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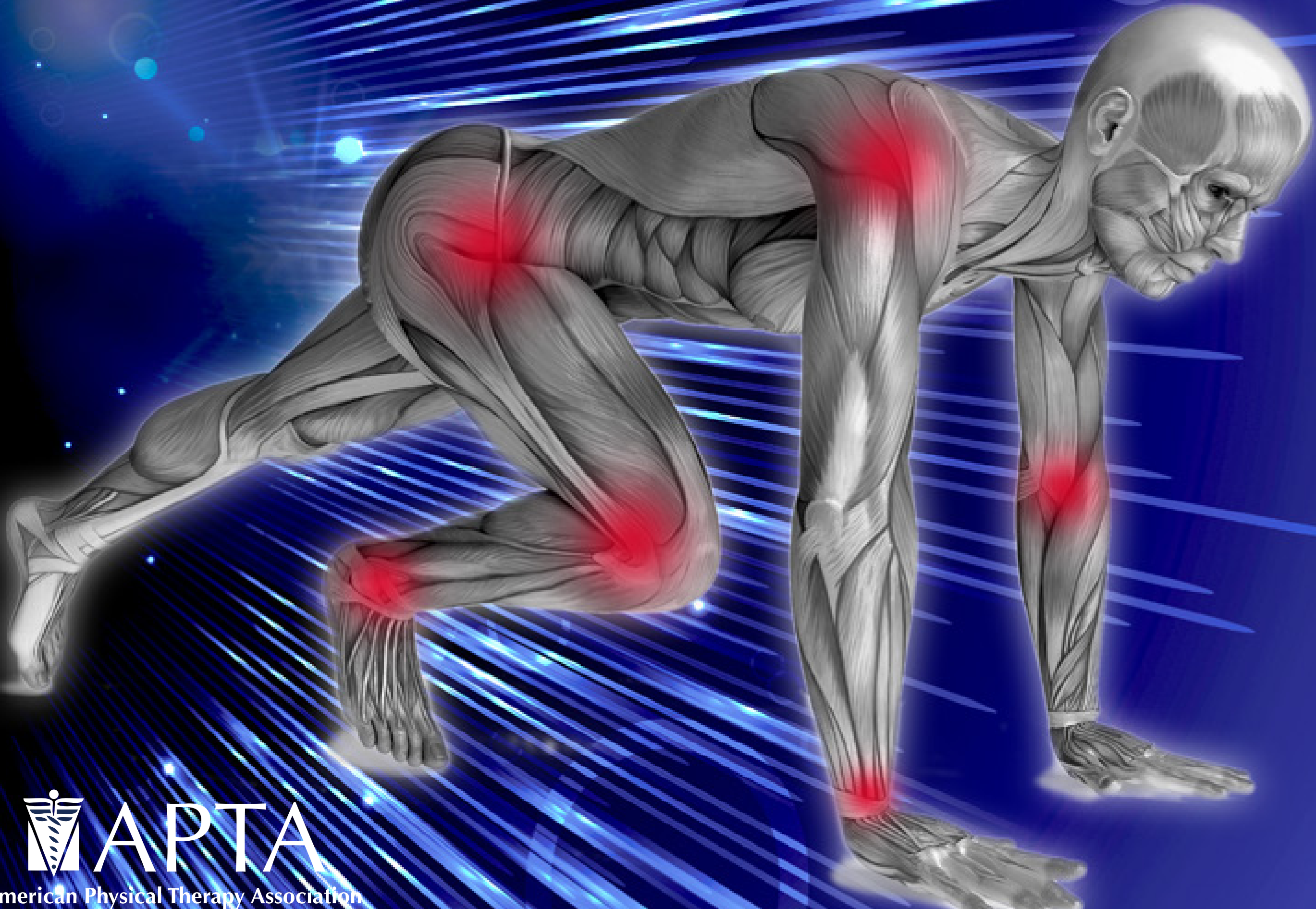
ORTHOPAEDIC Physical Therapy Practice



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American Physical Therapy Association

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ORTHOPAEDIC Physical Therapy Practice

In this issue

Regular features

VOL. 28, NO. 3 2016

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

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Outcomes in Orthopaedic Physical Therapy Practice

An Independent Study Course Designed for Individual Continuing Education
Independent Study Course 26.1

Course Description

This course provides a comprehensive review of commonly used outcome measures in physical therapy practice today. Patient-reported and performance-based outcome measures are covered. The scales and measures are also presented according to their application to the extremity or spine. A unique monograph on cognition and affect is also included. Psychometric and clinimetric principles are reviewed throughout.

Topics and Authors

- **Patient-reported Outcome Measures—Framework, Psychometrics, and Uses**
  D. Scott, Davis, PT, MS, EdD, OCS
- **Performance-rated Outcome Measures—Framework, Psychometrics, and Uses**
  Charles Sheets, PT, OCS, SCS, Dip MDT
- **Lower Extremity Outcome Measures**
  Joseph Zeni, Jr. PT, PhD; Kathleen Madara, PT, DPT
- **Upper Extremity Outcome Measures**
  Lori A. Michener, PT, PhD, ATC, SCS, FAPTA;
  Hillary A. Plummer, PhD, ATC
- **Patient Self-report Outcome Measures for Individuals with Spine Conditions**
  Todd E. Davenport, PT, DPT, MPH, OCS
- **Measures of Cognition and Affect**
  Kimiko Yamada, PT, DPT, OCS, ATC, CLT, CSCS

Continuing Education Credit

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

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

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Sharon Klinski—Managing Editor

Learning Objectives

1. Describe the advantages and disadvantages of patient-reported outcome measures as part of orthopaedic physical therapist practice.
2. Define the psychometric and clinimetric properties of patient-reported outcome measures and understand the importance of these properties.
3. Demonstrate an understanding of the importance of responsiveness to patient-reported outcome measures used to assess patient/client outcomes.
4. Discuss the clinical challenges and burdens associated with administering and scoring patient-reported outcome measures.
5. Interpret the similarities and differences between patient-report measures and physical performance measures.
6. Recognize potential biases and errors in the use of physical performance measures.
7. Identify the aspects of physical therapy evaluation, treatment, and reassessment best addressed through physical performance measures.
8. Describe psychometric properties of physical performance measures.
9. Incorporate physical performance measures into clinical examination, treatment, and reassessment, incorporating principles of diagnosis, prognosis, and meaningful clinical change.
10. Understand the importance of including validated outcome measures when evaluating patients with lower extremity pathology.
11. Identify the most appropriate measure given a specific diagnosis or region of injury.
12. Know the minimal detectable change scores and minimally clinically important difference scores associated with a variety of patient-reported outcomes and performance questionnaires.
13. Understand the value of using patient-rated outcomes for the appraisal of value-based health care outcomes.
14. Identify the criteria for selection of patient-rated outcome measures for upper extremity musculoskeletal disorders.
15. Describe the key psychometric and clinimetric properties needed to establish adequacy for clinical use of performance measures of the upper extremity.
16. Interpret the scores generated from patient-rated outcome and performance outcome measures for clinical decision-making and patient management.
17. Discuss best practices with regard to administering outcomes measures for individuals with spine conditions.
18. Summarize current research evidence related to the validity, reliability, and diagnostic accuracy of outcomes measurements for individuals with spine conditions.
19. Interpret outcomes measurements for individuals with spine conditions with respect to likely statistically significant and clinically important changes.
20. Appreciate the need to assess cognition and affect patient characteristics.
21. Understand some of the basic models of cognition, affect, and behavior change.
22. Describe different outcome measure tools for cognition and affect.

For Registration and Fees, visit orthopt.org/content/c/26_1_outcomes_in_orthopaedic_physical_therapy_practice
Additional Questions—Call toll free 800/444-3982

Editor's Note

Technology Platform Update: Part 2!

Christopher Hughes, PT, PhD, OCS, CSCS

The Orthopaedic Section Annual Meeting took place in Atlanta the first week in May. This was the largest turnout to date with 245 attending! The Grand Hyatt Hotel was a great host, and the feedback on the organization, the speakers, and format of presentation in the breakout sessions was extremely positive. Overall, there was lots of energy at the meeting and also a nice "neighborhood" feel to it.

As promised in my last editorial, the members of the Orthopaedic Section technology platform group were also there to provide a sneak peek at the new delivery system we have planned for our independent study courses (ISCs). We displayed our products and conducted a demonstration of the technology platform in the vendor area of the meeting.

Conference registrants were able to stop by our booth and preview a sample of the website and how courses will be displayed and purchased. At the end of the demonstration, participants filled out a survey of their impressions regarding the site's look, feel, and usefulness. To thank them for their time, we offered a discount on select courses they could purchase. The interaction with participants was valuable; it is always a pleasure to interact one-on-one with meeting attendees! A consistent flow of traffic led to a total of 60 participants who completed the survey.

I would like to share a few of the findings to some of the questions we asked. More than 95% of respondents said that the new site would meet their needs (Figure 1). Over 90% found the site either very appealing or extremely appealing visually (Figure 2).

Further, we learned that the majority of respondents select continuing education courses based on quality and content, and approximately 68% prefer to have both online and print access while 30% prefer online only access (Figure 3). Almost all would like the flexibility to view, download, and print course materials, and to access them on their desktop computer or tablet. Nearly 40% said they would view materials using their smartphone.

We were delighted to learn that more than 75% of respondents would recommend the Section's ISCs to a friend. When asked for written comments the following phrases were used: *"Looks great," "The website looks very appealing,"* and *"I am more likely to take an ISC with it offered online."*

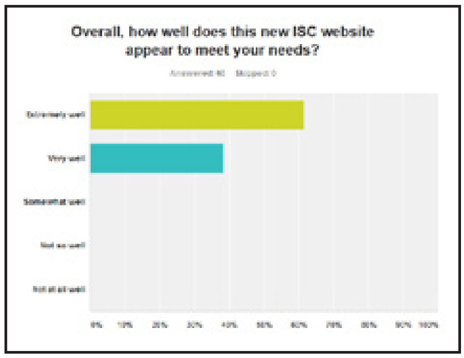


Figure 1

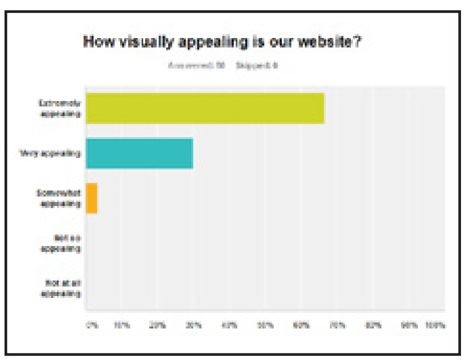


Figure 2

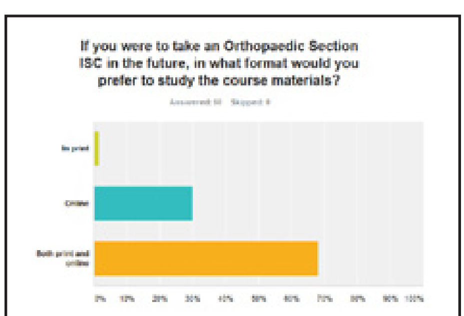
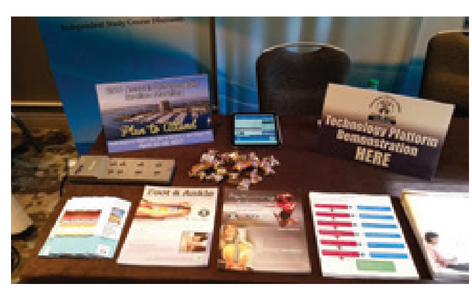


Figure 3

Based on these survey results, we at the Orthopaedic Section are confident that the ISC website we are building will meet your learning needs. What is clear to us is that you want continued quality content written by credible authors, and you want the flexibility to access these courses on multiple platforms. At the same time, many users like print and prefer it over the technology options available today. We are pleased to assure you that ISCs in print will remain an option. Meantime, the "tech" team continues to work, as it has over the past year, to bring you a high-quality website that hosts the Section's great learning opportunities. We anticipate a fall launch date for a fully operational site.

This is an exciting time to be a member and also be involved with the Orthopaedic Section. The resources provided by the Section are more important than ever, and the leadership continues to strive toward meeting the Section's goal to ***"provide exceptional educational content for continuing competence in orthopaedic physical therapy practice."***

Also in regard to *OP*, we have been getting quite a few submissions lately. We love the fact that both new and veteran authors have chosen *OP* as their place of publication. I hope you enjoy this issue of *OP!*



Display materials at our demonstration table.

In Memoriam

Charles M. Magistro, PT, DPT (hon), DrSci (hon), FAPTA, a passionate physical therapy leader whose contributions spanned education, research, policy, and community involvement died on April 21 at age 91. Magistro served as President of APTA from 1973-1976, after serving a term as Treasurer. As President, Magistro oversaw the first formal, professionally-managed Combined Sections Meeting and enhanced communication to components. Magistro was awarded the Lucy Blair Service Award, the Henry O. Kendall and Florence P. Kendall Award, and was named a Catherine Worthingham Fellow in 1990. He delivered the 22nd Mary McMillan lecture in 1987. In a statement on behalf of APTA, President Sharon L. Dunn, PT, PhD, OCS, described Magistro as "a truly historic figure" whose "soul is woven into who we are as a profession."

We would like to thank the following exhibitors for being a part of the 2016 Annual Orthopaedic Section Meeting:

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Course Description

This 3-monograph set addresses the unique aspects of evaluating and treating the patient following an automobile accident. Using an evidence-based approach, the authors present classification models and special considerations that need to be included to achieve an ideal outcome for this type of patient. Unique legal aspects of care are also covered. These include documentation, expert witness, and disclosure protocols for auto accident patients.

Topics and Authors

- **Evaluation and Treatment Strategies for Care of the Injured Cervical and Upper Thoracic Spine**
  Karen Walz, PT, MA, OCS, COMT, FAAOMPT
- **Evaluation and Treatment Strategies for Care of the Injured Lumbar Spine after a Motor Vehicle Accident** ***(Includes 26 online accessible video clips)***
  Terry Pratt, PT, MS, COMT, FAAOMPT
- **Management of Auto Injuries: Legal and Documentation Perspectives**
  Ronald W. Scott, PT, JD, LLM, EDD, MSBA, Esquire

Continuing Education Credit

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

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

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Sharon Klinski—Managing Editor

Learning Objectives

Upon completion of this course, the participant will be able to do the following:

- Review the current literature and apply findings to the musculoskeletal management of patients with cervical and upper thoracic spine injuries following an automobile injury.
- Discuss the evidence underlying motor vehicle trauma with regard to the neuromuscular somatosensory systems and its influence on tissue healing.
- Discuss the unique assessment and disposition of a patient following a traumatic automobile injury to the cervical and/or upper thoracic spine dysfunction.
- Perform the key tests to assess the tolerance to shear, torque, and compressive forces at the lumbar spine.
- Identify the key red flags in the subjective evaluation of the spine following auto injury.
- Design a treatment plan that is progressive and optimizes healing.
- Apply classification systems to categorize and treat spine injuries and highlight the distinguishing aspects of examination that differentiate between these categories.
- Discuss the biopsychosocial approach treatment of the lumbar spine after a motor vehicle accident.
- Utilize strategies to decrease fear-avoidance behaviors and encourage confrontational strategies in a patient recovering from an injury as a result of a motor vehicle accident.
- Discuss the importance of patient education for appropriate self-pain and ergonomic management techniques following motor vehicle accident injury.
- Discuss the unique legal obligation requirements for treating patients who have been injured in an auto accident.
- Effectively interact with auto injury patients, safeguarding the legal positions and rights of treating physical therapists and patients under care.
- Discuss the role of the therapist in communicating with legal counsel when caring for patients following an auto accident.
- Review the role of a physical therapist as percipient and expert witnesses in administrative and judicial proceedings.
- Review clinical documentation and communication protocols taking into account the legal protection of the patient and physical therapist.
- Develop, in consultation with practice attorneys, legally and ethically correct patient informed consent and disclosure protocols for auto accident patients and workers' compensation clients under care.
- Understand the responsibility of the physical therapist in preventing reimbursement fraud.

For Registration and Fees, visit orthopt.org/content/c/25_1_Orthopaedic_Care_in_Auto_Injury
Additional Questions—Call toll free 800/444-3982

Evidence-based Care of a 74-year-old Male Following Cervical Fracture and Acquired Neurological Symptoms: A Case Report

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ABSTRACT

Background: A 74-year-old male suffered a unilateral hangman's fracture of C2 with retropulsion involving the right transverse foramen, status post-fall. Complications included compression of the vertebral artery, epidural hematoma, and spinal cord compression C2-5. **Purpose:** To highlight the clinical reasoning during examination, evaluation, and treatment of a patient status post-cervical laminectomy with fusion, and acquired neurological symptoms consistent with Brown-Sequard Syndrome. **Methods:** The patient attended outpatient physical therapy 2-hour sessions, 3 times per week, over 7 weeks. The interventions prescribed combined cervical clinical guidelines per the International Classification of Functioning with the postoperative protocol for cervical laminectomy. **Clinical Relevance:** Evidence-based literature is essential to maximize the effectiveness of treatment for a patient with complex presentation. **Conclusion:** Clinically significant changes were seen using an individualized rehabilitation program based on current evidence.

Key Words: Brown-Sequard Syndrome, cervical laminectomy, fall-induced injuries

INTRODUCTION

Elderly patients accounted for 46% of 123 million visits to the emergency department in 2008.[1] This number of visits is still growing by one-third every 10 years.[1] The Census Bureau predicts 54 million people will be over the age of 65 by the year 2020, and 1 in 5 Americans will be over the age of 65 by the year 2045.[2] As the elderly population increases, a coinciding upsurge has been noted in cervical spine procedures due to the degenerative changes as part of the natural aging process.[3] These changes increase the risk in older adults of spinal cord injury after a relatively minor trauma.[4]

Degenerative changes affect intervertebral disks, vertebrae, facet joints, and narrowing of the vertebral canal resulting in cervical spondylotic myelopathy.[5] The National Inpatient Sample recorded that 81% of the cervical spine procedures performed were in patients over the age of 65 in 2009.[3] The previous decade showed a 47% increase in the total number of cervical spine procedures, thus indicating that degenerative cervical spine disease is an increasingly significant health issue in the United States.[5]

Cervical laminectomy is a surgery commonly used for cervical stenosis associated with spondylosis, disk herniation, and developmental stenosis.[6] The goals of a cervical laminectomy surgery are to decompress the spinal cord, decompress the nerve roots, and if necessary, to restore the alignment of the vertebrae.[7] Laminectomy surgery is also indicated in trauma situations where neurological structures are compromised by unstable fractures.[8] A subsequent spinal fusion surgery is often necessary to stabilize the involved segments of the spine.[9] The National Health Service recorded 13,300 admissions owing to traumatic fractures between 2007 and 2008.[10] The purpose of this case report is to describe the evidence-based clinical decision-making process of the examination, evaluation, and treatment of a 74-year-old male, status post-cervical laminectomy with fusion, and acquired neurological symptoms.

CASE DESCRIPTION

The patient is a 74-year-old male who underwent a C2-7 cervical posterior laminectomy with fusion as a result of a wave pushing him and tumbling him to shore while at the beach on vacation. The patient suffered a unilateral hangman's fracture of C2 with retropulsion of a posterior fragment involving the right transverse foramen, resulting in compression of the vertebral artery, an epidural hematoma, and spinal cord compression from C2-5. The patient received 8 weeks of inpatient rehabilitation postsurgery. The patient attended outpatient physical therapy (PT) 12 weeks post-hospital discharge in his hometown. Relevant past medical history included left shoulder adhesive capsulitis and osteoarthritis without functional limitations. Prior to his injury, the patient was independent in all activities of daily living (ADLs). The patient lived with his wife in a ranch house and had the support of his two adult children.

EXAMINATION

Subjective

A PT examination was conducted 20 weeks postsurgery. The patient's neck pain at initial evaluation was 9 out of 10 assessed with the Numeric Pain Rating Scale. The patient described the pain as constant and excruciating, from the posterior aspect of his neck radiating superiorly towards the cranium. The patient's chief complaints included neck pain, decreased neck active range of motion (AROM), a fear of falling, and limited AROM and limited strength of the left shoulder, absence of light touch sensation on the right upper extremity (UE) and the right lower extremity (LE) consistent with Brown-Sequard symptoms. The patient expressed difficulty with numerous ADLs including an inability to reach up into a cupboard for a cup, brush his teeth, stand upright, navigate stairs, grocery shop, and feel objects with his right hand during grasping and carrying. Gait instability was reported, including impaired ability to feel the initial contact of the right foot, with the ground while walking. The patient also expressed frustration in not being able to participate in his usual recreational activities secondary to his multiple impairments and physical limitations.

UPPER QUARTER SCREENING EXAMINATION

Range of Motion

The patient's cervical AROM was evaluated using a standard goniometer (Table 1). A study by Massouh assessed cervical AROM with standard goniometry comparing it with a cervical range of motion (CROM) goniometer.[11] The results revealed 60.6% reliability for readings made by the standard goniometer in comparison to the CROM.[11] A prospective clinical study conducted by Bible et al[12] concluded that the mean cervical spine AROM necessary during basic ADLs were 20° for flexion and extension, 14° for lateral bending, and 18° for rotation. The ADLs that require the most AROM are backing up a car, followed by personal hygiene activities such as hand and hair washing and shaving.[12]

The patient's left shoulder AROM was impaired (Table 2) and consistent with the patient's diagnosis of left shoulder adhesive capsulitis. Right shoulder AROM was within normal limits (WNL). A study by Kolber et al[13] measured active shoulder mobility comparing a digital inclinometer with a goniometer. The study showed an excellent intrarater correlation coefficient for goniometer of 94%.[13] A study by Namdari et al[14] concluded that the average shoulder motions required to perform functional tasks are 121° for flexion, 128° for abduction, 46° for extension, 59° for external rotation with the arm 90° abducted, and with the arm at the side internally rotated 102°.

