anticipate development of a major new set of education initiatives shortly for imaging. With advances in AOPT's web-based platform, greater potential now exists for the development and distribution of educational materials for imaging. Stay tuned as more information will be forthcoming.

ORF-SIG Dashboard:



ORF-SIG Members,

I hope all of you are doing well as the coronavirus (COVID-19) pandemic continues to impact all of our lives. Our thoughts and prayers go out to all individuals who have become ill, and/or lost family and friends due to the pandemic. Additionally, we know the pandemic has extended beyond our clinical walls greatly affecting the community as many private practices as well as outpatient clinics who have seen decreasing patient volumes and ongoing furloughs as our society transitions to a new normal. We continue to be grateful for those on the front lines of health care directly fighting the virus, as well as the other members of society working to change policies and processes to keep both their employees and patients safe.

Over the past few weeks, many of us have been returning to busier administrative schedules trying to adjust our patient care processes, in-person education, and mentorship, and developing several other ways to be innovative during this time of chaos. Thank you to all who have been able to continue and share their ideas so that programs and participants can continue to move forward.

If you have not already done so, please make sure to review the continually evolving ORF-SIG **CoVid-19 Resource Manual**. This manual provides further information on how residency and fellowship programs are overcoming accreditation challenges, ensuring patient participation, and program sustainability.

You can also find more great information from a 2-part podcast provided in conjunction with the Academy of Education's Residency and Fellowship SIG (RF-SIG). In part one, Dr. Linda Csiza, Dr. Jim Moore, Dr. Kathleen Geist, and I discuss how alternative methods for programs still ensure participant completion.

In part 2, leadership of the American Academy of Orthopaedic Manual Physical Therapy (AAOMPT), Dr. Cameron McDonald, Dr. Elaine Lonneman, and Dr. Mark Shepherd discuss the changes in ACOMPTE standards for fellowship programs. Additionally, there is a great discussion on how programs can provide synchronous and asynchronous learning and mentorship. Thank you to Dr. Christina Gomez of the RF-SIG for leading this discussion.

Finally, amidst all the COVID-19 concerns we are also reminded of the challenges our society still needs to overcome regarding social injustice, equity, and equality. I hope that we all take a step back and reflect on how we each can assist in not only treating all equally but how we can improve our community around us. In our last publication of *Orthopaedic Practice*, Dr. Samantha Perez, Dr. Jessica Bolanos, and Dr. Marlon Wong provided an excellent example of how a therapist can assist in overcoming a patient's barrier of health literacy and acculturation while still building a therapeutic alliance. Case examples such as these demonstrate how our profession can be leaders in overcoming injustices still present in our community and society as a whole.

Since the start of this pandemic, I have been a true believer that our profession has an opportunity to come out stronger after the dust settles. Since the beginning, we have seen great collaboration and communication within our APTA leadership from the different Academies and Sections putting together universal resources. The use of Telemedicine has now been moved to the forefront, while also breaking down pure face-to-face models of education and building new innovative ways for residents and fellows in training to complete their post-professional education and mentorship. Thank you for being leaders and innovators in post-professional residency and fellowship education.

Stay Healthy,
Matt Haberl
ORF-SIG President

Committee Updates

Research: Kathleen Geist, Mary Kate McDonnell

The ORF-SIG is currently accepting Resident and Fellow 2021 CSM Poster submissions for publication in Orthopaedic Practice and a cash prize of $250. Two winners will be chosen at their poster presentation in Orlando, FL. Contact Kathleen Geist (kgeist@emory.edu) if you are interested in submitting.

Practice/Reimbursement: Darren Calley and Kirk Bentzen

During the development of a mentorship survey, Dr. Kirk Bentzen was in the process of developing his dissertation for his PhD studies. Due to these common interests around the topic of mentorship, it was decided to conjoin these two projects. Recently, Dr. Bentzen completed his review of the literature, including the exploration of mentorship across a variety of professions and levels of education. The next step is to further refine the original survey to ensure it is complete for dissemination.