Neurological Testing

Sensation to light touch was tested using the dermatome screening test. Sensation to light touch on the left upper extremity and left lower extremity was normal; however, loss of sensation throughout the right upper extremity and right lower extremity was noted.

Manual Muscle Testing

Upper extremity strength was measured with manual muscle testing (MMT). Peek et al[15] concluded that MMT requires no equipment or calibration making it an easier and more convenient tool widely used by clinicians. Strength was found to be impaired and results are presented in Table 3.

Table 1. Cervical Normal, Functional, and Patient's Range of Motion

Motion	Normal	Functional	Initial Evaluation	Post-Evaluation
Flexion	0°-45°	0°-20°	0°-10°	0°- 20°
Extension	0°-45°	0°-20°	0°	0°- 20°
Right Rotation	0°-60°	0°-18°	0°-15°	0°- 25°
Left Rotation	0°-60°	0°-18°	0°-15°	0°- 30°

Table 2. Shoulder Normal and Functional Range of Motion

Left Shoulder Active Range Of Motion	Normal	Functional	Initial Evaluation	Post-Evaluation
Flexion	0°-180°	0°-121°	0°-90°	0°-160°
Abduction	0°-180°	0°-128°	0°-55°	0°-120°
Extension	0°-60°	0°-46°	0° - 5°	0°- 30°
External Rotation	0°-90°	0°-59°	0°-30°	0°- 70°

Table 3. Patient's Manual Muscle Testing

Left Shoulder Manual Muscle Testing	Initial Evaluation	Post-Evaluation
Flexion	3-/5	4+/5
Abduction	3/5	4/5
Extension	3/5	4+/5
External Rotation	3/5	4/5
Internal Rotation	3/5	4/5

Table 4. Hip and Ankle Range of Motion During Parameters of Gait

Gait Phase, Range of Motion	Normal Gait Parameters	Initial Evaluation	Post-Evaluation
Terminal Stance, 20° Preswing, 10°	Left Hip Extension	0°	0° - 10°
Midstance, 5° Terminal Stance, 10°	Left Ankle Dorsiflexion	0° 0°	 WNL

Abbreviation: WNL, within normal limits

LOWER QUARTER SCREENING EXAMINATION

Range of Motion

Left hip and ankle AROM were measured with a standard goniometer and found to be impaired (Table 4). The patient's right hip AROM and right ankle were WNL. According to Cleland et al,[16] a standard goniometer has an interrater reliability of 82% to measure hip ROM.

Manual Muscle Testing

Strength on the left hip and ankle was found to be impaired with greatest post-evaluation improvement in hip abduction and ankle dorsiflexion. The results are presented in Table 5.

Gait Analysis

The patient had limited left ankle dorsiflexion during midstance, inadequate left hip extension and limited left ankle dorsiflexion during terminal stance, and limited hip extension during pre-swing and initial swing during the single leg advancement. A forward head posture was maintained during ambulation and a straight cane was used in the right arm. The left arm showed limited swing due to adhesive capsulitis. The patient had a left pelvic hip hike to compensate for decreased ankle dorsiflexion during the terminal stance and decreased hip extension during the preswing and initial swing phase.

Functional Testing

Thirty Seconds Timed Sit-to-Stand Test

The Thirty Seconds Timed Sit-to-Stand Test is used to evaluate the patient's functional strength, endurance, and has an excellent interrater reliability of 95%.[19] The test was administered using an 18-inch chair with arms. The patient sits with a straight back, feet shoulder width apart on the floor, and one foot slightly in front of the other to assist with balance.[19] The tester demonstrates the test initially, followed by the patient performing a few practice trials. The test starts at the signal "go;" and then the tester counts the number of repetitions completed during the 30 seconds.[19] The results of the Thirty Seconds Timed Sit-to-Stand Test are presented in Table 6.

Berg Balance Test

The Berg Balance Test (BBT) assesses balance and the risk for falls in the elderly population with a reported 91% sensitivity and 82% specificity.[20] A minimally clinically important difference (MCID) of at least 6 points is needed to be considered a clinically significant change.[20] A meta-analysis by Downs et al[21] has shown that the BBT has a high interrater reliability and it is able to detect clinically significant changes with 95% confidence in the majority of patients. The BBT with a score of <45 is associated with 100% of fall risk.[22] The BBT consists of a 14-items, the tester records the lowest response category that applies for each item rating from 0 (lowest level of function) to 4 (highest level of function).[22] The score is often based upon a specified time, or number of repetitions, in addition to safety of movement. Points are deducted according to the patient's ability to maintain balance while attempting these tasks.[22] The results of the BBT are presented in Table 7.

The Romberg Test

The Romberg Test has multiple clinical uses including screening balance for patients with myelopathies and neuropathies.[23] The interrater reliability has been reported as 90%.[16] The MCID has not been established for this test.[23] To perform this test, patients must maintain their balance in a double limb stance for 30 seconds, first with eyes opened (EO) and then with eyes closed (EC).[23] The patient is asked to remove his or her shoes and stand with feet together and arms crossed in front of the body.[23] There are variations to this test such as one-legged stand, tandem, and partial tandem.[24] The Romberg test is scored by counting the number of seconds for which the patient is able to maintain his or her balance.[23] The scores of the Romberg Test for this patient are presented in Table 8.

Table 5. Hip and Ankle Manual Muscle Testing

Left Hip	Initial Evaluation	Post-Evaluation
Flexion	3/5	3+/5
Abduction	3/5	4-/5
Extension	3/5	3+/5
Left Ankle		
Plantar Flexion	3/5	4/5
Dorsiflexion at 0° knee	3-/5	4-/5
Dorsiflexion at 90° knee	3-/5	4/5

Table 6. Thirty Second Timed Sit-to-Stand Test

Normal Value	Initial Evaluation	Post-Evaluation
15 repetitions for a 74-year-old man to maintain physical independence	**8 repetitions** with moderate assistance of bilateral upper extremity using armrests and contact guard x1	**25 repetitions** performed consecutively as follows: 8 without assistance of arms, 7 with hands on the knees, 10 with hands on the armrests with contact guard x1

Table 7. The Patient's Berg Balance Test Scores

Initial Evaluation	Post-Evaluation
30/56	51/56

EVALUATION

The patient presented with left sided weakness, left shoulder adhesive capsulitis, UE and LE decreased ROM, UE and LE right sensory loss, and gait impairments. The patient's forward head position affected body alignment causing cervical AROM limitations, and possibly the radiating pain from the posterior aspect of the patient's neck superiorly toward his cranium. The patient's accentuated thoracic kyphosis interfered with his left scapular mobility and combined with left adhesive capsulitis led to decreased shoulder AROM, decreased shoulder strength, and decreased functional limitations of the UE, left greater than the right. The patient's limited hip and ankle AROM, decreased right LE sensation, accentuated thoracic kyphosis, and gait impairments created an unsteady gait pattern contributing to high risk for falls. The results of the functional testing supported these findings.

The patient was classified under a primary and a secondary practice pattern. The primary musculoskeletal practice pattern was for impaired joint mobility, motor function, muscle performance, and ROM associated with bony or soft tissue surgery. The secondary neurological acquired practice pattern was 5D for impaired motor function and sensory integrity associated with nonprogressive disorders of the central nervous system acquired in adolescence or adulthood.[25]

Prognosis

The patient's prognosis for established therapy goals was determined to be good in returning to functional activities due to his motivation, family support, and anticipated outpatient PT compliance.

Goals

The patient's goals were to return to baseline function in ADLs without pain, weakness, or limitation. Anticipated goals were established and consisted of improved cervi-

Table 8. The Patient's Average Romberg Test Scores

	Initial Evaluation	Post-Evaluation
Eyes Closed Double Limb Stance	10 seconds	30 seconds
Eyes Opened One-Legged Stand		
Right leg	RL – 9 seconds	RL – 18 seconds
Left leg	LL – 3 seconds	LL – 7 seconds

Abbreviations: RL, right leg; LL, left leg

cal mobility in all planes by the end of the fifth week to improve posture and decrease pain, and improve Berg Balance score test to 42/56 by the end of the fifth week to decrease risk for falls. Expected outcomes were established and included functional left glenohumeral AROM to be able to reach into a cupboard by the end of the seventh week, and improve the Thirty Seconds Sit-to-Stand Test score from 8 repetitions to 16 repetitions by the end of seventh week. The patient's goals were consistent with these established goals.

INTERVENTION

The patient attended outpatient PT for 2-hour sessions, 3 times per week, over a 7-week course of care. An exercise program was designed to help assist the patient with ADLs, instrumental activities of daily living (IADLs), gait, bilateral UE and LE strengthening and AROM, and cervical AROM.

The interventions prescribed in this case report followed clinical guidelines for neck pain and shoulder adhesive capsulitis per the International Classification of Functioning from the Orthopaedic Section of the American Physical Therapy Association.[26,27] The postsurgical rehabilitation 2 month postoperative protocol for cervical laminectomy recommends therapeutic painfree AROM exercises for cervical spine and UE, upper thoracic mobilization exercises, scapular retraction and protraction, general UE and LE strengthening, modalities, and manual soft tissue mobilizations.[26]

A literature review has shown increased effectiveness in addressing the management of an incomplete spinal cord injury by increasing the intensity of the exercises.[30] The intensity, progression, and addition of exercises were based on the patient's level of strength, pain, and AROM assessed weekly. The type of exercises were based on the patient's impairments to help assist with ADLs, IADLs, left UE and LE strengthening and ROM, reduced risk of fall, and improved gait. The patient performed cervical stretching exercises after each session and he received cervical manual myofascial and trigger point release bilaterally in his upper trapezius and scalenes weekly. Cervical and LE passive stretches were performed weekly at the end of each session. Balance and mobility training were based on repetitive functional activities of the LE such as sit-to-stand, targeted stretching, strengthening activities, coordination, and balance tasks.[31] Tasks were progressed to keep the therapy challenging. Examples included changing the height of the chair and eliminating bilateral UE assistance during the sit-to-stand exercise, increasing the resistance on the weights or the Thera-Band, increasing repetitions, increasing sets, and withdrawing assistance during the standing exercise at the wall or chair.[30] The patient's goals and achievements were reviewed, and a home exercise program that also included postural education, was updated weekly. The patient's skin was checked weekly for cuts or wounds due to loss of sensation on the right side of his body. A detailed report of the type of exercises, repetitions, sets, and a weekly progression of the exercises are shown in Table 9.

RESULTS

Goal achievement following 7 weeks of PT was as follows: met the anticipated goal of improving cervical mobility in all planes by reaching functional limit parameters in cervical AROM (see Table 1), met expected goal of reaching functional left glenohumeral AROM in flexion and external rotation and marked improvement in left shoulder functional AROM in abduction and extension (see Table 2), met anticipated goal of improving Berg Balance score test to 42/56 by reaching the MCID with an improvement of 21 points (see Table 7), met the expected goal of improving the Thirty Seconds Sit-to-Stand Test score from 8 to 25 repetitions (see Table 6). The following goals were not 100% achieved, however, contributed to the success of the patient's goal to return to baseline function: improvement in left shoulder muscle strength in all directions scoring from a 3-/5 classified as a fair score to a 4+/5 classified as a good score (see Table 3), reached minimum ROM gait parameters in hip extension and ankle dorsiflexion (see Table 4), and significant improvement in the Romberg test with EC during the double limb stance (see Table 8).

DISCUSSION

This case report addressed the complexity of an elderly patient who underwent a cervical laminectomy with fusion at multiple levels, with acquired neurological symptoms consistent with Brown-Sequard Syndrome status post-fall. The acquired neurological symptoms along with left shoulder adhesive capsulitis resulted in severe functional limitations, which made this case unique and complex. There is limited research regarding an optimal outpatient rehabilitation program with individuals with acquired neurological symptoms, given the complexity and variability within this population. In addition, there is limited research on evidence-based interventions while treating patients with multiple diagnoses, which may seem to diminish the effectiveness of traditional PT.

The interventions used in this case report followed clinical guidelines for neck pain, shoulder adhesive capsulitis, and gait/balance parameters.[26,27] There are stipulated minimum ROM parameters needed in each phase of the gait cycle to be able to perform ADLs such as 5° of ankle dorsiflexion at midstance, 20° of hip extension during terminal stance, 10° of ankle dorsiflexion during terminal stance, and 10° of hip extension during pre-swing limb advancement.[17] A study by Toebes et al[18] emphasizes the importance of meeting normal gait parameters as a preventative measure to decrease the risk for falls. The intensity of the intervention and the type of exercises were based on the ICF protocols for post-cervical laminectomy, and literature review. For motor improvement, the exercise intensity in an outpatient setting recommended by Larson and Denison was 3-hour sessions, 3 to 5 times per week for a minimum of 3 months.[28] The patient in this case report performed 2 hours session, 3 times per week, over a 7-week course of care with positive outcomes. The study by Larson

Table 9. Weekly Progression of the Exercises

Impairment	Week 1	Week 2	Week 3
Neck pain with movement[25,27] Weakness of the deep neck flexors muscles Limited flexion, extension, rotation ROM	Chin forward and backward glide Isometric neck extension Isometric neck flexion Supine neck flexion Supine right and left head rotation	Supine neck curl Seated isometric neck extension and side bend against physical therapist's hand	Seated protraction and retraction Seated R and L head rotation Seated R and L neck side-flexion
Limit upper thoracic mobility[26] Thoracic kyphosis Thoracic mobility interferes with scapular movement leading to decreased shoulder ROM		Seated trunk rotation with cervical rotation, looking over ipsilateral shoulder Supine trunk rotation, knees bent at 90°, with head rotation	Standing with hands on the back of a chair, cat and cow stretches Seated thoracic extension
Left shoulder adhesive capsulitis[26] Limited ROM IR, ER, abduction, flexion, and extension Weakness in rotator cuff muscles, deltoid, teres major, and serratus anterior Pain with flexion, extension, IR, and ER PROM after each session in all directions	Fingers wall reach flexion Supine shoulder flexion AAROM with a wooden stick Sidelying IR & ER rotation AROM Stretches: Standing facing wall shoulder flexion IR/ER	**Patient c/o of shoulder soreness and neck pain from previous week (9/10 NRI) No shoulder exercises this week due to increase in neck pain and shoulder pain	Pulley (warm-up) Using the fingers perform a wall walk Facing wall shoulder at 90° flexion, elbow 0°, scapular retraction/ protraction
L hip and R hip loss of sensation[29] Limit left flexion, extension, abduction ROM Limit strength L>R Limit sensation R>L	Supine straight leg raise Standing against the wall mini squats using body weight Mini lunge stepping forward w/ contact guard Stretches: Supine passive hamstrings stretch Sidelying passive quadriceps stretch	Front lunges and 45° side lunges with UE support on chair for balance Sit to stand from a chair using BUE support Supine straight leg raise Stretches: Supine hamstrings active and passive stretches	Supine straight leg raise with 2 lbs. ankle weight Hip abduction and adduction with BUE support on chair. Sit to stand from chair no UE support 3 sets to failure with 1-minute rest between sets. Side step – with chair in front for UE support as necessary for balance

Abbreviations: ROM, range of motion; R, right; L, left; AROM, active range of motion; IR, internal rotation; ER, external rotation; AAROM, active assisted range of motion; NRI, Numeric Rate Index; CW, clockwise; CCW, counterclockwise; MMT, manual muscle test; UE, upper extremity; BUE, bilateral upper extremity

Week 4	Week 5	Week 6	Week 7
Standing using large ball against the wall isometric exercises neck flexion, side bending, and extension 10 sec Seated active neck side bending, flexion, and rotation Seated trunk rotation with cervical rotation, looking over the ipsilateral shoulder Supine isometric neck extension exercises pressing on the pillow	Standing with heels against the wall; gentle chin protraction and retraction Seated AROM neck rotation and side bending	Neck lateral bend and rotation AROM Hold and relax exercises	*Post evaluation measurements* AROM measurement Flexion, extension, rotation, and side bending
Supine trunk rotation with knees bent			
Large ball shoulder in 90° flexion, elbow at 0° -small circles rotation CW and CCW to failure and scapular retraction /protraction Standing ER and IR green TheraBand Shoulder protraction and retraction – red TheraBand	Standing; elbow at 90° red TheraBand IR, ER, abduct, and adduct Shoulder flexion and extension; green TheraBand Standing facing away red TheraBand shoulder protraction and retraction		*Post evaluation measurements* ROM and MMT Sidelying IR & ER 3 lbs weight Supine shoulder flexion 3 lbs weight Supine scapular protraction and retraction shoulder in 90° flexion, elbow at 0°, punch with 4 lbs weight Seated reaching and grabbing a 2 lbs weighted ball from different directions
Supine half bridges knee at 90°, lifting the gluteus off the plinth Side lying hip abduction, and adduction with 4 lbs. ankle weight Sit to stand on 23" box no UE support 23-30 reps Standing calf raises Standing hip abduction (next to pole) Sidelying clams Supine straight leg raise with 4 lbs. ankle weight Stretches hold and relax and contract and relax hamstrings, quadriceps, and gastrocnemius	Standing next to pole without touching, hip abduction, hip flexion, and hip extension holding the position for 3-5 seconds Floor transfer, no cane, 3 times with stand-by assistance Sit to stand 23" box 30 reps 1 set Standing reaching forward without moving feet Supine half bridges Standing single leg calf raises to failure	Floor transfer – getting up from the floor, no cane or assistance 10 times Side lunges no UE support Half bridges Standing hip extension with contact guard assistance Squats 120° 40 reps with contact guard assistance	Post-evaluation measurements 35 sit<->stand transfers from a high box without BLE assistance Standing leg raise hip flexion, extension, and abduction with ankle weight 3 lbs 30 reps 1 set

Exercises frequency and time increased throughout the week based on patient's tolerance to pain: starting with 15 repetitions increasing to 20 repetitions and from 2 sets to 3 sets

Stretch holds 10-30 sec, 3 sets

Manual Myofascial Release in supine bilaterally to release upper trapezius and scalenes for 15 minutes at the end of the session

(Continued on page 164)

Table 9. Weekly Progression of the Exercises *(Continued from page 163)*

Impairment	Week 1	Week 2	Week 3
Impaired balance[29]		Standing balance EO near a chair for UE as necessary 5 sec hold	
Impaired ankle dorsiflexion[30]	Long seated w/knee at 0°, towel pull the foot into ankle dorsiflexion		

Abbreviations: ROM, range of motion; R, right; L, left; AROM, active range of motion; IR, internal rotation; ER, external rotation; AAROM, active assisted range of motion; NRI, Numeric Rate Index; CW, clockwise; CCW, counterclockwise; MMT, manual muscle test; UE, upper extremity; BUE, bilateral upper extremity

and Denison emphasized that intensity is not measured in time alone but rather by the type of therapeutic activity, the number of the exercises, the variation of those exercises, and their progression.[28]

Participants in the study by Pichierri et al[29] demonstrated a significant improvement on the Berg Balance Scale with exercises for body stability referred to in the study as single-task balance training exercises. The patient in this case report performed single-task balance exercises and obtained an improvement of 21 points in the Berg Balance Scale in 7 weeks.

The outpatient rehabilitation protocol post-cervical laminectomy with fusion recommends therapeutic exercise for cervical and UE AROM, scapular and cervical retraction, shrugs, upper thoracic rotation, and UE and LE general strengthening exercises.[26] Shoulder-stretching exercise recommendations, performed weekly, were used from the clinical practice guidelines for adhesive capsulitis.[27] Evidence-based literature was used to develop a plan of care, which addressed impairments and functional limitations.

The intensity and time of the exercises were increased throughout the week based on patient's tolerance to pain: starting with 15 repetitions increasing to 20 repetitions and from 2 sets to 3 sets.

The stretching exercises were held based on patient tolerance to pain that day. Manual myofascial release was performed for 15 minutes bilaterally in supine for trigger points in the upper trapezius and scalenes. The frequency of cervical myofascial release per week was determined by the patient's level of discomfort that day by the end of the session. This case report demonstrates how a physical therapy rehabilitation program designed by combining current evidence-based guidelines may have contributed to improvements in the patient's strength, AROM, gait, transfers, and balance.

There is limited research on patients with similar complications of post-cervical laminectomy, a presentation of Brown-Sequard Syndrome from undetermined causes, and an uncertainty of functional limitations from the patient's comorbidities prior to the surgery or fall. There is inherent limitation with the use of MMT to measure muscle strength because it uses ordinal data, which may not detect small changes in muscle strength and the floor and ceiling effect. The interventions were based on a compilation of several studies. This leads to uncertainty as to which types of interventions were beneficial and how they specifically contributed to the patient's betterment, reduced impairments, and overall improvements in functional mobility. As the patient was not treated in our facility until 12 weeks postsurgery, this may have contributed to an increase in muscle imbalance in the UE and the LE. Additionally, the clinical education course was only for 7 weeks, thus creating an essential need for prioritization during the intervention decision-making process to address his multiple impairments.

CLINICAL APPLICATIONS

The importance of clinical evidence based literature for patients with this level of complexity is essential in order to create an effective and personalized program. Additionally, patients with this level of impairment often require an increased length of time in outpatient PT to create the desired carry-over effect. Based on current evidence, the patient age, prior comorbidities, and post-cervical laminectomy with neurological complications, a total of 50 visits would be a reasonable number of visits to create the desired carry-over effect.[27] Due to the short duration of the clinical rotation, the author was unable to collect post-test data for the entire episode of care, which is a limitation of this report.

FURTHER RESEARCH RECOMMENDATIONS

Further investigation in randomized controlled studies to compare therapeutic activities, mobilizations, functional mobility training, and soft tissue techniques in patients with cervical laminectomy at multiple levels with acquired neurological complications would help to create an effective and personalized program for patients with this level of complexity.

In order to reduce future medical costs, it is recommended an additional analysis of the impact of high PT copayment in the rehabilitation for patients with this level of complexity.

Week 4	Week 5	Week 6	Week 7
EO single leg stance 10 sec Single leg stand on a 5” foam, contralateral LE tap forward, back and sideways		Touch toe on the BOSU Pick objects from the floor Standing one leg reaching forward and to the side with UE Standing march in place (2 minutes) Single leg stance EO and EC to failure	Berg Balance Test Touch toe on BOSU Touch toe 15” box
	Long seated w/ purple Thera-Band, dorsiflexion and plantar flexion		

Exercises frequency and time increased throughout the week based on patient’s tolerance to pain: starting with 15 repetitions increasing to 20 repetitions and from 2 sets to 3 sets.

Stretch holds 10-30 sec, 3 sets

Manual Myofascial Release in supine bilaterally to release upper trapezius and scalenes for 15 minutes at the end of the session

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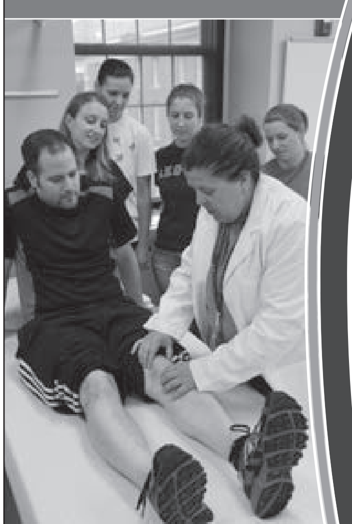

The Effect of Ankle Bracing or Taping on the Biomechanics of the Ipsilateral Knee During Sporting Activities: A Systematic Review

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ABSTRACT

Background and Purpose: Ankle injuries are commonly treated with bracing or taping, but the impact of these interventions on knee biomechanics is not clearly understood. The purpose of this systematic review was to investigate whether ankle bracing or taping alters the biomechanics of the knee. **Methods:** Studies were identified by searching multiple databases and reference lists of screened articles. Selected studies met the following criteria: at least one biomechanical variable measured at the knee, subjects tested in braced/taped and non-braced/non-taped conditions, and subjects free of ankle or knee injury during the previous 6 months. The quality of the selected articles was evaluated. **Results:** Of the 6 studies included, 5 found that taping or bracing significantly altered biomechanical variables at the ipsilateral knee. Taping decreased peak internal rotation and varus moments. Braces increased peak external rotation moment, knee internal rotation, and initial sagittal-plane knee angle upon ground contact, while significantly decreasing total excursion of the knee joint in the sagittal plane. **Clinical Relevance:** Ankle taping and bracing alter knee biomechanics, potentially changing the risk for non-contact knee injury during sporting activities. **Conclusion:** Further research is needed to determine the effect that altered knee biomechanics could have on the likelihood of knee injuries when using ankle bracing and/or taping.

Key Words: lower extremity, kinetic chain, orthotics, injury risk

INTRODUCTION

The ankle is the most commonly injured joint in the body.[1] Ankle sprains have been shown to be one of the most frequent sports-related injuries, comprising between 10% and 30% of all musculoskeletal sports injuries.[2,3] The majority of ankle injuries are caused by a combination of excessive plantar flexion and inversion.[1] Following an initial ankle sprain, regardless of severity, the risk of future injury to the affected ankle increases.[2] Preventative taping and bracing are commonly used in sports in an attempt to limit plantar flexion and inversion and the risk for reinjury. However, limiting motion at one joint often results in motion compensation at neighboring joint(s). Thus, limiting motion at the ankle may lead to changes in the forces experienced at the knee. Increased valgus, varus, and rotation forces about the knee have been shown to contribute to numerous musculoskeletal injuries of the knee.[4-7] For example, wearing an ankle brace could result in limited knee flexion, which in turn could result in poor landing mechanics associated with anterior cruciate ligament (ACL) injuries.[8] Alternatively, individuals with limited ankle dorsiflexion could also compensate with increased knee flexion thereby necessitating an increased quadriceps contraction for eccentric control. Theoretically, this compensation could lead to increased stress at the quadriceps insertion at the tibial tuberosity potentially increasing the likelihood of developing Osgood-Schlatter disease.[9] Although ankle injuries are more common than knee injuries, knee injuries are associated with a greater loss in playing time, and increased medical costs due to intensive rehabilitation periods.[10] Ankle bracing and taping have been shown to have neither positive nor negative effects on a number of performance-related parameters, including agility, sprint speed, vertical jump height, and postural control.[11-15] However ankle bracing and taping may still be considered a detriment to sport if they are associated with injury at other joints.

Although ankle bracing and ankle taping are common practice in athletics, whether used prophylactically or while recovering from an acute injury, their effects on the biomechanics of the knee are not widely appreciated. Therefore, the purpose of this review was to search the literature in an attempt to determine whether the use of ankle bracing or taping to reduce the incidence of ankle injuries alters the biomechanics of the ipsilateral knee during sports-related activities.

METHODS

Criteria for Inclusion in Review

Research Design: Randomized-control trials and case-control studies.

Participants: Participants of studies to be included in this review had to be between the ages of 14 and 60 years, had no history of ankle or knee injury within 6 months prior to the study, no history of a severe ankle or knee injury requiring more than a month of treatment or surgical intervention, and no history of neurological impairment. Participants must have served as their own controls, and been tested in both taped and non-taped, or braced and non-braced conditions.

Dependent Variables: Studies were included if they examined at least one biomechanical (kinematic or kinetic) variable measured at the knee.

Search Method: The databases searched were Academic Search Premier, CINAHL, MEDLINE, Rehabilitation & Sports Medicine Source, and SPORTDiscus, 2002-2012. An additional hand search was performed from the reference sections of articles that were selected for further review.

Key Words Used: Searches were conducted both in subject and title fields. (“Brace” or “bracing” or “braces” OR “tape” or “taping”) AND (“ankle” and “knee”).

Data Collection/Analysis

Study selection: Two investigators (JDS and KDH) were involved in the review/selection process. JDS performed the search and selected potential articles, which were then reviewed by each of the investigators independently. Disagreements on inclusion or exclusion of articles were resolved through discussion between the two investigators.

Quality assessment tool: A methodological assessment tool that covered all desired qualities could not be found, and thus a tool was constructed by modifying the tool used by Lankhorst el al[16] (Table 1). Other assessment tools that were considered were found to be designed for intervention-based, diagnostic, or prognostic studies, while this review was biomechanical in nature.

Data extraction: One of the investigators (JDS) performed the data extraction, which was then reviewed by both investigators. Any disagreements on interpretation of data were resolved through discussion.

RESULTS

Results of Study Selection

Searching the relevant databases yielded a total of 51 possible articles, and an additional 5 articles were added from the reference lists of hand-screened articles, giving a total of 56 articles in the initial selection pool. Forty-two of the 56 articles were excluded following a review of their titles and abstracts to assess inclusion and exclusion criteria, leaving 14 articles to be retrieved for further investigation. Eight articles were excluded for the following reasons: unpublished article, lack of a sporting task, non-experimental study, lack of biomechanical measure, and lack of an ankle brace and/or tape. Six articles were ultimately included in the review (Figure).

Quality of Studies

The quality of all 6 included articles was measured using the quality assessment tool described earlier (see Table 1). Table 2 shows the scoring for each of the articles for the 13 quality criteria. Only one of the studies included in this review met all 13 criteria;[17] one study[4] met 12; another[18] met 11, and the final 3 met 10 out of the 13 criteria.[19-21] All of the studies consisted of test situations that resembled realistic sporting tasks. Four of the studies[4,17,19,21] clearly described the randomization procedure for the order of testing conditions for the subjects; one was unclear as to their method,[20] and the final study did not describe a method to randomize the testing order for the subjects.[18] Common shortcomings among the studies were small sample sizes[19-21] (less than 20 subjects) and inclusion of only one gender.[4,19,21] Because the assessment tool used in this study was designed especially for this review, no system for cut-off scores or specific ranking based on the articles' scores was devised. Articles that scored the highest were considered to be the strongest, and no single item on the assessment tool was weighted more heavily than others.

Biomechanical Variables

A summary of the key effects of taping or bracing on various biomechanical variables for each study is shown in Table 3.

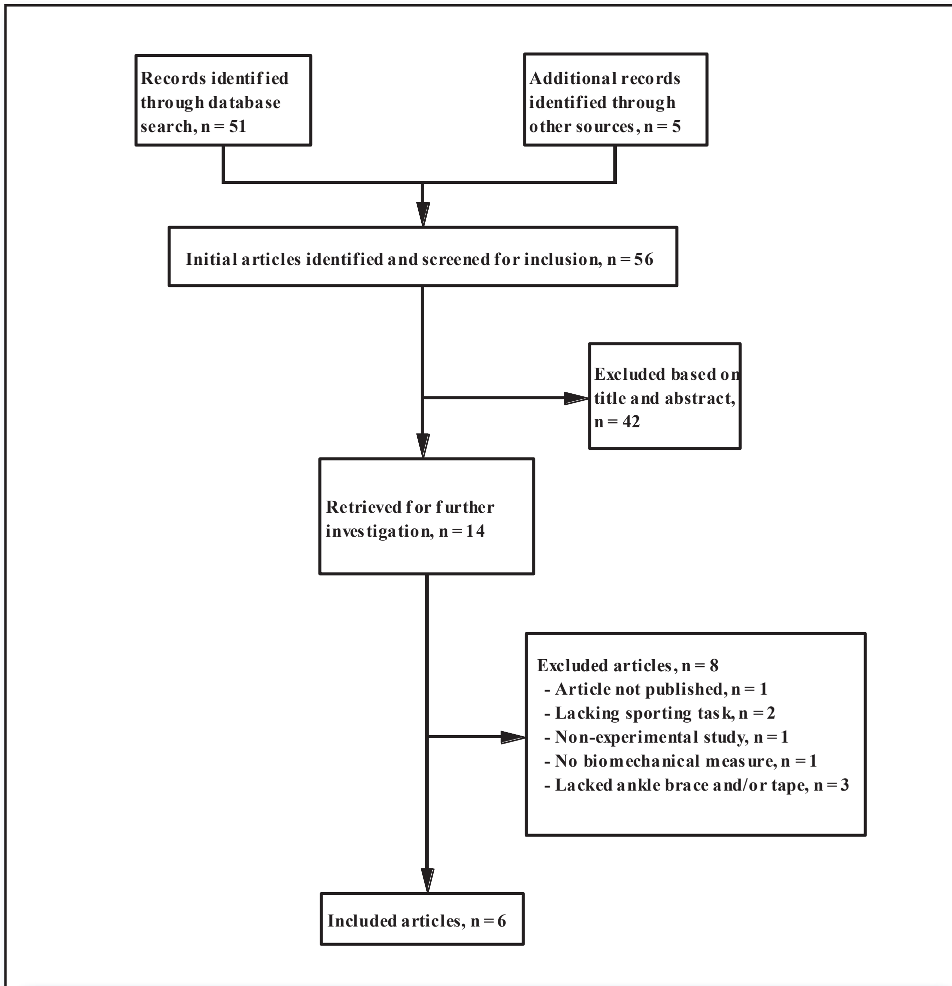

Figure. Flow diagram of the systematic review.

Table 1. Article Quality Assessment Categories and Criterion

Item	Criterion (1 point if criterion met)
Study Population	
1. Number of cases	Number of subjects was 20 or greater
2. Subject Gender	Study contained males and females
Study Design	
3. Inclusion and exclusion criteria	Clearly defined inclusion and/or exclusion criteria
4. Methods description	Clearly described methodology
5. Randomization	Method of randomization was used
6. Efficiency	Testing for all conditions was performed on the same day
7. Realistic athletic activity	Testing parameters were representative of a realistic sporting activity
Assessment of Outcome	
8. Definition of variables(s) and outcome(s)	Clearly described variables and outcomes
9. Assessment method	Assessment methods used to measure the variables/outcomes were suitable
Analysis and Data Presentation	
10. Consideration for confounders	Clearly discussed potential confounding variables
11. Control for confounders	Clearly described method used to control for confounding variables
Conclusion	
12. Authors' conclusions supported	Author(s)' claims were supported by the data in the study
13. Limitations presented	Authors discussed limitations of their study

Table 2. Quality Assessment Score for Each Article Included in the Review

Criterion	1	2	3	4	5	6	7	8	9	10	11	12	13	Score
Articles														
Venesky et al[18]	1	1	1	1	0	1	1	1	1	1	0	1	1	11
Cordova et al[19]	0	1	1	1	1	1	1	1	1	1	1	1	0	10
Santos et al[20]	0	1	1	1		1	1	1	1	1	0	1	1	10
Stoffel et al[4]	1	0	1	1	1	1	1	1	1	1	1	1	1	12
Hodgson et al[21]	0	0	1	1	1	1	1	1	1	1	1	1	0	10
DiStefano et al[17]	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Scoring Key: Positive (1), Negative (0), Not clear (Blank)														

Taping

Knee Flexion Excursion: Cordova et al[19] included measures of knee flexion excursion comparing taped and non-taped conditions and found no significant difference between the two conditions during a 0.3 m drop landing in a small sample of male subjects only. Stoffel et al[4] measured sagittal plane knee displacement, but compared it only between planned and unplanned conditions, not comparing taped vs. non-taped, and thus was not considered as part of this review.

Knee internal and external rotation moments: Stoffel et al[4] measured peak internal and external rotation moments during planned and unplanned side-stepping or straight running, both in taped and non-taped conditions. The authors identified that subjects who had their ankle taped exhibited significantly lower internal rotation moments compared to those without tape during all 4 tests.

Knee varus and valgus moment: Stoffel et al[4] also measured peak valgus and varus moments during side-stepping and running trials as described earlier. The authors found no significant difference in peak valgus moment between taped and non-taped conditions during side-stepping in a sample of only male Australian football players. Peak valgus moment, however, was significantly less in the taped condition during running and side-stepping trials, for both planned and un-planned conditions.

Knee axial rotation: No studies included in this review investigated axial rotation in taped conditions.

Bracing

Knee Flexion Excursion: Three articles[17,19,21] compared measures of knee flexion excursion in braced vs. non-braced conditions. One study[21] found no significant difference between using an Active Ankle T2® (Cramer Products, Gardner, KS) brace or no brace during a 0.61 m drop-jump onto a flat surface in a small sample of female volleyball players. The other two studies found significantly less knee flexion in the braced condition. One of the studies used a 0.3 m step-off onto a flat surface in a small sample of only male basketball players.[19] The other study used a forward jump from a 0.3 m box with a large sample of male and female basketball and volleyball players.[17] Studying landing from the forward jump, DiStefano et al[17] also reported a significantly greater knee flexion angle at initial ground contact when wearing an ASO® Ankle Brace (Medical Specialties Inc., Charlotte, NC). The mean initial knee flexion angle of those with non-braced ankles was 9.0 ± 9.0°, and the knees of those with braced ankles had a statistically significantly larger ($p = .0001$) mean initial angle of 12.0 ± 9.0°.

Knee internal and external rotation moments: One study investigated internal and external rotation moments in a braced condition during a drop-jump onto a 20° laterally declining surface intended to force inversion of the ankle. The use of an Active Ankle T2® brace led to a significantly greater peak external rotation moment.[18]

Knee varus and valgus moments: One study compared the effect of braced and non-braced conditions on peak valgus moment during a drop jump onto a 20° laterally declining surface and found no significant difference in valgus and varus moments whether using a brace or not in a group of 24 physically active male and female college students.[18]

Knee axial rotation: A single study[20] investigated degrees of axial rotation excursion at the knee during two sports-related tasks. The first considered an "open task" in which subjects turned to catch a ball while in single-leg stance. The second was a "closed task" in which subjects rotated their bodies to touch a target with their shoulders while in single-leg stance. No difference was found when wearing a brace in the "open task;" however, in the "closed task" subjects demonstrated a significantly greater amount of internal rotation when wearing an ankle brace.[20]

DISCUSSION

The aim of this review was to investigate whether the literature supported the notion that ankle bracing or taping alters the biomechanics of the ipsilateral knee during sports-related activities. We theorized the literature would support that use of ankle bracing would alter knee biomechanics during simulated sporting activities. In this review, mixed results were evident as it relates to the impact of how both taping and bracing affect the biomechanics of the ipsilateral knee. While some biomechanical variables at the knee were affected by the use of either a brace or tape at the ankle, others were not. Discussion of each of the measured variables and the impact that taping and/or bracing had on each variable are now described.

Knee Flexion Excursion

Two out of the 3 studies that measured knee flexion excursion during jump landings, found that wearing ankle braces led to decreased knee flexion when compared with a non-braced landing.[17,19] The disagreement in results may be because the 2 studies used a 0.3 m box height[17,19] as compared with the study that found no difference, which used a 0.6 m box height.[21] In addition, in the study that found no difference, all had previous experience wearing the exact type of ankle brace used in the study. Experience using the braces may have led to the development of landing strategies that could have impacted the results resulting in no knee excursion differences.[21] Hinged braces like the Active Ankle® brace can allow more plantar flexion and dorsiflexion than lace-up ankle braces, due to the location of its hinge at the level of the malleoli.[13] Allowing dorsiflexion with the foot flat on the ground requires the tibia to roll anteriorly on the ankle mortise preventing the knee from having to provide increased flexion to control a jump landing or running task. While the greater initial knee flexion angle in subjects with braced ankles in the DiStefano[17] study were statistically significant, a difference of 3°, and a 9° standard deviation would not likely be clinically significant. Among the 3 studies[17,19,21] investigating the effects of braces on knee flexion excursion, each used a different type of brace, making comparison between studies somewhat difficult. The only study that examined the effect of ankle taping (basket weave technique) found no difference in knee excursion between taped and non-taped ankles.[19] The relatively shallow height of the jump (0.31m) in this study may not have been sufficient to require greater knee flexion excursion, while that from a greater height may have had a different impact.

Initial Ground Contact Knee Flexion Angle

DiStefano et al[17] reported that the mean initial knee flexion angle of those with braced ankles was significantly larger than those not wearing a brace. The 12° knee flexion angle for those wearing the brace is important because research has shown that knee flexion angles between 10° and 15° place the ACL at greatest risk.[22-25] The increased flexion angle is likely due to the tendency of the ASO® Ankle Brace to limit plantar flexion and dorsiflexion. Decreased dorsiflexion limits anterior roll of the tibia on the talus thus requiring the knee to compensate by increasing its angle of flexion. The studies included in this review did not investigate the effects of taping on knee angle at initial contact.

Peak Internal Rotation and External Rotation Moments

Two of the included studies investigated internal and external rotation moments. The first examined the effect of taping during side-stepping and straight running, among Australian football players.[4] The authors found all 4 of their testing conditions elicited significantly less peak internal rotation moment in the taped condition versus the non-taped condition. Anticipated lower extremity biomechanics during running on flat surfaces would consist of some tibial internal rotation excursion as the subtalar joint pronates during weight acceptance.[25] Taking this into account, the results of this study suggest ankle bracing and taping did not limit the quantity of subtalar joint pronation thereby failing to alter tibial rotation moment. The second study examined the effect of the Active Ankle® brace in physically active college students during a drop landing on a 20° laterally declining surface intended to force inversion of the ankle.[18] The investigators recruited a mixed gender sample and showed that when wearing an Active Ankle® brace and landing on a laterally slanted surface, peak external rotation moment was significantly greater than in the no support condition. Normal biomechanics of the lower extremity consist of some external rotation excursion about the subtalar joint and knee during forced inversion of the ankle.[25] The Active Ankle® brace, which has been shown to successfully limit axial rotation of the ankle,[26] would be expected to increase external rotation about the knee to compensate for lost rotation at the ankle.

Peak Valgus and Varus Moment

Stoffel et al,[4] who examined 4 testing conditions (planned and unplanned side-stepping, and planned and unplanned running), found that only the planned side-stepping task elicited a valgus moment, but it was not significantly different between taped and non-taped conditions. In a separate study, Venesky et al[18] found no significant difference in peak valgus moment in the knees of subjects wearing Active Ankle® braces compared to those with no support. As it relates to varus moment, Stoffel et al,[4] also showed that amongst the 4 different conditions, subjects with taped ankles experienced significantly less peak knee varus moment compared with when their ankles were not supported by tape. As ACL injury risk increases with increased peak varus moment,[4] the use of ankle taping in this study may suggest that prophylactic ankle bracing may also be protective to the ACL. However, limitations of taping, such as length of time that it remains effective[4] must also be taken into consideration when choosing a prophylactic intervention.