Communication: Kirk Bentzen, Kris Porter, Kathleen Geist

ABPTRFE Updates: Recently the American Board of Physical Therapy Residency and Fellowship Education (ABTPRFE) released updates to their Policies and Procedures and the use of Primary Health Conditions. See their updates here:

Policies and Procedures Updates: Policy 13.5: Addition of Clinical Sites

Primary Health Conditions Update

Please let us know if you have any further questions and or concerns regarding the new policy changes.

Membership: Bob Schroedter, Tyrees Marcy

Remember to access our member-only communication forums to share and develop ideas.

ORF-SIG Facebook group

AOPT ORF-SIG Communities HUB

Nominating: Mary Derrick, Bob Schroedter, Tyrees Shatzer

The ORF-SIG is investigating the opportunities afforded by digital collaboration technologies to create a virtual town square where communications within the SIG, across SIGs, and with outside organizations can be shared, unified, referenced, and streamlined to members. More is coming, but we are excited about the myriad possibilities this project can have to inform, to organize, and to foster collaboration among all stakeholders.

President's Message

Francisco Maia, PT, DPT, CCRT

As you were all made aware earlier this year, I stepped into the role of President for the Animal PT SIG and will be finishing the term 2019-2022. I am also excited to announce that Jenny Moe has agreed to step into the Vice President's role that became vacant, but we will be holding an official election for the Vice President/Education Chair position this November. With that in mind, I wanted to take the time to officially introduce myself and discuss my vision for the future of the Animal PT SIG.

I was born and raised in Sao Paulo, Brazil, and moved to the United States in 2005. I graduated with a Kinesiology degree from Indiana University in 2009 and with my Doctor of Physical Therapy degree from the University of Pittsburgh in 2012. However, working with animals was never on my radar until 2014. Ever since my teen years, I have known that I wanted to be a physical therapist. Being an athlete myself, my interest in this field developed after realizing that I was always curious about the rehab process when I became injured. Once I graduated, I started to work in an outpatient setting, and although I did enjoy what I was doing I did not feel passionate enough to see myself doing that for the rest of my career. I was looking for something else and that was when I heard about canine rehabilitation. Right away I knew that was what I was meant to do: combine my skills and knowledge as a physical therapist with my passion for dogs.

Throughout 2014 I went through the coursework with the Canine Rehabilitation Institute to become a Certified Canine Rehabilitation Therapist, and after completing my certification in early 2015 my wife and I moved to Chicago where I started to work as an animal physical therapist at a well-established veterinary clinic. While working there I was able to hone my skills and make a successful transition from humans to canines; however, things did not go as planned.

Unfortunately, there are 2 main issues that physical therapists encounter when making that transition: we either cannot find a job at a veterinary clinic or if we do, they often tend to underpay us compared to what we earn as human physical therapists. I found myself in the second scenario and agreed to take a nearly 50% pay cut to what I used to earn so I could work within my passion. During that time, I was able to supplement my income by working as a contractor in home health and that was fine for a year or so until I did my taxes and realized that I wasn't even breaking even with my household expenses between both jobs.

When I took that job at the veterinary clinic, I thought that if I worked there for a year, and showed them my value as a physical therapist, I could get a raise that would make up for the lower salary from that first year. But that was not what happened. Around that time, I also started noticing a shift in their business model: whereas the clinic was built with the premise of veterinarians and physical therapists working together, they were hiring veterinary assistants to carry out the majority of the treatments as the business grew. It was a gradual change in their business model, but it got to the point where I had to confront them and was told that they saw no difference between a veterinary assistant and a physical therapist.

It was hard to hear that. Were they telling me that all the struggles and pain I went through during 7 years of school to get my DPT was not worth it? That the skills and knowledge I had acquired through that journey were matched by those of an assistant with a certification as a canine rehabilitation assistant? The feeling of not been valued, along with other personal issues, led me into a downward spiral. My lack of confidence and low self-esteem started affecting my relationships. I was working within my passion for canine rehabilitation, yet I still dreaded every…single…day.