Research has shown that females have a higher incidence of non-contact ACL injuries than males.[27,28] However only one of the studies in this review[18] that investigated varus and valgus moment included female subjects, and it did not analyze males and females separately. As a result, the effect of ankle brace wear on females while landing is not known.

Knee Axial Rotation

Santos et al[20] measured knee internal rotation motion during two trunk rotation tasks. The authors found that in a trunk rotation task in which the subject is unable to compensate with the upper extremity, subjects demonstrated significantly greater internal rotation when wearing an Active Ankle® brace than when not wearing a brace. Investigation of internal rotation about the knee when wearing ankle braces is important, because increased rotation would mean increased stress to knee ligaments and other connective tissue, thus increasing the risk of injury.[20] Knee axial rotation was not measured in taped subjects in the studies included in this review. In this single study, those wearing a commonly worn ankle brace experienced increased knee internal rotation, although wider conclusions cannot be made without further studies.

Limitations

The first notable limitation of our review was the limited number of studies that were ultimately included. Therefore, before firm conclusions related to the effect of ankle bracing or taping on the kinematics and kinetics at the knee can be reached, additional research is necessary.

A second limitation of this review is that the studies included used different braces. Further research is needed to investigate how different types of braces (lace-up, soft, semi-rigid, rigid) compare with one another in each of these biomechanical parameters.

The third limitation of this review, and the articles included in it, is that they only investigated healthy subjects. While many healthy subjects do use bracing or taping, bracing and taping are also very commonly used following acute and chronic injuries. Additional research is needed to determine whether the biomechanical impact of bracing and taping is the same in the injured population.

Finally, before a clinical decision can be made as to whether the use of ankle taping or ankle bracing increases a subject's risk for knee injury during sporting tasks, more research is necessary to determine a critical threshold for each biomechanical variable that leads to an increased risk of injury. This review did not include knee injury as an outcome. Further research is necessary to determine whether ankle taping or bracing produces an increased injury rate at the knee.

Table 3. Summary of Methods and Results of Included Studies

Measured Variable	Author	Test Condition	Study Population
Knee Flexion Excursion	Hodgson et al[21]	0.61 m drop-jump, flat surface	12 division-I female volleyball players, mean age = 19.83 yrs (±1.7 yrs)
	Cordova et al[19]	0.31m, step off, flat surface	13 male recreational basketball players, mean age = 22.3 yrs (± 2.2 yrs)
	DiStefano et al[17]	Forward jump from 0.3m box, to flat surface	22 male and 20 female recreational basketball or volleyball players, playing at least 3x/week, mean age (not given). Age range = 18-22 yrs
Initial ground contact knee angle (sagittal-plane)	DiStefano et al[17]	Forward jump from 0.3 m box, to flat surface	22 male and 20 female recreational basketball or volleyball players, playing at least 3x/week, mean age (not given). Age range = 18-22 yrs
Peak internal rotation moment	Stoffel et al[4]	45°side-step (planned)	22 male elite or semi-pro Australian Rules Football players, mean age = 22.1 yrs (± 2.3 yrs)
		45°side-step (unplanned)	
		Running (planned)	
		Running (unplanned)	
Peak external rotation moment	Venesky et al[18]	0.3m drop-jump onto 20° slant board	12 male and 12 female physically active college students, participating in at least 3 days/week of exercise, mean age = 21.7 yrs (± 2.6 yrs)
Peak valgus moment	Stoffel et al[4]	45°side-step (planned)	22 male elite or semi-pro Australian Football players, mean age = 22.1 yrs (± 2.3yrs)

Abbreviations: deg, degree; m, meter; Nm, newton meter; SEM, standard error of mean; SD, standard deviation

Tape/Brace	Mean	SD or SEM	Significance
No support	21.97°	SEM=1.88	
Brace (Active Ankle T2)	20.75°	SEM=1.38	Not significantly different from no support (p = 0.266)
No support	45.1°	SD=9.0	
Tape (basket weave)	43.8°	SD=8.7	No significant difference (p value not reported)
Brace (McDavid Ultra, semi-rigid)	42.6°	SD=6.8	Significantly less than no support (p < 0.05)
No support	82.0°	SD=16	
Brace (ASO Ankle Brace)	79.0°	SD=16	Significantly less than no support (p = 0.04)
No support	9.0°	SD=9	
Brace (ASO Ankle Brace)	12.0°	SD=9	Significantly greater than no support (p = .0001)
No support	26.9 Nm	SD=19.3	
Tape	22.0 Nm	SD=9.8	Significantly less than no support (p < 0.001)
No support	31.6 Nm	SD=21.0	
Tape	25.9 Nm	SD=11.3	Significantly less than no support (p < 0.001)
No support	20.8 Nm	SD=12.8	
Tape	15.8 Nm	SD=12.5	Significantly less than no support (p < 0.001)
No support	19.0 Nm	SD=19.4	
Tape	12.9 Nm	SD=12.8	Significantly less than no support (p < 0.001)
No support	20.4 Nm	SD=8.2	
Brace (Active Ankle T2)	22.0 Nm	SD=8.6	Knee ER significantly greater than no support (p < 0.05)
No support	56.0 Nm	SD=41.0	
Tape	65.8 Nm	SD=52.0	No significant difference (p = 0.056)

(Continued on page 174)

Table 3. Summary of Methods and Results of Included Studies *(Continued from page 173)*

Measured Variable	Author	Test Condition	Study Population
	Venesky et al[18]	0.3 m drop-jump onto 20° slant board	12 male and 12 female physically active college students, participating in at least 3 days/week of exercise, mean age = 21.7 yrs (± 2.6 yrs)
Peak varus moment	Stoffel et al[4]	45°side-step (planned)	22 male elite or semi-pro Australian Football players, mean age = 22.1 yrs (± 2.3 yrs)
		45°side-step (unplanned)	
		Running (planned)	
		Running (unplanned)	
Knee internal rotation	Santos et al[20]	1-leg stance, turn trunk to catch ball	4 males and 6 females, that had never used an ankle brace previously, mean age = 26.4 yrs (no SD provided)
		1-leg stance, turn w/ arms at side to hit target w/ shoulder	

Abbreviations: deg, degree; m, meter; Nm, newton meter; SEM, standard error of mean; SD, standard deviation

CONCLUSION

Overall, the results of this review are mixed with a slight bias towards an alteration in knee biomechanics during sporting activities. While the studies in this review used a variety of braces, the Active Ankle® brace was the most commonly used, being adopted in 3 of the 5 studies. This brace has been shown previously to be effective in limiting inversion and eversion at the ankle while still allowing plantar flexion and dorsiflexion due to its hinge being located at the level of the malleoli. The Active Ankle® brace was found during a variety of sporting tasks to significantly increase knee external rotation moment and internal rotation moment, while not significantly altering knee flexion angle or peak valgus moment. No other brace was used across multiple studies in this review. Taping was performed in two of the studies and was shown not to impact knee flexion excursion during drop jumps, but it did decrease both peak varus moment and peak internal rotation moment during side-stepping and running tasks, whether these movements were planned or not.

APPLICATION

The combination of anterior translation of the tibia generated by active muscle contraction and increased moments at the knee during running, cutting, and jump landings is believed to be responsible for the increased risk to the ACL. With known biomechanical parameters leading to increased injury risks, a braced or taped condition that increases any of these parameters could potentially increase the risk for non-contact knee injury during sporting tasks.

Tape/Brace	Mean	SD or SEM	Significance
No support	-91.7 Nm	SD=28.3	
Brace (Active Ankle T2)	-86.7 Nm	SD=25.0	No significant difference (p = 0.08)
No support	82.4 Nm	SD=70.0	
Tape	78.0 Nm	SD=42.2	Significantly less than no support (p = 0.015)
No support	70.0 Nm	SD=41.8	
Tape	64.1 Nm	SD=38.4	Significantly less than no support (p = 0.02)
No support	79.7 Nm	SD=45.1	
Tape	71.0 Nm	SD=52.7	Significantly less than no support (p < 0.001)
No support	75.3Nm	SD=49.7	
Tape	68.1 Nm	SD=41.5	Significantly less than no support (p < 0.001)
No support	20.9°	SD=8.9	
Brace (Active Ankle)	16.8°	SD=12.9	No significant difference (p value not reported)
No support	14.86°	SD=9.4	
Brace (Active Ankle)	21.34°	SD = 12.13	Significantly greater than no support (p < 0.05)

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Trigger Point Dry Needling for Musculoskeletal Pain and Disability: A Systematic Review of Comparative Effectiveness Research

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ABSTRACT

Background: Dry needling (DN) has been proposed to reduce pain and improve function related to myofascial trigger points (MTrPs). Several primary studies and systematic reviews have been conducted to examine the effect of DN versus placebo. However the comparative effectiveness of DN and established interventions has yet to be established. **Purpose:** The purpose of this systematic review was to determine whether DN was more effective than other established therapies to treat MTrPs. **Data Sources:** MEDLINE Complete, EBSCO, CINAHL, SportDiscus and Cochrane library databases were searched. **Study Selection:** Randomized controlled trials that used DN directed to MTrPs and used at least one other intervention method were included. Studies that had a placebo or sham group were excluded. **Data Extraction:** Of 394 records screened, 8 studies met the established criteria. The quality of each study was assessed using the PEDro scale. **Data Synthesis:** When DN was compared to standard therapy programs, 3 of the 4 studies found that DN was more effective in reducing pain and 1 found no difference. When DN was compared to stretching, DN reduced pain more effectively. Dry needling was not significantly more effective than high-power pain threshold ultrasound (US), laser, nonsteroidal antiinflammatory drugs, and percutaneous electrical nerve stimulation (PENS). **Limitations:** Included studies were relatively small and some lacked sound methodology. **Conclusions:** The results are mixed on the effectiveness of DN over standard rehab. More large scale, high quality studies are needed before definitive decisions can be made about the role of DN in physical therapy practice.

INTRODUCTION

Myofascial trigger points (MTrPs) are palpable,[1] hyperirritable[1] localized areas of tenderness within taut bands of skeletal muscle, which may be commonly associated with musculoskeletal pain.[2,3] When MTrPs are compressed it can lead to local tenderness, referred pain[2] and can also produce a local twitch response (LTR), or muscle fasciculation.[3] There are two main types of MTrPs: active and latent. Active MTrPs are active without any external elicitation and produce both local and referred pain and can lead to local muscle weakness.[3,4] Active MTrPs are the main source of pain, while latent MTrPs do not produce symptoms unless externally elicited, such as by pressure.[4]

The exact pathology of MTrPs is unknown,[5] and their clinical evaluation and relevance is still quite controversial.[2] Although the exact physiology of these MTrPs is unknown, the underlying cause of MTrPs can be from a variety of sources including poor muscle balance, poor posture, overuse, or a direct injury.[6] Because MTrPs are prevalent in patients presenting with musculoskeletal pain,[4] there are a variety of interventions that have been established as common practice including stretching, spray and stretch, ultrasound, transcutaneous electrical nerve stimulation, laser therapy, injection of local anesthetic and dry needling (DN).[4,6] Dry needling is an technique involving insertion of a fine needle into specific MTrPs without the use of any medication.[4] The use of DN is thought to help in the reduction of pain derived from MTrPs by providing a localized stretch to the shortened sarcomeres.[8] This helps the sarcomeres to reset to their resting length thus reducing the taut bands of skeletal muscle and reduce the pain related to MTrPs.[8] It is also thought that DN can help with hypoxia by causing an increase in skin and muscle blood flow from the needle insertion itself. Dry needling can also help with pain reduction by stimulating A-delta nerves, which can lead to opioid mediated suppression of pain.[8]

A growing body of placebo-controlled literature supports the effectiveness of DN compared to sham needling. In a systematic review by Kietrys et al[9] in 2013, the authors examined the current literature for studies that compared DN to sham or placebo or other interventions. Based on the evidence, the authors concluded that DN is recommended compared to a sham or placebo intervention for the reduction of pain in the treatment of upper quarter myofascial pain syndrome. Three of the articles the authors examined showed positive results in favor of DN over sham or placebo for immediate pain reduction and two of the articles examined showed results in favor of DN over sham or placebo for reduction in pain at 4 weeks postintervention. However comparative effectiveness studies are less common and no systematic reviews showing only the comparative effectiveness literature have been published. Although DN may show effectiveness over sham needling in some studies,[7] results are still mixed in this area. Dunning et al[10] state that several studies that use the in-and-out technique of DN have shown some benefit in pain relief. However, the authors also point out that no high-quality, long-term studies support the use of DN. Perhaps most notably, the comparative effectiveness of DN relative to other interventions has yet to be summarized. The purpose of this systematic review was to assess the methodological quality of the comparative effectiveness literature involving DN in order to determine the relative clinical benefit of this emerging intervention.

METHOD

Data Sources and Searches

Relevant randomized controlled trials were identified by searching MEDLINE complete, CINAHL Plus with Full Text, and SPORTDiscus with Full Text with the search terms DN and randomized controlled trials, and DN and the publication type set to randomized controlled trials. Articles were last searched on October 24, 2014. Abstracts were reviewed, and if needed, full text were obtained to make decisions about articles that fit the above identified inclusion and exclusion criteria.

Study Selection

Types of Studies. Randomized controlled trials that used the technique of DN and at least one other comparison group were included. In addition the articles had to describe a study of DN directed to MTrPs. Articles were excluded if they were not printed in English.

Types of Participants. The participants in the trials had to have an identified area of an MTrP in order to be included in this study, no restrictions were made based on age or gender.

Types of Interventions. In order to be included, the trials must have an included: (1) the intervention of DN and (2) another type of intervention that was targeted at treating these identified MTrP. In addition the articles could not use a sham or placebo DN.

Types of Outcomes Measures. Trials were used that included a dependent variable measurement involving pain as an outcome measure, in order to create a basis for uniform comparison across studies. Other outcome measures used in the articles were taken into consideration as well and examined, however, the only requirement was to have at least one outcome measure that addressed pain.

Data extraction and assessment

Two authors worked on the article collection and data extraction. The review was not blinded to any of the information including the journal, author, or outcome measures. The PEDro scale was used to assess the methodological quality of the studies used. Article scores were obtained from the PEDro database when available. When no scores were available, authors used the PEDro scale to rate the article by consensus.

Data synthesis and analysis

No meta-analysis synthesis was used on the data collected from these articles. In this case, the dependent variable measurements were heterogeneous enough among the few included studies, and so a narrative literature synthesis was conducted rather than a meta-analysis.

RESULTS

The literature search originally revealed 394 articles through the databases used and through screening and the use of the inclusion and exclusion criteria, 8 articles were ultimately deemed appropriate for inclusion (Figure 1). These articles examined the effects of DN versus various other intervention options including manual therapy, stretching, high-powered ultrasound (US), non-steroidal anti-inflammatory drugs (NSAIDs), and standard rehabilitation therapy. In addition, these articles used different outcome measures that focused on pain, range of motion, electromyography (EMG), sleep quality, and patient-reported outcomes (Table 1).

Outcome Measure: Pain

Ziaeifar et al[8] compared manual therapy MTrP release by a therapist to DN (Table 2). The outcome measures were taken before the treatment sessions and after one week. In the DN group, needling was performed repeatedly until there were no more LTRs. In the manual therapy group, the therapist applied gradually increasing pressure to the MTrP until the tension and the tenderness in the MTrP was released. The results from this study showed that both the standard intervention group and the experimental group significantly improved after intervention when compared to before intervention measurements in both the visual analogue scale (VAS) and the pressure algometer. In addition, there was also a significant between group difference in regards to pain intensity as measured by the VAS but not in regards to the pressure algometer. These results show that both the standard intervention and the DN significantly reduced pain intensity, however, the DN did in fact have more of an effect on reducing pain intensity than the standard intervention.

In a study done by DiLorenzo et al, 101 patients were randomized to receive either the clinic's standard rehabilitation therapy alone or therapy combined with DN[11] (see Table 2). The outcome measurements were taken on day 1 and then again 24 hours after every subsequent intervention for the DN group. The measurements for the standard group were taken on day 1 and then on days 9, 15, and 21. The results showed that VAS scores improved significantly for both groups at the first measurement period; in addition, there was a significant between group difference in favor of DN. For the next measurement period, the DN group showed significant improvement but the standard group did not, and there was a significant between group difference in favor of DN. For the last group measurement period, both groups again showed a significant VAS score improvement, and again there was a significant between group difference in favor of DN. These results would suggest that DN was more effective than the standard intervention at reducing pain. However, it is unclear from the results presented if the between group comparisons are in fact for the same time period because different data recording periods were used for both groups. In addition, it is unclear if the significant improvement that the DN group made for every measurement period was the result of comparing the new measurement to the baseline or to the previous session's measurement. While it does appear that DN made significant improvements in pain reduction, it is difficult to compare these results to the standard rehabilitation procedure without knowing this additional information.

Bahadir and colleagues[12] completed a small study (n=20) that randomly assigned patients to receive either DN or high–power pain threshold ultrasound (HPPTUS; see Table 2). Both groups received EMG evaluations. The HPPTUS group therapy was repeated two times followed by stretching. After the EMG evaluation, the DN group had the intervention applied and then rested before performing stretching. Both groups were instructed to continue stretching at home. All reported outcome measures were taken before the intervention, after a 30-minute rest, after the intervention was performed for the HPPTUS group, 1 hour after the original EMG evaluation in the DN group, and then again 5 days after the original EMG measure. The results from this study in regards to pain showed that there was a significant decrease in VAS scores in the HPPTUS at the initial-immediate assessment and the initial-last assessment, and there was a significant decrease in the DN group at the initial-last assessment but not the initial-immediate assessment. These results suggest that the HPPTUS was more effective than DN in reducing pain in the short term (immediately after intervention), but not after a delayed amount of time (5 days postintervention).

Pérez-Palomares and colleagues[13] conducted a study that randomly assigned 121 patients with low back pain patients to receive either percutaneous electrical nerve stimulation (PENS) to DN (see Table 2). The PENS group received 9 treatment sessions and the DN group received treatment for 3 sessions. The VAS pain and quality of sleep were mea-

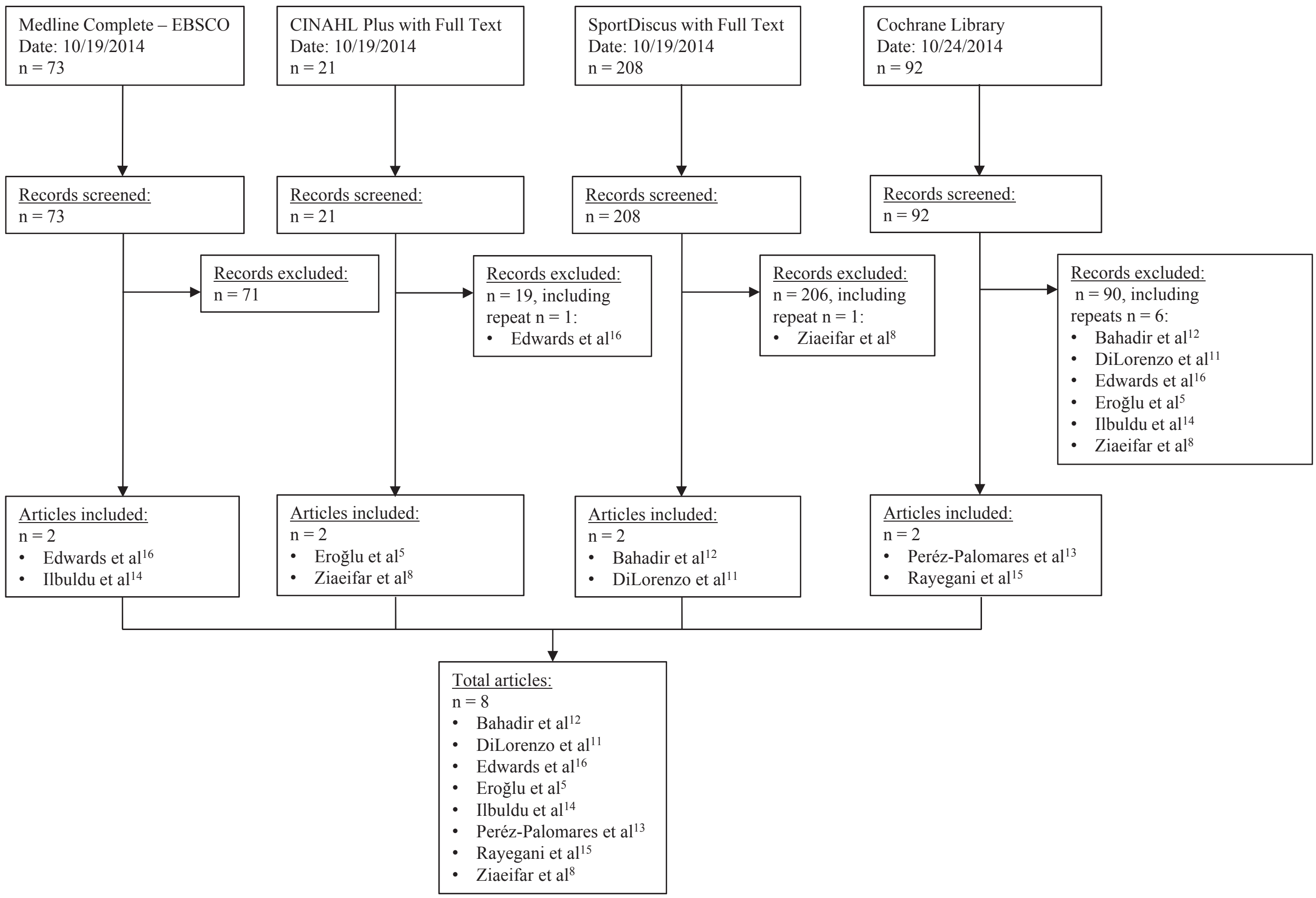

Figure. Search results.

Table 1. Outcomes Measures in Included Studies

Author	Outcome Measure
Eroğlu et al[5]	• Pain: Visual Analog Scale (VAS) Pain Pressure Threshold (PPT)-algometer) • Quality of Life Scale (Nottingham Health Profile) • Range of Motion (Active ROM neck: flexion, extension, bilateral lateral flexion, bilateral rotation/ shoulder: abduction, adduction, flexion, extension, internal and external)
Ziaeifar et al[8]	• Pain (VAS, PPT-algometer) • Disabilities of Arm, Shoulder and Hand (DASH)
DiLorenzo et al[11]	• Pain (VAS) • Quality of life, Functional Mobility (Rivermead Mobility Index) • Sleep Questionnaire to address daytime rest & sleep quality
Bahadir et al[12]	• Pain (VAS) • EMG • ROM (Active ROM lateral flexion)
Pérez-Palomares et al[13]	• Pain (VAS, PPT-algometer) • Sleep quality (VAS) • Quality of life (Oswestry Disability Index)
Ilbuldu et al[14]	• Pain Intensity (VAS, analgesic usage, algometer) • Cervical ROM (Flexion, extension, bilateral rotation, bilateral lateral flexion) • Quality of life (Nottingham Health Profile)
Rayegani et al[15]	• Pain (VAS, algometer) • Quality of life (SF 36)
Edwards et al[16]	• Pain (Short form McGill Pain Questionnaire, included a VAS, PPT-algometer)

sured at the beginning, before the second DN and sixth PENS interventions, and at the end of therapy. Algometry and quality of life were measured only at the beginning and end of intervention. The results found that in regards to pain, when the initial VAS score was subtracted from the final score there was no significant difference between the groups. In addition, when algometry difference was found, again by calculating the initial minus the final assessment, there was no significant difference between any of the body regions measured between the groups. These results suggest that there is no difference in pain results between the therapies of PENS and DN, suggesting DN is no more effective than PENS. However, it is possible that the PENS could in essence act in a somewhat similar fashion to DN as the needle is inserted below the skin in order to apply the electrical current. This insertion of the needle could potentially serve the same purpose as when the needle is inserted in the technique of DN.

Eroğlu et al[5] also conducted a study of 60 subjects that examined DN, comparing it to oral flurbiprofen and lidocaine injection (Table 2). Measurements for VAS pain, algometry, neck range of motion and patient-reported outcomes were taken pr-intervention and on the third and fourteenth days of intervention. The patients in the oral flurbiprofen group were given 100 mg tablets 2 times per day for 7 days. The patients in the lidocaine group and DN were given the same needling procedure except the lidocaine group also received an injection of 0.2 ml of 2% lidocaine solution through the needle. In addition, all of the patients were given a home exercise program (HEP) and instructed to follow it. The authors[5] found that all groups showed significant improvement in algometry and VAS pain, and in addition, there was no significant between group differences for any of the outcome measures. These results show that DN was no more effective than oral flurbiprofen or lidocaine injection in reducing pain associated with MTrPs.

A study by Ilbuldu et al[14] compared the effectiveness of DN to that of laser and placebo laser. In this study, 60 patients were randomized into DN, laser, or the placebo laser group (Table 2). The DN group received 4 intervention sessions, and the laser group received treatment for 12 sessions. The placebo group received probe intervention with the machine turned on and set but no beam applied. In addition all the groups received instruction in stretching and were required to exercise regularly. Patients were also given paracetamol tablets as needed for pain and the number of tablets used throughout the study was recorded. Outcome measures included VAS pain scale, algometry, cervical ROM, and the Nottingham health profile. Measurements were taken preintervention, postintervention (4 weeks), and at a 6-month follow-up. The results for pain showed that the VAS pain for rest and activity decreased in all groups postintervention and at the 6-month follow-up. In addition, there was a significant between group difference in favor of the laser group at the postintervention measurement for VAS rest and activity but this disappeared at the 6-month follow-up. In regards to algometry, there was a significant between group difference in favor of the laser group for pain threshold at the postintervention measure but again this disappeared at the 6-month follow-up. There was no difference for pain tolerance between any of the groups. The analgesic usage was also shown to be significantly less in the laser group postintervention, but again, not at the 6-month follow-up. These results suggest that laser is more effective than DN at reducing many aspects of pain postintervention in the short term but not in the long term (6-month follow-up).

Rayegani et al[15] conducted a study where 28 subjects were randomly assigned to receive either DN or physiotherapy (see Table 2). The DN group consisted of a session of needling, and afterwards patients were advised to apply ice and Capsaicin cream. The physiotherapy group had 10 sequential sessions of therapy that included superficial heat, TENS, US, and upper trapezius (UT) stretching by a therapist. In addition, both groups were instructed to stretch daily for a month. Outcome measures, VAS pain, algometry, and the SF-36 questionnaire, were taken preintervention and one week and one month after the last intervention session. The results in regards to pain showed that at the one week follow-up there was significant reduction in rest, night and activity pain in both the physiotherapy and DN groups. In addition, there was a significant increase in pain pressure threshold as measured through algometry in both groups as well. There were no significant differences between groups. At the one month follow-up, there was again a significant reduction in activity, rest and night pain; a significant increase in pain pressure threshold in both groups; and there was no significant difference between groups. These results show that while both interventions are effective in reducing pain in subjects with myofascial pain syndrome, there is no difference between DN and physiotherapy in regards to pain reduction; thus DN is no more effective than physiotherapy in reducing pain.

A study by Edwards et al,[16] randomly assigned 40 patients into 3 groups of 13 or 14 subjects to receive either DN and active stretching, stretching alone, or no intervention (Table 2). The outcome measures (the Short Form McGill Pain Questionnaire (SFMPQ) and algometry) were measured preintervention, after 3 weeks, then 6 weeks from the commencement of intervention. Participants in the DN group received a varying number of DN sessions. After needling, stretching was performed and patients were instructed to continue these stretches at home. The patients in the stretching group received instruction in stretching exercises and were instructed to continue these at home. The results showed that there was no significant difference between groups at the 3-week measurement. However, at the 6-week measurement, the DN and stretching group showed significantly improved scores on the SFMPQ compared to the no intervention group and significantly improved pain pressure threshold compared to the stretching alone group. These results suggest that DN is more effective than stretching alone at reducing pain pressure threshold; however, the fact that there is no significant difference in the SFMPQ suggests that DN has a limited role in reducing pain over stretching alone.

Outcome Measure: Electromyography

In 20 subjects, Bahadir et al[12] compared DN to HPPTUS. This was the only study reviewed that used EMG activity as an outcome measure (see Table 2). The number of LTRs in the HPPTUS group decreased significantly both from initial EMG measurement (taken before intervention), immediate EMG measurement (taken after the intervention on the same day), and final EMG measurement (taken on the fifth day). The number of recordings of spontaneous electrical activity (SEAs) decreased significantly from the initial to immediate assessment but not from the initial to the final assessment. In the DN group, the number of LTRs and SEAs did not decrease significantly from the initial to the immediate assessment or from the initial to the final assessment. While the HPPTUS group did experience a more significant reduction in LTRs and SEAs than the DN group, it is possible that the EMG needle insertion itself may have had a similar effect to DN. In addition, the number of sessions of HPPTUS carried out was greater than that of DN, which could also account for this discrepancy.

Table 2. Summary of Findings for Included Studies

Study	Type of Study	Evidence Rating	Conditions	Sample Characteristics
Ziaeifar, Arab, Karimi, & Nourbakhsh[8]	Randomized Controlled Trial	4/10	3 times/week for 1 week, for both the treatment (TCT) and the experimental group (Dry Needling or DN).	33 patients with myofascial trigger point MTrP in the upper trapezius (UT) muscle. Intervention group: 17 participants mean age 26.5 ± 8.57, mean weight 56 ± 5.92 kg, mean height 163.7 ± 4.49 cm. Experimental group: 16 participants, mean age 30.06 ± 9.87, mean weight 60.37 ± 6.96 kg, mean height 165.3 ± 7.56 cm.
DiLorenzo, Traballesi, Morelli, Pompa, Brunelli, Buzzi, & Formisano[11]	Randomized Controlled Trial	6/10	Both DN and standard rehabilitation groups, received standard rehabilitation therapy. The DN group received 4 sessions of DN, each 5-7 days apart.	101 patients that were post-cerebrovascular accident (CVA) and were experiencing shoulder pain on the hemi-paretic side due to MTrP, 54 patients in DN group and 47 patients in control group. Mean age DN group 69.56 ± 6.21, control group 67.43 ± 9.05. Gender males: females DN group 14:40, control group 14:33. Post stroke mean duration (weeks) DN group 3.50, control group 3.57.
Bahadir, Majlesi, & Unalan[12]	Randomized Controlled Trial	2/10	3 consecutive days for the High-powered pain threshold ultrasound (HPPTUS) group and then home stretching exercises for 2 consecutive days, and 1 treatment and 4 consecutive days of home stretching exercises for the DN group.	23 female patients with MTrP in the UT muscle (3 participants dropped out so only 20 finished the study).
Rayegani, Bayat, Bahrami, Raeissadat, & Kargozar[15]	Randomized Controlled Trial	4/10	DN group consisted of 1 session followed by 1 month of home stretching program. Physiotherapy group consisted of 10 sequential sessions of superficial heat, Transcutaneous Electrical Nerve Stimulation (TENS) Ultrasound (US), UT stretching by a therapist and 1 month of home stretching program.	28 participants with MTrP in the UT muscle. DN group 14 participants, mean age 32 ± 10. Physiotherapy group 14 participants, mean age 38.6 ± 4.2
Ilbuldu, Cakmak, Disci, & Aydin[14]	Randomized Controlled Trial	6/10	3 Laser sessions/week for 4 weeks and home stretching program for Laser group. 3-placebo Laser sessions/week for 4 weeks and home stretching program for placebo group. 1 session/ week for 4 weeks and home stretching program for dry needling group.	60 females between the age of 18-50 with MTrP in UT muscle, mean age placebo group 32.35 ± 6.88, DN 35.29 ± 9.18, Laser 33.90 ± 10.36

Outcome Measures	Important Results
Pain intensity: Visual Analog Scale (VAS), Pain Pressure Threshold (PPT), Disability of the Arm, Shoulder and Hand (DASH) questionnaire	There was a significant difference from pretreatment to posttreatment for VAS, PPT, & DASH for both TCT (P = 0.000, 0.001, & 0.006 respectively) & DN (P = 0.000, 0.000, & 0.001 respectively). In addition there was a significant difference between DN & TCT group posttreatment for the VAS (P = 0.01) but not for PPT or DASH.
Pain (VAS), duration of hospitalization, Functional Mobility (Rivermead Mobility Index), Sleep Questionnaire to address daytime rest & sleep quality	H^0= baseline VAS scores. H^1, H^+ and H^3 = subsequent VAS assessments. VAS pain scale decreased significantly for the DN group from entry throughout each successive measurement, P-values H^1 <0.001, H^+ 0.005, H^3 0.05; however for the standard rehabilitation group the VAS scores were significant for H^1 and H^3 both with a P = 0.05, but H^+ did not have a significant reduction with a P = 0.25. In addition there was a significant between group difference for each time period, H^1 P <0.001, H^+ P <0.001, and H^3 P <0.001. Sleep questionnaire reported that the DN group had 85.19% of the participants responds yes to question 1 (did you rest well in wheelchair or bed during the last 2 weeks?) and 68.08% of the standard rehabilitation group responded yes as well, with a P = 0.034. In addition 92.59% of the DN group and 74.47% of the standard rehabilitation group responded yes to question 2 (did you sleep well during the last 7 nights?) with a P = 0.039. RMI effectiveness [100 x (discharge scale score – initial scale score)/(maximum scale score – initial scale score)] for DN group was 50.01% ± 15.38% and for standard rehabilitation was 47.54% ± 17.34%.
Pain (VAS), Electromyography (EMG), Range of Motion (ROM), (Active ROM lateral flexion)	There was a significant decrease in VAS for HPPTUS from initial to immediate assessment and initial to last assessment (P = 0.007 & 0.005). For the DN group there was only a significant decrease from the initial to last assessment but not the initial to immediate assessment (P = 0.007 & 0.785). There was a significant improvement in ROM for HPPTUS from initial to immediate and initial to last assessment (P = 0.011 & 0.007). However, for the DN group there was only a significant decrease from the initial to last assessment but not the initial to immediate assessment (P = 0.005 & 0.783). There was a significant difference for LTR from initial to immediate and initial to last assessment for HPPTUS (P = 0.009 & 0.015), but none for the DN (P = 0.160 & 0.129). There was a significant difference only for initial to immediate assessment for HPPTUS not the initial to last (P = 0.016 & 0.123) and none for DN (P = 0.109 & 0.564). In addition there was a significant between group difference in favor of the HPPTUS for VAS (P = 0.009) and number of LTRs (P = 0.015) but not for ROM (P = 0.136) or number of SEAs (P = 0.123)
Pain (VAS & algometer), Quality of life (SF-36)	There was a significant reduction in rest, night, & activity pain in the physiotherapy and DN group at the 1 week follow-up, as well as significant increase in PPT. For the SF-36 scale at 1 week in the physiotherapy group there was significant improvement in social functioning, role limitation due to physical problems and physical functioning (P <0.05) but no significant changes in vitality, role limitation due to emotional problems, general health, and mental health. For the DN group no significant changes were observed in the SF-36 scale. At 1 month follow-up both groups had significant decrease in activity, rest and night pain and significant increase in PPT, bodily pain, physical functioning, role limitation due to physical problems and social functioning (P <0.05. There were no significant between group differences for any of the outcomes (P >0.1).
Pain Intensity (VAS, analgesic usage, algometer), Cervical ROM (Flexion, extension, bilateral rotation, bilateral lateral flexion), Functional status (Nottingham Health Profile)	Decrease in rest and activity subgroups of VAS at posttreatment. Significant decrease VAS rest (P < 0.05) and activity (P = 0.001) in laser group compared to DN and placebo groups at posttreatment, but this disappeared at the 6 month follow-up. Significant increase in pain threshold in laser compared to DN and placebo (P < 0.001) at the posttreatment, but again this disappeared at the 6-month follow-up. Significant difference in analgesics used, fewer in laser group (P < 0.05) at post treatment, but not at 6-month follow-up (P > 0.05). Significant increase in flexion at posttreatment in DN & laser groups, but no difference at the 6-month follow-up (P >0.05). Significant increase in extension in laser group compared to DN and placebo group (P < 0.001), but no difference at the 6-month follow-up (P > 0.05). There were no differences in rotation. Significant difference in right and left lateral flexion in laser group compared to DN and placebo group (P < 0.001 & < 0.01) at post treatment, but not at 6-month follow-up. For the Nottingham Health Profile, there was a significant difference in pain and physical activity subgroups at posttreatment (P < 0.001 & < 0.05) for laser compared to DN and placebo groups, but this disappeared at the 6-month follow-up. There were no other significant differences in any of the subgroups in the Nottingham Health Profile.

(Continued on page 184)

Table 2. Summary of Findings for Included Studies *(Continued from page 183)*

Study	Type of Study	Evidence Rating	Conditions	Sample Characteristics
Edwards & Knowles[16]	Randomized Controlled Trial	6/10	DN group received a stretching home exercise program (HEP) and a varied amount of DN sessions over a 3-week period depending on patient condition and convenience of patient and therapist (mean number treatment sessions 4.6). Stretching group received a HEP in stretching and performed this program for 3 weeks and received follow up sessions to check up on stretching form (mean number treatment session 2.9). In addition the DN and stretching group received instruction in posture. After the 3 weeks of intervention, both groups had a 3-week period of no intervention. The control group received no treatment.	40 subjects aged 18 and over and with identifiable MTrP. Mean age DN group 57 ± 12, Stretch group 55 ± 17, control group 57 ± 19.
Eroğlu, Yilmaz, Bodur, & Ates[5]	Randomized Controlled Trial	7/10	All groups received instruction in a stretching HEP. The DN group received 1 session of DN, the LI group received needling and injection of lidocaine, and the OF group received 2x100mg/day tablets of oral flurbiprofen for 7 days.	60 patients, 7 males & 53 females. Mean age DN group 33.75 ± 8.10, LI group 32.85 ± 9.06, OF group 34.55 ± 8.30.
Pérez-Palomares, Olivan-Blazquez, Magallon-Botaya, De-la-Torre-Beldarrain, Gaspar-Calvo, Romo-Calvo, Garcia-Lazaro, & Serrano-Aparicio[13]	Randomized Controlled Trial	5/10	Percutaneous Electrical Nerve Stimulation (PENS) group received 9 sessions, 3 sessions (lasting 30 minutes) per week on alternate days for 3 weeks. DN group received 3 sessions, 1 per week with at least an 8-day latent period between sessions, for 3 weeks. Each session was followed by the spray and stretch technique, where each muscle was passively stretched in 3 sequences and vapocoolant spray was applied to the pain reference zone in 3 sweeps for each sequence.	122 patients, 91 females & 31 males. PENS group and DN group percentages: gender male 18.8% & 32.8% respectively, female 81.3% & 67.2% respectively (P-value 0.08); age less than 40 34.4% & 50.0% respectively, 40-60 45.3% & 31.0% respectively, greater than 60 20.3 % & 19.0& respectively (P-value 0.18).

Outcome Measure: Range of Motion

Three studies examined ROM as an outcome measure (see Table 2). Bahadir and colleagues[12] examined ROM in the cervical region in a group of 20 subjects. The results from this study[11] show that the HPPTUS group had significant improvement in ROM from preintervention to immediately postintervention, but the DN group did not. In addition, both groups showed significant improvement in ROM from initial intervention to 5 days postintervention. These results suggest that both interventions can be helpful in increasing ROM in cervical lateral flexion after an extended period (5 days), but only HPPTUS shows immediate improvements. However, both of these groups underwent an EMG evaluation that involved needle insertion, which could in essence behave like DN.

Eroğlu et al[5] also conducted a study with 60 subjects using ROM as an outcome measure. The results from this study showed that the neck ROM for lateral flexion and rotation increased significantly on the third and fourteenth days in all groups, regardless of intervention. In addition the authors found there was no between group difference.[5] These results suggest that DN is no more effective than the previously established interventions of NSAIDs (oral flurbiprofen) or lidocaine injection.

One other study that met the search criteria was included for review. This study was done by Ilbuldu et al[14] where the effectiveness of DN was compared to that of laser and placebo laser. The results showed that there

Outcome Measures	Important Results
Pain: Short- Form McGill Pain Questionnaire (SFMPQ), PPT-algometer)	No significant difference between groups at 3 weeks after trial started. At 6 weeks after trial started, the DN group was significantly different compared to the control group in SFMPQ (P = 0.043), and was significantly different compared to the stretch group in PPT scores (P = 0.011). There was a significant difference in PPT and SFMPQ in the DN group.
Pain (VAS), Quality of Life Scale (Nottingham Health Profile [NHP]), ROM (AROM neck: flexion, extension, bilateral lateral flexion, bilateral rotation/ shoulder: abduction, adduction, flexion, extension, IR, ER)	Treatment: Algometric Sensitivity F_n 0.58, P-value 0.55, VAS-pain score F_n 2.073, P-value 0.13, Lateral Flexion right F_n 0.854, P = 0.42, Lateral Flexion left F_n 1.29, P = 0.27,Roation right F_n 2.174, P = 0.11, Rotation left F_n 1.92, P = 0.14. Time: Algometric Sensitivity F_n 108.28, P <0.001, VAS-pain score F_n 73.97, P<0.001, Lateral Flexion right F_n 38.74, P <0.001, Lateral Flexion left F_n 26.83, P-value <0.001, Rotation right F_n 23.76, P <000.1, Rotation left F_n 17.30, P <0.001. Interaction: Algometric Sensitivity F_n 1.22, P = 0.29, VAS-pain score F_n 0.41, P = 0.76, Lateral Flexion right F_n 0.685, P = 0.56, Lateral Flexion left F_n 0.55, P-value 0.67, Rotation right F_n 0.40, P = 0.79, Rotation left F_n 0.70, P = 0.56. Nottingham Health Profile: Treatment: NHP-pain F_n 0.67, P = 0.49, NHP-physical activity F_n 0.02, P = 0.97, NHP-fatigue F_n 1.13, P = 0.32, NHP-sleep F_n 1.91, P = 0.14, NHP-social isolation F_n 1.76, P = 0.30, NHP-emotional reactions F_n 0.83, P = 0.42. Time: NHP-pain F_n 53.79, P <0.001, NHP-physical activity F_n 27.00, P <0.001, NHP-fatigue F_n 34.10, P <0.001, NHP-sleep F_n 38.23, P <0.001, NHP-social isolation F_n 5.99, P = 0.002, NHP-emotional reactions F_n 39.35, P<0.001. Interaction: NHP-pain F_n 0.17, P = 0.93, NHP-physical activity F_n 0.73, P = 0.56, NHP-fatigue F_n 3.06, P = 0.02, NHP-sleep F_n 1.78, P = 0.13, NHP-social isolation F_n 1.33, P = 0.25, NHP-emotional reactions F_n 1.38, P = 0.23.
Pain (VAS, PPT-algometer), Quality of Life Scale (Oswestry Disability Index), & Sleep Quality (VAS)	PENS & DN groups VAS pain (Initial-final): 2.38 (±2.27) & 2.35 (±2.58) respectively (P = 0.94); VAS sleep quality (Initial-final): 1.72 (±2.67) & 1.85 (±2.66) respectively (P = 0.68). PENS & DN groups PPT (Initial-final): right deep paraspinals 0.91 (±4.39) & 1.04 (±4.45) respectively (P = 0.93); left deep paraspinals 1.75 (±4.6) & 2.06 (±3.35) respectively (P = 0.83); right quadratus lumborum 0.89 (±3.10) & 1.73 (±3.47) respectively (P = 0.33); left quadratus lumborum 0.76 (±2.77) & 1.64 (±2.91) respectively (P = 0.12); right gluteus medius 0.77 (±3.27) & 0.87 (±2.76) respectively (P = 0.32); left gluteus medius 058 (±2.46) & 1.77 (±3.44) respectively (P = 0.14). PENS & DN group Oswestry Disability Index (Initial-final): personal care 0.38 (±0.97) & 0.34 (±0.82) respectively (P = 0.94); lifting weight 0.59 (±1.42) & 0.06 (±0.96) respectively (P = 0.03); walking 0.17 (±0.98) & 0.15 (±0.57) respectively (P = 0.86); sitting 0.21 (±0.89) & 0.33 (±1.05) respectively (P = 0.51); standing 0.25 (±0.84) & 0.41 (±0.82) respectively (P = 0.26); social life 0.72 (±1.10) & 0.72 (±3.03) respectively (P = 0.178). Number of patient with more than 40% reduction in VAS pain: PENS 28 (53.85%) & DN 24 (46.15%).

was a significant increase in flexion at postintervention in the DN and laser groups, but this disappeared at the 6-month follow-up. In addition, ROM for extension was significantly increased compared to the DN and placebo groups at postintervention measurement, but again this disappeared at the 6-month follow-up. There was no significant difference in rotation for any of the groups or follow-ups. In regards to lateral flexion, both left and right were increased in laser group compared to the DN and placebo groups at 4 weeks but at 6 months there was no difference. These results would suggest that laser was more effective than DN to help increase cervical ROM in the short term, but there was no difference between the two interventions in the long term (6 months).