It all came to a crash in the summer of 2017. I knew I wanted to continue working with canines, but that situation was not feasible. I also could not just go find a new job in this field because, as previously mentioned, they are unfortunately not as easy to come by. Going back to treating humans full-time was not what I wanted to do, but I also did not want to stay at that job any longer than I had to. But an idea, which for me seemed crazy at that time, kept coming back: What if I combined my passion for canine rehab with my experience as a home health contractor? Meaning, what if I started a mobile canine rehabilitation business? I knew there was a need for such services in a city like Chicago, but there was one huge problem: I knew nothing about business. I had focused so hard on becoming the best canine physical therapist I could be and now lacked all the other skills necessary to get a business even started, let alone growing one.

At that point, I was ready to move forward, but I had to learn how to do so. Failure was not an option, because that meant going back into human physical therapy full-time, so I decided to take the jump and learn this business stuff. Over the last few years, I have invested a lot of my time, money, and energy into learning how to operate and grow a successful and profitable canine rehabilitation business. I do not doubt that the skills I have learned as a business owner will help me lead the Animal PT SIG as well. Although it was not easy, growing my own business is one of my life accomplishments that makes me most proud. We now operate a 1,300 square foot facility on Chicago's north side and employ 2 physical therapists and 2 administrative staff.

So how does my journey tie-up with my mission for the Animal PT SIG? At one point I realized that if I, who knew nothing about business up until 3 years ago, could start and grow a successful canine rehabilitation business then I see no reason why others in similar scenarios wouldn't be able to do the same. Of course, they would need some guidance and support as well, and that is where I want to lead the Animal PT SIG towards. Those who work in the field of animal rehabilitation know that we face an array of obstacles, most prominently including legislative issues and lack of a job market. But strength will come in numbers, and my goal is to help guide a new generation of physical therapists to continue the work established by the leaders in our profession over the last 20 years.

We have started our work to establish 4 standing committees that will help move our mission forward: Practice/Legislation, Communications, Membership, and Research. Each committee will be focusing on a different category that is vital for the growth of our profession as outlined by the Strategic Planning published in 2018. We intend to develop a structure that would allow more

members to be involved, thus helping bridge the gap between our membership and the leadership team while helping develop and mentor the new generation of physical therapists that will continue with our mission for decades to come. We could always use more help, so if you are interested in joining these committees email me at francisco@thek9pt.com. You do not have to be working in animal rehabilitation to be a member of these committees, but you will need to be an Animal PT SIG member and have a passion to help us continue growing this field so we can help more animals and their owners by paving the way for more physical therapists who wish to successfully make the transition from 2-legged to 4-legged animals!

A New Leash On Life: Assistive Mobility Aids for Dogs – What to Consider and Why

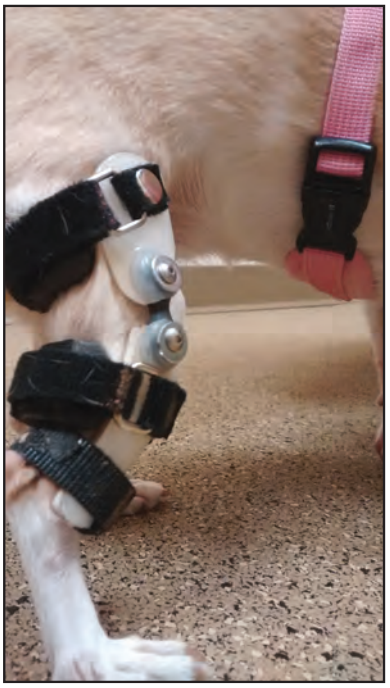
Jen McNutt, BSc. MSc.PT, GCIMS, CHT,
Diploma in Canine Rehabilitation

There are numerous options for assistive mobility devices available for people, such as crutches, canes, and walkers. Physical therapists will often prescribe these aids for patients with impairments with balance, fatigue, pain, weakness, joint instability, peripheral nerve impairment, spinal cord injuries, and degenerative diseases, among other clinical indications. Generally, the primary goal in prescribing these devices is to minimize weight-bearing, either partially or fully, and to enable a person to ambulate with greater ease.