Outcome Measure: Quality of Sleep

Two studies examined the quality of sleep as an outcome measure (see Table 2). In the study by Pérez-Palomares and colleagues[13] where PENS was compared to DN in 121 subjects with low back pain, a VAS scale was used to identify quality of sleep. The final score was subtracted from the initial score and compared across groups; there was no significant difference between the PENS group and the DN group. This would suggest there is no benefit of DN over PENS in regards to sleep quality.

Another study by DiLorenzo et al[11] also examined quality of sleep using a sleep questionnaire that consisted of 2 questions. These questions were answered only at the last visit with a yes or a no response. The authors[11] found that 85.2% of the DN group felt that they rested well in the wheelchair or bed during the last 2 weeks (question 1) compared to 68.1% of the standard rehabilitation group, which was a significant between group difference. In addition there was also a significant between group difference for question 2 which asked the question, "Did you sleep well during the last 7 nights?" For this question, 92.6% of the DN group answered "yes" whereas only 74.5% of the standard rehabilitation group answered "yes." These results would suggest that the addition of DN to the standard rehabilitation program did have positive effects that helped the patients to sleep better.

Outcome Measure: Patient-reported Outcomes

Pérez-Palomares and colleagues[13] also examined patient-reported outcomes in their study that compared PENS to DN (see Table 2). The authors[13] used the Oswestry Disability Index. As with their other outcome measure comparisons, the final measurements were subtracted from the initial measurements. In the subcategories of personal care, walking, sitting, standing, and social life, there was no significant difference found between groups. However, in the area of lifting weight, there was significant difference in favor of the DN group. This would suggest there is a slight benefit of DN over PENS in quality of life, specifically in the lifting weight subcategory of the Oswestry Disability Index.

In the study by Eroğlu et al,[5] the authors used the Nottingham Health Profile, which included the subcategories of pain, physical ability, fatigue, sleep, social isolation, and emotional reactions, as a measure of quality of life (see Table 2). The authors found that all groups showed a significant improvement in the quality of life measure in all subcategories. When between group comparisons were made, it was found that the only significant difference was for the subcategory of fatigue on the third and fourteenth day measurements. This difference was found for the lidocaine group, and since this is not an intervention that physical therapists can administer, which is the focus of this paper, the difference was not considered. These results suggest that in terms of quality of life, DN is no more effective than oral flurbiprofen.

Ziaeifar et al[8] also used a patient-reported outcome measure in their study. In this case they used the DASH (Disability of Arm, Hand, and Shoulder; see Table 2). The authors found that there was a significant change in DASH scores from preintervention to postintervention in both groups. There was no significant difference between groups, suggesting that DN has no greater benefit than MTrP compression therapy in regards to aspects of quality of life measured by the DASH.

DiLorenzo et al[11] examined patient-reported outcomes through the use of the Rivermead Mobility Index (RMI; see Table 2). The authors[11] calculated the effectiveness of RMI through the use of the equation [100 x (discharge scale score – initial scale score)/(maximum scale score – initial scale score)]. The authors[11] did not comment on the significance of the different values calculated, only that the effectiveness was 50.0% for the DN group and 47.5% for the standard rehabilitation group. From this it appears that there was no significant difference between the groups and thus DN was no more effective than the standard rehabilitation intervention.

The study by Ilbuldu et al[14] examined the effectiveness of DN compared to that of laser and placebo laser (see Table 2). The patient-reported outcome used was the Nottingham Health Profile. In the subcategories of pain and physical activity, a significant difference was noted postintervention in favor of the laser group over the placebo laser and the DN groups. However, this difference disappeared at the 6-month follow-up. In addition, for the subcategories of fatigue, sleep, social isolation, and emotional reaction there were no significant differences at postintervention or the 6-month follow-up. These results would suggest that the laser was more effective in helping to reduce pain and increase physical activity in the short term but not the long term, which coincides with the results from the outcome measures that the authors used to address pain including analgesic usage, VAS pain scale, and algometry.

Rayegani et al[15] used the SF-36 in their study as the measure of patient-reported outcomes (see Table 2). The results showed that there was significant improvement in the subcategories of social functioning, role limitation due to physical problems, and physical functioning in the physiotherapy group. However, in this same group, no significant improvement was found in the subcategories of vitality, role limitation due to emotional problems, or general and mental health. In contrast, the DN group showed no changes in any of these subcategories. There were no significant differences between the groups. At the 1-month follow-up, there was a significant increase in bodily pain, physical functioning, role limitation due to physical problems, and social functioning in both groups with no significant difference between groups. These results show that DN is not more effective at improving quality of life in the short term as measured by the SF-36 and in some areas, physical therapy may even be more effective.

DISCUSSION

This systematic review was undertaken to summarize the relative effect of DN compared to other interventions that physical therapists may use to treat symptoms and disablement related to MTrPs. Dependent variable measurements of the included studies were pain, EMG activity, ROM, sleep quality, and quality of life. In regards to the outcome measure of pain, there were only 3 studies that showed that DN was better than the intervention to which it was compared.[8,11,16] However, notably, DN was more effective in 3 of the 4 studies that examined manual therapy interventions.[8,11,15,16] However, when compared to other modalities, DN was no more or less effective in reducing pain in all 4 of the studies examined.

In regards to ROM measurement and EMG activity (specifically reduction of LTRs), DN was not found to be more effective in any of the studies. When examining sleep and quality of life, the results of the studies are again somewhat mixed but most favor the result of DN being no more or less effective than other interventions.

Considering all results it appears that DN by far has the greatest effect on pain reduction. It is still unclear if DN is more effective than other common interventions used. However it does appear that DN is more effective in reducing pain over manual therapy. This would support the argument for the use of DN in the clinic as a method for pain reduction. Lastly it is important to note that these studies were of relatively small size and had varying levels of quality in regards to their methodologies, with PEDro scores ranging from 2/10 to 7/10. Thus, it is important for more research to be conducted in this area, specifically a high quality, large scale study that compares DN to a standard rehabilitation intervention.

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Constipation and Low Back Pain in an Athlete: A Case Report

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ABSTRACT

Background and Purpose: Physical therapists need to be informed that low back pain in an athlete may originate from a gastrointestinal dysfunction such as constipation. A 21-year-old Caucasian American male basketball player was referred to physical therapy with intermittent back and hip pain. The athlete had recurrent bouts of lower back and hip pain since he was in high school. However, the athlete reported no specific incident where he injured his lower back or hips, but included periodic constipation on his medical history. The purpose of this case report was to describe how an athlete with nonspecific low back pain was evaluated for a gastrointestinal dysfunction as a potential source of pain. **Methods and Findings:** A review of the literature was conducted to find the latest treatment strategies for an athlete with low back pain originating from constipation. **Clinical Relevance:** The key step in managing constipation should be to rule out secondary causes of constipation, such as anatomical lesions, endocrine disorders, neurologic diseases, or medication side effects. **Conclusion:** A young athlete with a history of lower back and hip pain without a specific mechanical cause or injury should be carefully evaluated to rule out a gastrointestinal dysfunction.

Key Words: athletic performance, back pain, gastrointestinal dysfunction, lumbar dysfunction

INTRODUCTION

Any type of gastrointestinal (GI) dysfunction, such as constipation, diarrhea, irritable bowel syndrome, can significantly alter athletic performance in a negative way. The GI system should be thoroughly examined as a part of a comprehensive physical evaluation. A GI dysfunction may cause referred pain, cramping, and tightness, which could be implicated as the primary cause of a patient's complaints of pain. To this author's knowledge, peer-reviewed evidence supporting physical therapy assessment and management of a basketball player with back and hip pain that may be due to a GI dysfunction is absent in the literature. The purpose of this case report was to describe how an athlete with nonspecific low back and hip pain and recurrent constipation was evaluated for GI dysfuction as a potential source of pain.

OVERVIEW OF CONSTIPATION

Constipation affects between 2% and 27% of the population in Western countries.[1] Moreover, constipation affects daily life with 13.7 million days of restricted activity.[2] Additionally, 60% of those affected by constipation have an impaired ability to work and 12% missed work or school.[2,3]

Constipation may be due to stress, irregular or disordered eating habits, inadequate hydration, habits from childhood, inappropriate supplement use (such as antacids with calcium carbonate), inappropriate over-the-counter product use (such as laxatives), or an undiagnosed medical condition, such as depression.[4-7] Physical therapists should be familiar with the diagnostic criteria[8,9] (Table 1) and potential causes[10,11] (Table 2) of constipation in order to perform a thorough medical history and avoid missing signs and symptoms that may suggest GI system dysfunction. Individuals with back pain may develop constipation due to muscle splinting and muscle guarding due to reduced bowel motility. Furthermore, constipation may result from decreased abdominal effort due to back pain.[12]

CASE DESCRIPTION

History

A 21-year-old Caucasian American male basketball player was referred to physical therapy from his family physician with a diagnosis of back pain. The athlete had intermittent bouts of lower back and hip pain since he was in high school. He attributed his lower back and hip pain to aggressive basketball training and his intense conditioning program so he could try out for a collegiate basketball team as a walk-on player. However, the athlete reported no specific incident where he injured his lower back or hips. This finding was viewed as a need to proceed with caution (yellow flag) during the rest of the evaluation.

Past Medical and Family History

Past medical history included GI disturbance due to lactose intolerance, gastroesophageal reflux disease (GERD), right ankle sprain, and a fracture of the right radius when he was a teenager. The athlete indicated he did not smoke or consume alcohol. He lived on a college campus and attended school full-time. His exercise history included full-body strength training 3 days per week for one hour, cardiovascular conditioning 2 times a week for 60 minutes, and basketball drills 5 days per week for 45 minutes.

Signs and Symptoms

The athlete described his pain as a cramping, tightness type of pain in his left greater than right lower abdomen and dull, low back pain. He indicated pain periodically radiated to the front of his hips and groin region. The athlete indicated his bilateral hip pain ranged from a low of 0 to a high of 7 out of 10 on a visual numeric pain scale. Similarly, his back pain ranged from 0 to 5 on a visual numeric pain scale. The athlete also reported some difficulty with sleep due to the anxiety from his college coursework and trying to compete at the collegiate level. The athlete did not have any constitutional symptoms, such as fever, diaphoresis, sweats, nausea, vomiting, diarrhea, pallor, dizziness/syncope, fatigue, or weight loss.[12]

Risk Factors

The only risk factors identified for low back and hip pain in this athlete were that he sat for prolonged periods during studying and participated in a high intensity sport. Specifically, had the athlete been sitting with poor or slumped posture for prolonged periods this may have been a potential cause of low back pain. Furthermore, prolonged sitting may create tightness in the hip flexor muscles and would need to be assessed during the physical examination.

Systems Review

A systems review identified the following clusters of signs and symptoms during the initial subjective screening[12]:

- musculoskeletal/neurologic–dull low back pain and radiating pain into the front of the hips and groin,
- psychologic–sleep disturbance, and
- gastrointestinal–abdominal pain, constipation.

Table 1. Diagnostic Criteria for Functional Constipation*

Must include two or more of the following[8]:

- Straining during at least 25% of defecations
- Lumpy or hard stools in at least 25% of defecations
- Sensation of incomplete evacuation for at least 25% of defecations
- Sensation of anorectal obstruction/blockage for at least 25% of defecations
- Manual maneuvers to facilitate at least 25% of defecations (for example, digital evacuation or support of the pelvic floor)
- Fewer than 3 defecations per week

*Criteria fulfilled for the last 3 months with symptom onset at least 6 months prior to diagnosis

Table 2. Some Potential Causes of Constipation

- Anxiety
- Chronic back pain
- Depression
- Hypercalcemia
- Hypothyroidism
- Inactivity (perhaps due to an illness or injury)
- Inadequate dietary fiber
- Malnutrition
- Medications (such as anticholinergics, antidepressants, antiemetics, calcium channel blockers, or opiates)
- Multiple sclerosis
- Parkinson's disease
- Pathological lesions of the bowel (such as diverticular disease, hemorrhoids, or obstructions due to incarcerated hernias, adhesions, or tumors)
- Potassium depletion
- Scleroderma
- Situational stress
- Thiamine (also known as Vitamin B1) deficiency

Red Flags

Red flags, as identified by Goodman and Snyder,[12] are areas in an individual's medical history and clinical examination that may be associated with a high risk of serious disorders, such as cancer, fracture, infection, or inflammation. Red flags require immediate attention for either further screening or an appropriate referral. For this athlete, the red flags included the following:

- intermittent low back pain without any known cause of injury and
- symptoms did not fit expected mechanical or neuromuscular patterns.

Pharmacology

The athlete's medication list included the use of a nonsteroidal anti-inflammatory drug (ibuprofen) for pain as needed several times a week. He also used famotidine (antacid) several times a week for an upset stomach and GERD. The adverse reactions and side effects of ibuprofen in the GI system include constipation, GI bleeding, hepatitis, dyspepsia, nausea, vomiting, and abdominal discomfort. The adverse reactions of famotidine include constipation, diarrhea, and nausea.[13] The athlete indicated he was not taking nutritional supplements for the past year since he had previously experienced GI disturbances.

SCREENING QUESTIONS

According to Goodman and Snyder,[12] a positive finding in one area during a musculoskeletal evaluation could lead to further questioning in the following areas: integumentary, rheumatologic, cardiovascular, pulmonary, psychologic, gastrointestinal, hepatic/biliary, hematologic, genitourinary, gynecologic, endocrine, and immunologic. The medical history provided clues that some of the over-the-counter medications the athlete was taking may be causing GI disturbances. The subjective history focused on additional questions. The checklist of additional questions included whether the athlete was experiencing nausea, vomiting, swallowing difficulties, indigestion and heartburn, food intolerances, and bowel and bladder dysfunctions (for example, constipation, diarrhea, or incontinence). The athlete indicated he had occasional indigestion, and he may have food intolerances to bread and pasta. The athlete indicated he had not mentioned his observed food intolerance to his physician.

As a part of the family physician's evaluation, the visual Bristol Stool Form Scale was used with the athlete.[14] The Bristol Stool Form Scale ranges from Type 1 to Type 7 using descriptions expressed in everyday language. Type 1 is classified as a person having stools that are separate hard lumps like nuts, which may be indicative of constipation. Type 4 is classified as being stools that are like a sausage or snake, smooth and soft, and Type 5 as soft blobs with clear-cut edges. Both Type 4 and Type 5 may be thought of as normal or ideal stools. Finally, Type 7 is classified as stools being watery with no solid pieces, which may be indicative of diarrhea. The athlete was classified as a Type 1 on this scale, indicating constipation.

Diagnostic Procedures

The physician had ordered a blood test, which included a thyroid function test. The test result was negative for a thyroid dysfunction.

Diagnostic Imaging

The athlete did not undergo any diagnostic imaging. The referring physician indicated that this type of diagnostic testing of the GI system was not required until further conservative measures such as physical therapy were completed.

Examination/Evaluation

A physical examination was initiated with observation of the athlete while in the clinic waiting room. The athlete sat with slumped posture. However, his gait revealed no specific abnormalities. His posture revealed internally rotated shoulders, forward head, and moderate winging of the medial scapular border bilaterally. Standing pelvic alignment was normal. The athlete also had normal medial longitudinal arches and no unusual wear patterns on his athletic shoes. The athlete was observed to use a chest breathing strategy with mild use of the scalene muscles.

No atrophy of the arm or leg muscles was noted. Seated blood pressure on the right arm was 110/60 mm Hg. His pulse was 67 beats per minute at the right wrist, respiration at 14 breaths per minute, oxygen saturation at 98%, and oral temperature at 98.6°F. No jugular venous distension was noted.

Auscultation of the heart and the lungs did not appear to reveal abnormal sounds. Palpation of the chest revealed symmetrical and normal chest expansion. Percussion of the chest, back, and abdomen did not elicit pain or a dullness sound.

Lower extremity pulses, light touch sensation, and vibration sense were intact, with the deep tendon reflexes 2+ out of 4 and manual muscle testing 5 out of 5. Active trunk flexion, extension, sidebending, and rotation ranges of motion were full and painfree. Passive hip range of motion was noted to be full and painfree bilaterally. Supine leg length was normal. Patrick's test (FABER) was negative. Supine and sidelying hip compression and distraction did not elicit pain symptoms. Flexibility testing revealed mild tightness of the iliopsoas and rectus femoris bilaterally. Passive straight leg raise was approximately 80° bilaterally without pain. Functional testing consisting of single leg balance (30 seconds), stairclimbing, full squat, and standing multidirectional lunges were symmetrical and negative for pain.

The supine iliopsoas muscle test slightly increased left lower abdominal pain. This test, as described by Goodman and Snyder,[12] suggests a possible irritation of the psoas muscle due to an inflamed appendix or peritoneum. The authors describe the iliopsoas muscle test being performed in supine with the patient performing a straight leg raise and the therapist applying resistance to the distal end of the thigh as the patient tries to hold the leg up. The obturator muscle test, as described by Goodman and Snyder,[12] was negative. The authors describe the obturator muscle test as being performed in supine with active assisted hip flexion and 90° flexion at the knee, where the therapist holds the ankle and rotates the leg internally to stretch the obturator muscle.

Palpation of the sacrum and lumbar spine did not elicit pain symptoms. Since the patient had lower abdominal pain, palpation of this region was performed and revealed a mild tenderness on the left greater than right lower abdomen. Goodman and Snyder[12] indicate that clients with constipation and tender psoas trigger points may report anterior hip, groin, or thigh pain when the fecal bolus presses against the trigger points. Special tests such as the pinch-an-inch test, Blumberg's sign, and McBurney's point in the lower abdomen were negative to palpation.[12] Palpation of the entire abdomen did not appear to reveal masses. Auscultation and percussion of the abdomen did not reveal abnormal sounds.

DIAGNOSIS/PROGNOSIS

The physician's diagnosis was low back pain ICD-9-CM 724.2, which was equivalent to the 2015 ICD-10-CM M54.5 low back pain. The physical therapy diagnosis was classified as hip and lumbar dysfunction.

PLAN OF CARE

Patient goals were to reduce low back and hip pain to a 0 to 2 out of 10 and determine if a food allergy may be contributing to his symptoms. Physical therapy goals were to decrease pain, teach techniques to help manage constipation, provide a home exercise program, and contact the physician regarding medical evaluation for food intolerances. The physical therapy plan of care included further assessment, patient education, manual therapy as indicated, and therapeutic exercise.

INTERVENTIONS

The athlete attended a total of two physical therapy sessions, including the initial evaluation. The following interventions were used:

1. Instructed the athlete to:
    a. perform 15 diaphragmatic breaths in supine every morning before using the bathroom;
    b. perform self-directed gentle abdominal massage in supine (10 clockwise strokes from right to left) after performing diaphragmatic breathing exercises;
    c. use a step stool, small plastic wastebasket flipped on its side, or to consider purchasing a Squatty Potty toilet stool (see www.squattypotty.com) to be placed underneath the feet during a bowel movement; and
    d. use perineal self-acupressure via patient education handouts.[15]
2. Recommended to the physician the potential need for further evaluation for gluten intolerance. The athlete was referred by the physician to a dietitian and placed on a temporary elimination diet.
3. Discussed additional selected remedies for constipation[16-37] (Table 3).

OUTCOMES

A follow-up phone call with the athlete after 3 months revealed that he had continued to use the instructions (Table 3) provided in physical therapy on most days of the week and used the Squatty Potty on a daily basis. He also indicated that the elimination diet provided by the dietitian revealed he was sensitive to gluten; therefore, he had avoided it for the past two months. He rated himself as a Type 4 on the Bristol Stool Form Scale, which may be considered an ideal or normal stool. The athlete indicated he no longer had constipation and had not experienced any intermittent hip or back pain for the past two months.

DISCUSSION

The key step in managing constipation should be to rule out secondary causes of constipation, such as anatomical lesions, endocrine disorders, neurologic diseases, or medication side effects. Therefore, a comprehensive differential screening is indicated for individuals who have atypical symptoms. In this case study, it was found that the athlete did not have mechanical hip or back pain, but rather a GI dysfunction with constipation. Furthermore, gluten intolerance may have contributed to the athlete's symptoms and subsequent constipation. Further research in this area may be warranted and the effects of GI symptoms need to be further studied with a larger sample size to determine the prevalence of GI symptoms and constipation in individuals with hip and back pain.

A thorough pharmacological review was indicated in this case since nonprescription and prescription medications, as well as supplements, may provide clues to various dysfunctions. Ciccone[38] indicated that a person taking over-the-counter aluminum-containing antacids for an upset stomach may lead to constipation. Additionally, nonsteroidal anti-inflammatory drugs have been implicated in GI symptoms.[9,39]

Seeing a physician is imperative if a person has chronic constipation as there might be a medical reason or medication side effect that needs to be addressed. The physician in this case ordered a thyroid function test for this athlete. Even though the test was negative, the physician was trying to rule out the thyroid as a source of the constipation. A cross-sectional study by Werhun and Hamilton[40] found that an abnormal thyroid-stimulating

Table 3. Selected Remedies for Constipation

- Ritualize bowel habits.[16]
- Don't ignore the urge to use the bathroom.[17]
- Don't be in a hurry when using the bathroom.[18]
- Get regular exercise.[19]
- Consider using a bidet to gently lubricate and stimulate the perineal area to help the anal sphincter relax during defecation.
- Do a gentle and slow abdominal massage.[20]
- Lower your stress levels.[21]
- Eat probiotic and prebiotic foods.[22]
- Avoid excess calcium.
- Eat prunes.[23]
- Try eating a sweet potato.[24]
- Avoid chocolate and unripe bananas until constipation symptoms have cleared.[25]
- Drink enough fluids.[26]
- Get enough fiber in your diet through vegetables, fruits, and whole grains.
- Use a safe breathing technique during a bowel movement. Learn diaphragmatic breathing techniques.[6,27] Using a "huffing" type of breathing technique—breathing out with small breaths[20,28] may help minimize stress to the heart and small blood vessels in the brain.[29-31]
- See an acupuncturist to learn how to use the perineal self-acupressure point and other acupressure points.[15,32]
- Try an aromatherapy massage with essential oils such as rosemary and lemon.[33]
- Consider physical therapy for pelvic floor training,[7,34] abdominal muscle training and massage,[35] visceral osteopathy,[36] and connective tissue manipulation[37] for reducing symptoms of constipation.

hormone test was associated with constipation. Additionally, prolonged use of over-the-counter laxatives without a physician's guidance may lead to chronic constipation. If a person has constipation only periodically, then the selected interventions such as those in Table 3 may be helpful. Finally, it has been argued that the Western style seated toilet is not the ideal position for a bowel movement[41-43] and therefore, the Squatty Potty toilet stool was recommended for the athlete. The Squatty Potty is a toilet stool which is either 7 inches or 9 inches in height, depending on the flexibility of the person and the size of the toilet, and is designed with a forward slant to ergonomically align the body for a complete and comfortable rectal elimination. It has been proposed that raising the feet with a stool along with trunk flexion while on the toilet[28] may help improve the optimum angle for rectal emptying. The rectoanal angle typically straightens with fully-flexed hips and this has been proposed to facilitate rectal emptying.[42]

This case study demonstrates that physical therapists need to work with other clinicians when there are red flags or symptoms which go beyond the scope of physical therapy. Treating this athlete showed that all symptoms need to be accounted for in order to establish the best intervention plan and outcome.

CONCLUSION

In conclusion, a young athlete with a history of lower back and hip pain without a specific mechanical cause or injury should be carefully evaluated to rule out a gastrointestinal dysfunction. A thorough medical history which accounts for all symptoms, over-the-counter products, and seemingly unrelated symptoms, such as stomach and gastroesophageal reflux, will guide a physical therapist during the evaluation and follow-up treatments. This case study presents a low-cost approach to intervention, due to the limited number of visits utilized and cost effective clinical recommendations, in helping an athlete resolve chronic symptoms of low back and hip pain. The case study also shows the importance of collaboration with other clinicians in evaluating and treating patients referred to physical therapy.

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2016 Annual Orthopaedic Section Meeting Highlights

"Treating the Cervical and Lumbar Spine: Can Art, Science, and Practice Guidelines All Get Along?"

The recently held 4th Annual Orthopaedic Section Meeting in Atlanta, Georgia, focused on the benefits and challenges of using the clinical practice guidelines (CPGs) to manage individuals with dysfunction in the cervical and lumbar spine. Dr. Julie Fritz's keynote presentation on moving the practice of physical therapy forward by using the practice guidelines and understanding care pathways was followed by a healthy discussion lead by a panel of experts. This collegial interchange set the tone for the meeting and was followed by a wonderful reception where physical therapists and physical therapy assistants could mingle with the speakers and the Orthopaedic Section Board of Directors.

The format for the following two days was similar to past years, beginning with a 2-hour general session in the morning followed by a round of smaller-concurrent laboratory breakout sessions. This year, the leaders of the breakout sessions gave their topic lectures during the general session. This modification allowed all lecturing to be completed in the morning so that the breakout sessions could immediately start with practicing skills required to apply the content of the lectures to a case example.

The clinical practice guidelines for the cervical spine were discussed by distinguished leaders in the field including Joshua Cleland, PT, PhD, OCS, Robert Landel, PT, DPT, OCS, FAPTA, Paul Mintken, DPT, OCS, FAAOMPT, and Kenneth Olson, PT, DHSc, OCS, FAAOMPT. Each speaker presented updated evidence for the 4 diagnostic classifications outlined in the neck pain CPG, and then led a lab session to address the examination and treatment of neck pain with radicular symptoms, headache, movement coordination impairment, or mobility deficits. A similar agenda was followed for the lumbar spine on the second day. Chad Cook, PT, PhD, MBA, FAAOMPT, Anthony Delitto, PT, PhD, FAPTA, Jake Magel, PT, PhD, DSc, OCS, FAAOMPT, Sheri Silfies, PT, PhD, and Michael Timko, PT, MS, FAAOMPT, were the respected professionals leading the lectures and breakout sessions. A new mid-day "lunch and learn" session was held by Joe Godges, DPT, MA, OCS, where he discussed the future directions of clinical practice and the CPGs.

Following section breakout sessions, attendees shared their thoughts about the Annual Meeting:

"Excellent Conference! The labs were excellent, and I will definitely attend in the future."

"Greatly appreciated all the effort that went into this course. I met some fantastic colleagues that were very generous with sharing ideas and suggestions to help me be a better PT. It was a full 2 days and I was still ready to learn more."

"The conference was very well organized. I came out of the 2 day conference feeling enriched & optimistic about the future of PT!"

"I found this meeting to be a wonderful follow up to my orthopaedic residency which I completed 2 years ago. Very applicable and great hands on practice."

"Course was outstanding. I attended the Ortho Section meeting in Phoenix last year and that convinced me that it is worthwhile attending if at all possible. Well planned, excellent speakers. Excellent job by all in the Ortho Section."

As the Orthopaedic Section continues to grow and expand this Annual Meeting, we will continue to assess and measure feedback from attendees and Section members in an effort to provide quality continuing education to advance clinical practice. We would like to thank all of the presenters, exhibitors, and attendees for making this event a great success! If you missed out this year, please mark your calendars for April 20-22, 2017, for the 5th Annual Orthopaedic Section Meeting in San Diego, California. Stay tuned for details regarding this upcoming Annual Meeting!

2016 Outstanding Component Recipient

The **Orthopaedic Section** has been awarded the 2016 Outstanding Component Award!

Component award winners were recognized during the Component Leadership Meeting in Nashville, June 5, 2016.

The Orthopaedic Section received accolades as Outstanding Section for delivering exceptional value to its members through development of mentoring program focused on students and new professionals, achievements in the performance arts practice setting, completion of the new Imaging Manual, publication of 10 clinical practice guidelines with another 12 in development, creation of the National Orthopaedic Physical Therapy Outcomes Database, and use of a volunteer involvement form to increase member involvement.

Book Reviews

Michael J. Wooden, PT, MS, OCS
Book Review Editor

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

Performing Arts Medicine in Clinical Practice, Springer, 2016, $159
ISBN: 978-3319124261, 183 pages, Soft Cover

Author: Bird, Howard A.

Description: This book addresses the special aspects of treating performing artists, primarily musicians and dancers, with musculoskeletal problems. It describes the demands places on various musicians, dancers, and vocalists, and presents a selection of case studies to highlight the unique aspects of these performers. **Purpose:** The aim is to provide a resource for those disciplines involved in the management of these performing artists, and the book is intentionally written in a "simple style" to be accessible to a variety of readers. While the objective is worthy, the target audience may be too broad, thus the book misses the mark for any one discipline. **Audience:** It is hard to say exactly for whom the book is intended, as the author states that it is meant to be a guide that "all readers" might find of interest. The credentials of the primary and contributing authors are not stated, although the primary author refers to a career in rheumatology in a university setting. This book may have some small value for physicians, athletic trainers, physiotherapists/physical therapists who have little to no experience in treating performing artists. **Features:** The first chapter aims to present the background and history of performing arts medicine as well as additional references. However, the presentation is limited mostly to the U.K. and lacks information from other parts of the world. The reference list of 14 citations is obviously incomplete. The subsequent three chapters present various issues particular to different instruments, styles of dance, and vocalists. Each musical instrument and the special issues that may be associated with it gets fewer than four sentences. The chapter on dance is longer, but covers only classical ballet and modern dance. A few special topics are discussed afterward, with a number of case studies on issues such as degenerative arthritis, overuse syndromes, hypermobility, scoliosis, and medications. Although these are somewhat useful, they are incomplete and are presented only from the perspective of a rheumatologist. One highlight is the inclusion of the dancer's perspective in a few of the case studies. Illustrations and pictures are scarce, as are the "future trends" and bibliographies at the end of each chapter. The book includes resources primarily for practitioners living and working in the U.K. Some key organizations, such as International Association of Dance Medicine and Science (IADMS) and Performing Arts Medicine Association (PAMA), both international, are mentioned as research outlets but not highlighted. **Assessment:** As a simple introduction to performing arts medicine for practitioners in the U.K., this book is adequate at best. For most readers, however, their money would be better spent on memberships to some of the primary performing arts medicine organizations (IADMS and PAMA), that consistently provide excellent research and resources targeted at and consumable by a variety of disciplines and healthcare professionals. The author's target audience is too broad for the book to provide comprehensive information for any one group, and the obvious focus on the U.K. makes it less useful for other readers.

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

Tests and Exercises for the Spine, Thieme Medical Publishers, Inc., 2015, $54.99
ISBN: 9783131760012, 197 pages, Soft Cover

Author: Fischer, Peter, MTC, MSPT, DPT

Description: This book presents an algorithm for the development of a safe, efficacious, and evidence-based exercise program for use in treating the spine. Originally published in 2012 in German, this is the first English language edition. **Purpose:** The purpose is to help physical therapists determine the most effective therapeutic exercises for treating spine patients. There are literally thousands of exercises to choose from, and this book uses a protocol for determining the most effective ones. **Audience:** The book is appropriate for veteran and new therapists alike. The thought process of the author is clearly a result of his many years of treating spinal patients. **Features:** The book presents a clear, easy-to-follow protocol for test utilization that guides clinicians to the most effective exercises for treatment. It is solely geared for therapists who treat spinal patients, but it would be helpful to see this protocol applied to orthopedics in general. The language is clear and easy to follow and there are many pictures throughout. **Assessment:** Most physical therapists can easily recall the books they used in school to learn about therapeutic exercise. Some may still have many of those books and, perhaps, some new ones. I remember learning most of the tried and true exercises I still use today, and I may even have trouble describing why I use some of them. This book offers an algorithmic, evidence-based approach to developing a safe and efficacious therapeutic exercise program. This approach is right on target for today's outcomes-based environment.

Charles R. Wolfe III, PT, DPT, DAC
U.S. HealthWorks Medical Group, Inc.

Soccer Injury Prevention and Treatment: A Guide to Optimal Performance for Players, Parents, and Coaches, Demos Medical Publishing, 2014, $16.95
ISBN: 9781936303656, 201 pages, Soft Cover

Author: Gallucci, John, Jr., MS, ATC, PT, DPT

Description: This comprehensive book presents clear descriptions of youth and overuse soccer injuries, biomechanical analysis of soccer kicks and headers, and detailed descriptions of injuries by body part, including concussions. It also discusses strength, conditioning, nutrition, and hydration specific to soccer athletes. **Purpose:** The purpose is to provide a detailed look at every joint and the mechanism of injury for soccer injuries, their diagnosis, treatment, and prevention. The book does an exemplary job of presenting the information in layman's terms for the intended audience. **Audience:** As the title indicates, this book is intended for players, parents, and coaches, although it is appropriate for practicing clinicians as well. The author has extensive knowledge in this field as a physical therapist, athletic trainer, and medical coordinator for Major League Soccer. **Features:** The book includes discussions of youth and overuse injuries, as well as injuries of the spine, lower and upper extremity, and concussions. The author also describes prevention principles through strength and conditioning as well as nutrition and hydration. The concussion chapter is excellent and written in layman's terms. From a clinician's perspective, the chapter on youth injury serves as an excellent review of disorders that are not commonly seen in the clinic. As a result, this book can serve as an ongoing resource. Features include a glossary and index, as well as numerous pictures and figures showing exercises and anatomical images of various body regions. **Assessment:** This is an excellent book for soccer players, parents, and coaches. For clinicians, it provides an excellent review of anatomy, injuries, exercise physiology, and exercises that

(Continued on page 198)

(Continued from page 197)

could be used in the clinic and for treating players on the pitch the following day.

Christopher D. Blessing, MS, MPT, OCS, CSCS
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Differential Screening of Regional Pain in Musculoskeletal Practice, Jaypee Brothers, 2015, $87
ISBN: 9789351529545, 512 pages, Hard Cover

Author: Sebastian, Deepak, BPT, DPT, DO, ND, PhD, PGDR, MHS, MTC, OCS, FAAOMPT

Description: Because of the author's background as a physical therapist, osteopath, and naturopath, this book takes a unique approach to pain screening for the musculoskeletal system. It approaches the differential diagnosis component more medically than most physical therapy books on the subject. **Purpose:** The purpose is to provide a region-specific look at the differential diagnosis process to help physical therapists recognize when symptoms are nonmusculoskeletal in origin and to train them to think more frequently outside the musculoskeletal scope. These are worthy objectives, although this is not a new concept. **Audience:** Parts of the book seem geared towards entry level students, while other parts have great content for those in residency and/or fellowship programs. The emphasis is on orthopedic practice (MD, DO, ND, PT, DC). **Features:** The first three chapters are unique, covering topics that other differential diagnosis books don't. The first is an overview of regional pain, the second is a very in-depth discussion of the role of the chemical basis of musculoskeletal pain (very interesting), and the third covers drug-induced regional pain. The rest of book (chapters 4 -10) is based on region-specific tissue review and how those tissues can generate symptoms outside the musculoskeletal system. The value of the book lies in the body region-focused chapters that allow readers to home in on an area to determine all signs and symptoms and the tissues in that region that could be generating symptoms. Each chapter is stuffed a little full, especially with the orthopedic examination of every body region, which seems unnecessary for a book with a focus outside the musculoskeletal region. **Assessment:** This book has good qualities for experienced practitioners. Many of the diseases (common and obscure) that I have learned about over the years, but didn't have a resource for, are in here. It covers symptoms in a similar fashion to "Diagnosis for Physical Therapists: A Symptom-Based Approach," Davenport et al. (F. A. Davis, 2012), but this book is easier to navigate, although more simplistic in presentation. This book also goes into greater depth than "Primary Care for the Physical Therapist: Examination and Triage," 2nd edition, Boissonnault (Elsevier, 2011), but the Boissonnault is perfect for an entry-level understanding of the critical thinking process of differential diagnosis. On the other hand, "Differential Diagnosis for Physical Therapists: Screening for Referral," 5th edition, Goodman and Snyder (Elsevier, 2011), is very systems and medically oriented for differentially understanding disease. Overall, this book is a worthy resource for the way it presents information in a condensed way, but it lacks the polish of these competing books.

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A World of Hurt: A Guide to Classifying Pain, Thomas Land Publishers, Inc., 2015, $67
ISBN: 9780985372910, 367 pages, Soft Cover

Author: Kolski, Melissa C., PT, OCS, Dip MDT; O'Connor, Annie, PT, OCS, Cert. MDT

Description: This book covers the complex issue of musculoskeletal pain. Each chapter is summarized nicely with a highlighted Key Messages section. **Purpose:** The purpose is to discuss the various aspects and science behind musculoskeletal pain and the development of a pain mechanism classification system. **Audience:** The book is intended for any practitioners who interact with patients with chronic pain, as well as patients. However, the scientific information and the clinical jargon would be poorly understood by most patients dealing with chronic pain. The authors are both experienced clinicians, certified in the McKenzie Method of Mechanical Diagnosis and Therapy, and are certified orthopedic clinical specialists. **Features:** This well-organized book first introduces the concepts of pain and the pain mechanism classification system before exploring this system in great depth in subsequent chapters and discussing how it affects patient evaluation and treatment. Throughout, there are patient handouts which would be useful for the appropriate patient type. There are also some very useful tables that are easy to follow. The McKenzie Method of Mechanical Diagnosis and Therapy is explained and the classification system is presented by the authors in the many case studies. One shortcoming is the authors' statement that for patients who have an irreducible derangement, other interventions, such as injection or surgical consult, are recommended. Such a statement takes pathology and other diagnostic factors out of the equation. **Assessment:** Overall, this book does an excellent job of discussing key aspects of pain mechanisms and how they influence patient management.

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Palpation Techniques: Surface Anatomy for Physical Therapists, 2nd Edition, Thieme Medical Publishers, Inc., 2015, $99.99
ISBN: 9783131463425, 420 pages, Soft Cover

Editor: Reichert, Bernhard, MScPT, MT; Stelzenmueller, Wolfgang, PT; Matthijs, Omer, PT, ScD, MOMT

Description: It is essential for physical therapists to have precise palpation skills, and this book will enable clinicians to be exact in identification of structures. This edition updates the 2011 edition with new resources and information on palpation techniques for surface anatomy. **Purpose:** The purpose is to encourage readers to engage in specific palpation techniques with the most up-to-date information on anatomy, biomechanics, and pathology. With color photographs and drawings on the body to outline anatomical structures, this book is sure to meet that goal. **Audience:** This is a great resource for both physical therapy students and experienced clinicians. It is written in a format that is clear and concise for all levels of experience. The detail of the photographs will easily allow students to visualize the layers and relationships of anatomical structures with each other. Experienced clinicians will benefit from this as a review for areas treated less frequently and advancing knowledge as techniques change, i.e. palpation of the lateral pterygoid. It also serves as an excellent educational tool for clinicians to use with patients to describe anatomical relationships during treatment sessions. **Features:** Overall, the book is well organized. It starts with discussion of fundamental principles of palpation. Each of the subsequent 11 sections is dedicated to a specific body region, all of which follow a similar format, allowing for easy reading. All pictures are in color, with additional drawings on the body to represent the bones, muscles, and/or tendons for better clarity. This feature is incredibly valuable to help readers gain a better understanding of the anatomy and relationships with other structures. One inconsistency, however, is that only the head/jaw section includes some muscles with their pain referral patterns. This would have been useful to include for all muscles. **Assessment:** There are very few books dedicated to palpation of the musculoskeletal system. This second edition is a great addition. The color pictures and body drawings are a wonderful way to enhance the learning experience for all levels of readers.

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OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

A Pilot Survey on Prevalence of Work-Related Musculoskeletal Injuries in Sign Language Interpreters

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BACKGROUND AND PURPOSE

Sign language is the fourth most used language in the United States, following English, Spanish, and Chinese.[1] It is used by the deaf and individuals who are hard of hearing as a primary means of communication, as well as by hearing people who service the deaf and hard of hearing. Sign language interpreters play an important role in legal proceedings, theaters, school settings, and more. They translate speech into sign language and back again. It has been estimated that 16 million hearing-impaired Americans use the services of sign language interpreters each year.[2] The act of signing can be a physically demanding task as interpreters are required to perform forceful, complex, and repetitious movements combined with awkward postures of the neck, shoulder, arm, hand/wrist, and fingers.[3] Often, sign language interpreting will also involve high static loading of back and neck muscles to help the interpreter stand or sit upright while working.[4] The amount of time an interpreter signs for can be extensive and without rest. Sessions can vary from approximately 20 minutes to 50 minutes with certain tasks requiring longer periods and often having no formal predetermined rest breaks.[4] This can be taxing on the neck, back, and upper extremities and it is possible that continued interpreting without adequate care or rest could lead to permanent damage of soft tissue and nerves as well as an inability to work.[1] Work-related musculoskeletal disorders (WRMDs) of the hand and wrist are reported to be associated with the longest absences from work across multiple fields.[5] Absences from work result in a loss of productivity and an inability to carry out activities of daily living. This inability to function is a considerable burden to the interpreter, the interpreter's employer and the deaf community.[6]

A major challenge for the rapidly growing sign language interpreter profession is how to mitigate the work-related risks to help build a healthy work force of interpreters capable of handling the increasing workload.[6] It is important to identify the frequency with which musculoskeletal disorders appear in this population, in order to target additional awareness and risk reduction efforts.[1] In a survey of 1,398 interpreters conducted by Johnson et al,[7] 74% reported symptoms such as pain or stiffness in the neck and 70% reported symptoms in the hand/wrist region. A survey of 71 interpreters by Freeman and Rogers[3] showed 38% reported their most painful symptoms were associated with maintaining a static posture and were present in their back, neck and/or shoulders, while the remaining 62% reported most painful symptoms occurred in hands, wrists, and/or fingers.