There is also a myriad of offerings for braces and joint supports on the market for humans. Physical therapists will recommend the use of a support or brace to help stabilize a joint following injury to a ligament or tendon or to provide compression around a joint to help minimize swelling, increase proprioception and reduce pain. Joint supports vary in level of stiffness and the amount of support they provide. Generally, if there is a complete ligament rupture or a considerable amount of laxity and instability in a joint, orthotic type support (a support with hard plastic or metal components and hinges) is recommended. First and second- degree sprains and strains often can be supported while healing with a softer, less bulky support.

Similar clinical reasoning can be used in the prescription of assistive mobility aids for a canine population. Veterinary rehabilitation professionals and pet owners are becoming increasingly aware of the benefits assistive mobility aids can provide in improving the quality of life for pets. Indeed, there is a growing market of options for aids such as carts, wheelchairs, harnesses, and braces/supports available for canine patients. Of course, there are also options for cats, horses, chickens, and likely any animal out there that one would be brave enough to prescribe an orthotic device; however, for this article, canine assistive aids will be the primary focus. Also of note, examples given below of companies offering assistive aids are not exhaustive.

Whenever one is considering an assistive mobility aid for a canine client, certain considerations should be made. Medical concerns are the most obvious consideration. This includes the diagnosis or functional impairment and why the dog needs an assistive aid. One must know if the condition is acute or chronic, neurological or orthopedic, or a degenerative condition that will worsen over time. For example, a dog with a degenerative neurological condition may require a rear-wheel cart to start, with the option of modifying the cart to a 4-wheelchair in the future as his weakness progresses. It is also important to consider other medical concerns and co-morbidities, such as circulation issues, skin conditions, endocrine issues, and other orthopedic concerns.



Along with medical concerns, one of the most important questions to answer is, *What is the goal of the assistive mobility aid, and will the chosen aid accomplish the goal?* Clinical reasoning must go beyond a goal of 'increasing mobility' and instead (1) define what the mobility impairment(s) is and (2) define what needs to be done to address the impairment(s). For example, a dog with advanced osteoarthritis in the hips, the goal would not be 'to help him ascend stairs with more ease.' Instead, (1) impairment: weakness and pain in the hind end, and (2) goal: to reduce the weight-bearing demand on the hindlegs. A clearly defined goal will support the clinician in choosing the most appropriate assistive aid for his or her canine patient.

After considering medical needs, clearly defining a goal, and narrowing down aids that would accomplish the goal, it is important to consider other things such as the dog's breed, age, and temperament; environment; ease of use of the device; owner compliance; and cost.

- Environment: Consider the dog's walking surfaces inside and outside the house. Ask owners about stairs going into the house and within the house, whether there is carpet, throw rugs or smooth surfaces to navigate, and whether the dog will be using the device outdoors, indoors, or both. Ask about the layout of an owner's home, including the width of hallways and doorways. Also, consider factors such as the type of vehicle the owner drives.
- Ease of use: Consider the comfort of handles on harnesses and if the straps are appropriate for the owner's stature. Some harnesses can be put on with the pet laying down and some require the dog to be standing. Some wheelchairs are adjustable with the pet in them, others are not. Consider the owner's physical health in terms of his or her ability to lift a large dog into a wheelchair or pull straps of a brace tight enough. The mobility aid chosen must fit well and be comfortable for the pet; however, the mobility aid must also be easy for the owner to don and doff.
- Temperament, breed, and age: Active dogs will require more rugged equipment or more supportive bracing. A dog that runs at the park frequently would do better with angled wheels on a wheelchair for quick turns, whereas a less active dog would do well with straight wheels that are easier to maneuver around a home. Older dogs with weakness will likely need a mobility device for a more long-term period, whereas a young dog with an acute injury would need a

short-term solution. If choosing an aid for a puppy, one would have to account for growth.

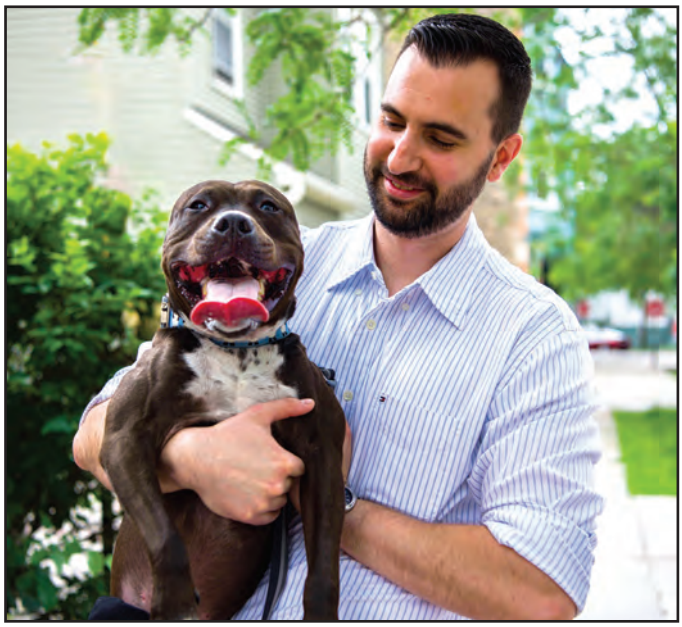
- Owner compliance: This is where careful consideration of ease of use of a device becomes important. If an aid is easy to use, the owner is more likely to use it with the dog.

There are numerous options available to assist dogs with mobility such as wheelchairs, harnesses and slings, braces and supports, and others. Choosing the best aid for a dog will depend on thorough clinical reasoning, as described above, and knowledge of all available options. A good rule of thumb when selecting aids is to first try finding something 'off-the-shelf' that will accomplish the goal. If there are no suitable ready-made options available, look to companies that offer custom designs. Should there still be nothing available, be creative and figure out how to modify something to achieve the goal, or find a company that will design a novel product to meet the dog's needs.

Wheelchairs are typically chosen for dogs experiencing considerable difficulty walking due to illness, injury, degenerative disease, neurological diseases or balance problems, or for paralytic dogs who benefit from being in an upright position. Where a significant gait impairment is not expected to improve, wheelchairs should be considered. They may also be an option for short-term use to help mobilize a neurological dog and retrain walking. Some dogs can regain mobility quicker if the dog can use a cart for practicing and strengthening gait patterns after spinal cord injuries. These aids can be costly; however, some companies rent dog wheelchairs.

There are 3 main categories of a dog wheelchair: Rear-wheel, front-wheel, and 4-wheeled. Rear-wheel carts provide support for hind end weakness, front-wheel for foreleg weakness, and 4-wheeled for weakness in 2 ipsilateral limbs, 3, or 4 limbs. When choosing one of these wheelchairs for a dog, one must consider sizing, adjustability, wheel size and material, the weight of the cart, owner's ability to load the dog into the cart, ease of transport, and if a 2-wheeled chair can be modified to a 4-wheeled chair later if needed. Companies designing wheelchairs for dogs include K9 Carts, Doggon' Wheels, Walkin' Pets, Eddie's Wheels, Best Friend Mobility, and New Life Mobility.

Lt. Dan as a 12-week old puppy using a cart for assistance due to neurological issues.



Lt. Dan and Francisco Maia

Harnesses and slings are for dogs that require minimal to moderate assistance with walking, stairs, and rising from recumbent positions to sitting and standing but do not require the full support a wheelchair offers. Both harnesses and slings may be used immediately postsurgically to safely help pets outside to void, and later postsurgically or after acute injuries, to strengthen and retrain gait. Slings are best suited for short-term use. Harnesses are more appropriate for weakness or balance issues secondary to age, injury, or disease and to assist with activities of daily living and fall prevention. Three types of harnesses include the front-end harness, rear-end harness and combined front and rear end harness. When choosing one, it is important to consider where the handle on the harness is in relation to where the dog needs support. For example, if the dog is weak in the front and hind end, a handle at his center of gravity will work best; however, if the dog suffers from hind end weakness a handle placed more caudally would be best. One may also consider if there is an opening for voiding, how the harness is put on the animal (ie, does the dog need to be standing, or can it be put on lying down), and the owner's strength, age, and build. For example, ergonomically a 5-foot tall owner may have a very hard time providing the lift a Great Dane will need to help take him down the stairs to the front door safely. Harness options include Walkin' Pets, Help 'Em Up Harness, Walkabout Harness, Ruffwear Web Master, and Ginger Lead.

Similar to humans, the options available for orthotics and supportive joint braces for dogs is extensive. Generally, the goal of any brace is to help stabilize a joint, reduce swelling, reduce pain, provide compression, enhance proprioception, and/or enhance mobility. There are many off-the-shelf braces available, as well as, custom soft supports and hard orthotic braces. Companies offering off-the-shelf and custom products include DogLeggs, TheraPaw, Balto, Hero, OrthoPets, OrthoDog, Walkin' Pets, and Orthovet. One can find tarsal supports, carpal supports, stifle braces, hip supports, back braces, shoulder hobbles, elbow supports, neck supports, specialized boots, and dorsi-flex assist boots.

Other mobility aid options include halos to assist blind dogs in navigating their surroundings more safely. Drag bags provide a slippery surface to help paralytic dogs drag their hind legs without causing abrasions. Strollers and wagons offer ways for dogs who

cannot use wheelchairs an option to move around in the outside environment and provide mental stimulation.

There are so many assistive mobility aids available for dogs with mobility impairments. Using sound clinical reasoning, including a well-defined goal and consideration of various other factors is paramount in selecting the most successful aid for one's canine patient.

RESOURCES

Ann Arbor Animal Hospital. Assistive devices for animals. https://annarboranimalhospital.com/2015/04/assistive-devices-for-animals/. Accessed July 29, 2020.

Assistive devices for dogs with arthritis. *Canine Arthritis Resources and Education*. https://caninearthritis.org/article/assistive-devices/. Accessed July 29, 2020.

Borghese I. Brace Yourself.

Goldberg ME, Tomlinson JE. The disabled patient 1: assistive devices and technology. In: *Physical Rehabilitation for Veterinary Technicians and Nurses. Wiley Online Library; October 18, 2017*. https://doi.org/10.1002/9781119389668.ch10.

Jacob JA. Assistive devices give pets with disabilities a new "leash" on life. *Veterinary Practice News*. September 20, 2018. https://www.veterinarypracticenews.com/assistive-devices-give-pets-with-disabilities-a-new-leash-on-life/2/. Accessed July 27, 2020.

O'Sullivan S, Schmitz T. *Physical Rehabilitation*. 5th ed. Philadelphia, PA: FA Davis Company; 2006:545-550; 1213-1250

Rodler L. Orthopedic equipment for dogs designed for increased mobility and extra support. *Whole Dog Journal*. Published Feb 22, 2011. Updated March 21, 2019. https://www.whole-dog-journal.com/care/senior_dog/orthopedic-equipment-for-dogs-designed-for-increased-mobility-and-extra-support. Accessed July 26, 2020.

Stenhouse E. The best dog wheelchairs (2020 Reviews). Pet Life Today. June 9, 2020. https://petlifetoday.com/best-dog-wheelchairs/. Accessed July 26, 2020.

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