A review of the literature yields very little in terms of studies attempting to isolate specific aspects of the job that cause or might exacerbate pain. A systematic review by van der Windt et al[6] on occupational risk factors of shoulder pain found the available evidence was not consistent for most risk factors, not of generally high methodological quality and the strength of these associations was modest. Pope et al[8] noted complaints of pain to be higher in workers of various occupations who associated their work activities with stress or worry, or reported the work to be monotonous. From these previous reports, it is clear that more needs to be known about the prevalence, specifics, and occupational risk factors of musculoskeletal injury to sign language interpreters. Treatment protocols and preventative measures need to be developed for this specific and overlooked worker group.

Physical therapists are health care providers who not only treat WRMDs but also provide consultation to patients and their employers on safe work practices, including prevention strategies.[3] The aim of this survey is to identify the prevalence of musculoskeletal pain experienced by a community of sign language interpreters as a result of their work and to identify the need for educational materials that might be developed to help this population reduce risk of injury.

METHODS

A survey (Table 1) was designed using SurveyMonkey to elicit responses from interpreters regarding their present or previous experiences with WRMDs, as well as demographic and job-specific information on work demands, duration, and experience. The survey used a variety of multiple choice, dichotomous, and Likert-type items. The survey was reviewed and approved by Bellarmine University IRB Committee (IRB #417). Respondents were sign language interpreters recruited from the Centers for Accessible Living (CAL) in Louisville, KY. A 23-item survey was sent via e-mail to all sign language interpreters employed by CAL. Eighteen (n=18) interpreters responded to the survey (response rate 51%); all were volunteers, and written informed consent was obtained. All 18 respondents were considered active interpreters and all were female.

FINDINGS

Demographics and Work Experience

Eighteen (100%) of the interpreters were active signers, and all were female. According to the survey (see Table 1), 17 (94.4%) interpreters reported their ethnicity as white and one (5.6%) interpreter reported her ethnicity as black. Four (22.2%) interpreters were between 20 and 30 years old, 7 (38.9%) were between 30 and 40 years old, 3 (16.7%) were in the 40 to 50 age range, and 4 were over the age of 50 (Figure 1). Eleven (64.6%) of the interpreters reported regularly participating in physical activity for exercise, 6 reported they did not regularly partici-

Table 1. Overview of Survey Results

Participant	Gender	Age (yrs)	Race	Active Interpreter (Y/N)	Yrs As An Active Interpreter	Job Satisfaction	Job Setting	Hrs Signing Per Day	Pain in last Year (Y/N)	Initial Pain Onset	Pain (0-10) at Worst	Area(s) of Body Affected	Onset of pain
Participant 1	Female	30-40	White	Yes	10-20 years	Excellent	School/classrooms	10+	Yes	1+ years	5	Elbow/Forearm, Hand/Wrist, Fingers	1 hour into signing
Participant 2	Female	30-40	White	Yes	5-10 years	Great	School/classrooms	10+	Yes	2-4 weeks	3	Neck, Shoulder, Upper Back, Low Back	1 hour into signing
Participant 3	Female	30-40	White	Yes	10-20 years	Excellent	Other	10+	No	N/A	0	(none)	N/A
Participant 4	Female	30-40	White	Yes	10-20 years	Excellent	Other	10+	Yes	1+ years	8	Neck, Hand/Wrist, Upper Back	45 minutes into signing
Participant 5	Female	20-30	White	Yes	0-2 years	Great	Other	10+	Yes	1-3 months	4	Shoulder, Hand/Wrist, Upper Back, Low Back	30 minutes into signing
Participant 6	Female	Over 50	White	Yes	20+ years	Great	[Skipped]	10+	Yes	1+ years	4	Neck, Shoulder, Elbow/Forearm, Hand/Wrist, Fingers, Upper Back, Low Back	1 hour into signing
Participant 7	Female	20-30	White	Yes	0-2 years	Good	Other	10+	Yes	3-6 months	3	Shoulder, Elbow/Forearm, Hand/Wrist, Fingers	1 hour into signing
Participant 8	Female	Over 50	White	Yes	20+ years	Excellent	Other	10+	Yes	1+ years	3	Neck, Shoulder, Elbow/Forearm, Hand/Wrist, Fingers, Low Back	1 hour into signing
Participant 9	Female	40-50	White	Yes	5-10 years	Excellent	School/classrooms	10+	Yes	1+ years	5	Neck, Shoulder, Hand/Wrist	45 minutes into signing
Participant 10	Female	40-50	White	Yes	5-10 years	Great	Other	8 - 10	Yes	1-3 months	3	Neck, Upper Back	1 hour into signing
Participant 11	Female	Over 50	White	Yes	10-20 years	Good	School/classrooms	10+	Yes	1+ years	6	Neck, Shoulder, Elbow/Forearm, Upper Back	[Skipped]
Participant 12	Female	Over 50	White	Yes	20+ years	Poor	School/classrooms	10+	Yes	1+ years	10	Neck, Shoulder, Elbow/Forearm, Hand/Wrist, Upper Back, Low Back	45 minutes into signing
Participant 13	Female	30-40	White	Yes	10-20 years	Good	Other	10+	Yes	1+ years	2	Neck, Shoulder	1 hour into signing
Participant 14	Female	30-40	Black or African American	Yes	10-20 years	Excellent	School/classrooms	10+	Yes	1+ years	6	Neck, Elbow/Forearm, Hand/Wrist, Fingers, Low Back	1 hour into signing
Participant 15	Female	40-50	White	Yes	10-20 years	Good	School/classrooms	10+	Yes	1+ years	10	Neck, Shoulder, Elbow/Forearm, Hand/Wrist	45 minutes into signing
Participant 16	Female	20-30	White	Yes	2-5 years	Good	Other	10+	Yes	1+ years	2	Hand/Wrist	1 hour into signing
Participant 17	Female	20-30	White	Yes	0-2 years	Excellent	Other	10+	Yes	6-12 months	6	Hand/Wrist, Fingers, Low Back	1 hour into signing
Participant 18	Female	30-40	Black or African American	Yes	2-5 years	Great	School/classrooms	10+	Yes	1+ years	5	Shoulder, Hand/Wrist, Feet/Ankles	45 minutes into signing

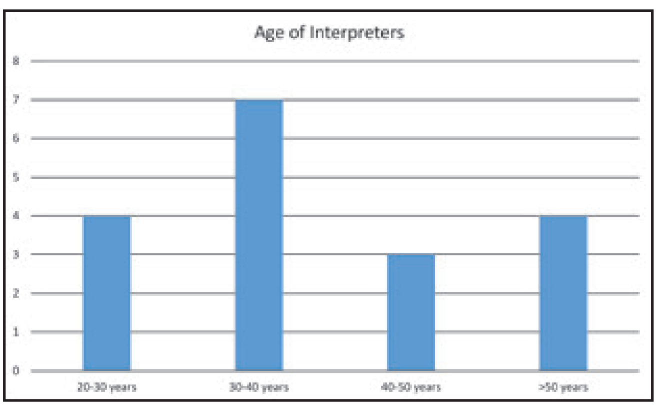

Figure 1. Age of interpreters.

pate in any physical activity for exercise, and one interpreter declined to respond to this question. Data are presented in Table 1. The most common type(s) of exercise reported were walking (84.6%), running (30.8%), swimming (30.8%), weight lifting (23.1%), yoga/Pilates (23.1%), biking (15.4%), and dance, with one (7.7%) interpreter reporting regularly participating in horseback riding. Three (16.7%) interpreters reported a length of career in signing between 0 and 2 years, 2 (11.1%) reported signing between 2 and 5 years, 3 (16.7%) reported signing between 5 and 10 years, 7 (38.9%) reported signing between 10 and 20 years, and 3 (16.7%) reported signing for over 20 years (Figure 2).

Job Details

Seventeen interpreters (94.4%) reported signing >10 hours per week with one (5.6%) reporting signing 8 to 10 hours per week. In regards to the question of overall job satisfaction all interpreters were generally satisfied with their current job, with only one (7.7%) interpreter indicating "poor" satisfaction.

Signs and Symptoms of WRMDs

Seventeen interpreters (94.4%) reported experiencing pain associated with their work activities over the previous year. The interpreters who reported experiencing pain reported symptoms in the following anatomical location(s): hand/wrist (76.5%), neck (64.7%), shoulder (64.7%), elbow/forearm (47.1%), upper back (41.2%), lower back (41.2%), fingers (35.3%), and feet/ankles (5.9%) (Figure 3). Interpreters described the nature of their symptoms as aching (77.8%), pain (55.6%), stiffness (55.6%), tingling (50%), numbness (33.3%), weakness (22.2%), cramping (22.2%), burning (16.7%), and/or swelling (11.1%) (Figure 4). When asked to rate their pain levels when at its most severe (between 0 = "no pain" and 10 = "you need to go to the emergency room"), 11.1% rated it as a 2/10, 22.2% rated it as a 3/10, 16.7% rated it as a 5/10, 16.7% rated it as a 6/10, and 11.1% reported it as a 10/10. Ten (55.6%) interpreters reported time of onset of symptoms to be when signing for an hour or greater, 5 (27.8%) reported symptom onset at 45 minutes, and one (5.6%) reported symptom onset at 30 minutes (Figure 5). Two interpreters did not respond to the time of onset of symptoms question. When prompted to select the primary motion(s)

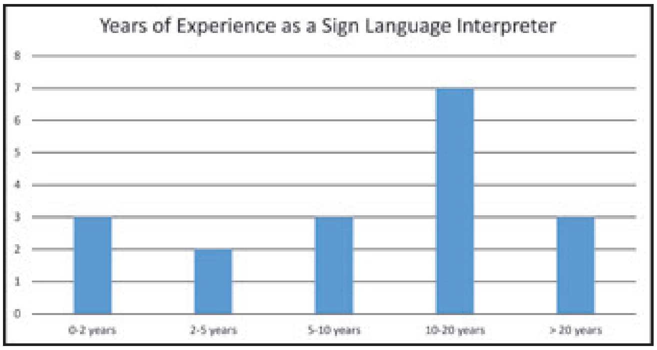

Figure 2. Years of experience as a sign language interpreter.

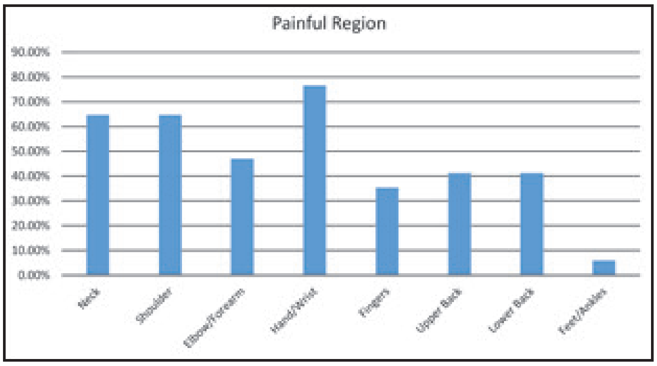

Figure 3. Painful body region(s) reported.

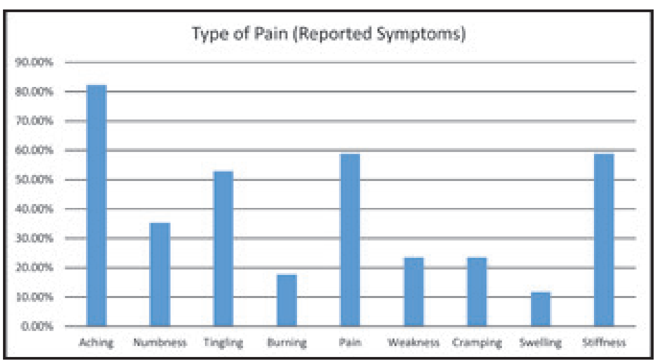

Figure 4. Type(s) of pain (symptoms reported).

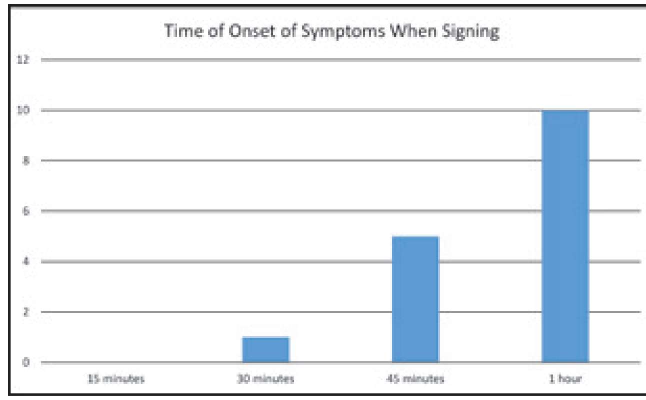

Figure 5. Time of onset of symptoms when signing.

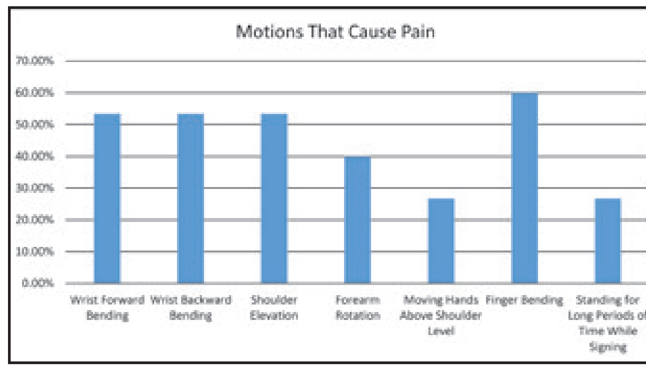

Figure 6. Motions that cause pain.

or activities that cause pain, 15 interpreters responded, and 3 did not respond to the question. The motions that were most frequently reported as causing pain were finger bending (flexion) (60%), followed by wrist forward bending (flexion) (53.3%), wrist backward bending (extension) (53.3%), shoulder elevation (53.3%), forearm rotation (40%), moving hands above shoulder level (26.7%), and standing for long periods of time while signing (26.7%) (Figure 6).

Loss of Time at Work

Three (17.6%) of the interpreters reported they had lost time at work due to their work-related pain, while 14 (82.4%) reported they had not lost time at work due to their pain. One interpreter failed to answer this question.

Intervention

Eight (53.3%) interpreters reported having sought treatment for work-related musculoskeletal problems from a health professional. Of those who sought treatment, 4 (50%) reported seeing a chiropractor, 3 (37.5%) a physical therapist, 2 (25%) orthopaedic physicians, 2 (25%) a primary care physician, and 1 (12.5%) had received treatment from an occupational therapist. Ten (55.6%) interpreters reported previously attending an educational workshop on workplace ergonomics. In a separate question, 8 (44.4%) reported having attended a workshop specifically on stretching techniques. Of the 12 who reported having not attended an educational workshop on ergonomics, stretching, or both, all (100%) responded they would be interested in attending a workshop focusing on proper workplace ergonomics and stretching techniques to help prevent musculoskeletal overuse injuries in the future.

DISCUSSION

This pilot study is a preliminary, community-based investigation on the prevalence of musculoskeletal injuries experienced by sign language interpreters from a local organization in a defined geographic region (metropolitan area in the Midwest). Seventeen (94.4%), of the 18 interpreters surveyed, reported experiencing pain associated with their work over the previous year. A wide range of ages responded to the survey, with the majority being between 30 and 50 years old (55.6%), and having been actively working as an interpreter for 10 to 20 years (38.9%). All of the interpreters who had been actively interpreting for less than 2 years, as well as the interpreters who have been actively interpreting for more than 20 years, reported experiencing work-related musculoskeletal pain in the previous year. Therefore, interpreters are reporting work-related injuries whether they are relatively new to interpreting or have been doing the job for over two decades. This demonstrates that years spent interpreting may not be a strong risk factor for developing a work-related injury. Future research is needed to investigate the rate at which each of these groups are experiencing injuries, as well as examining the types of injuries between them. Another important implication might be to address any pre-existing risk factors (eg, prior surgery, medical history, etc.) that are beyond the scope of the current study. Similarly, it will be important to decipher between interpreters who only sign at their jobs and those who may continue signing to a deaf child or spouse at home.

Interpreters were asked about job satisfaction in order to determine if any correlation exists between it and the severity of injury report. One participant (5.6%) reported poor job satisfaction, with the rest of the interpreters reporting either good, great, or excellent (94.4%) job satisfaction. A strong relationship between report of pain and job satisfaction cannot be made based on this data; however, it may be worthy to note that the single interpreter (participant 12) that selected the lowest job satisfaction option ("poor"), was one of the two interpreters who also reported the highest pain severity option ("10"). Future research is needed on the possible psychosocial connections that job satisfaction, job demands, work setting, work stress, personality factors, etc. can have on reported pain severity for a sign language interpreter.

Ten (58.8%) of the interpreters in our study reported their onset of symptoms typically occurred after 1 hour of signing, 5 (29.4%) reported symptoms occur following 45 minutes, and 1 (5.9%) reported an onset after 30 minutes (see Figure 6). Previous research has demonstrated that limiting the length of time spent signing without a break with a job rotation strategy, when possible, may be an important preventative strategy to reduce risk of injury.[10] Ansesio-Cuesta et al[10] developed an algorithm used to design a rotation schedule for job positions with high repeatability. This is relevant because sign language is comprised of highly repetitive motions, and interpreters' exposure to repetitive movements is a significant risk factor that can lead to WMSDs of the neck, shoulders, elbow, hand/wrist, and back. Unfortunately, a job rotation strategy may not be applicable or realistic for all interpreters. Implementation of a rotation schedule should not replace the redesign of jobs to reach acceptable risk levels.[10] Other preventative measures including educational and prevention programs developed by health and safety professionals, such as physical therapists, need to be used in conjunction with a rotation schedule to prevent work-related musculoskeletal injuries in sign language interpreters.

Employers of sign language interpreters could benefit from a reduction in time lost by their employees at work due to pain. Fourteen (82.4%) interpreters reported having previously lost time at work due to work-related pain. David et al[11] describes the development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related MSDs.[11] This may be a useful tool in developing an intervention protocol for a sign language interpreter based on the setting and his or her individual and psychosocial risk factors. The QEC involves both an Occupational Safety and Health practitioner and the worker (in this case the interpreter) in the assessment and has "fair to moderate" levels of inter- and intra-observer reliability.[11] The QEC was designed for industrial work sectors; however, it seems to have potential as a useful tool in developing treatment interventions for sign language interpreters. Perhaps developing a tool specific to sign language interpreting should be considered to address the specific nature of the job.

Along with job rotation strategies and screening tools, physical therapists could develop additional preventative measures in this worker population and provide treatment interventions including but not limited to therapeutic exercise; stretching, strength, and/or endurance training; therapeutic modalities; and patient education. A randomized controlled trial conducted by Chao, et al[12] compared the effects of various treatment interventions on groups of computer workers with work-related neck and upper extremity pain, and showed biofeedback training produced favorable outcomes in reducing pain and improving muscle activation of neck muscles in patients with work-related neck and shoulder pain.[12] Continued research in this area may provide effective plans of care for treatment of sign language interpreters.

Future research is needed on the effectiveness of physical therapist directed interventions for sign language interpreters. While the sample in the current pilot survey was small, and may not be generalizable to other geographical regions, it does indicate a need for education of the general public in the role physical therapists have in addressing WRMDs.

The current pilot study was not without limitations. The findings suggest a high prevalence of WRMDs in sign language interpreters; however, the study was unable to control for several confounding variables. In order to provide a more detailed and valid analysis of work-related injuries in sign language interpreters, it is necessary for other contributing factors to be assessed. This includes but may not be limited to information such as individual medical history and general health or physical activity levels, tobacco use, sleep habits, and mental health. Also, all collected data was based on subjective report. Objective measurements such as range of motion and muscle testing, postural alignment as well as a field observation of signing movements, may improve the validity of these findings. Second, the sample size was small and homogenous in nature, thus limiting the interpretation of the results. A larger number of respondents would ensure greater confidence in the results that can be better generalized across the profession. Also, all respondents were female and all worked in the same community for the same employer. Although this survey could not account for gender-based differences, it may be important to note the Registry of Interpreters for the Deaf reports 84% of its members are female.[13] A longer response period may also provide a more accurate understanding of the prevalence of these injuries. For instance, the timing of the administration and response to the survey may yield different findings such as certain times of year (graduation season, school summer breaks, etc.) when sign language interpreters are more/less active. Third, the non-response of some survey items could lead to a non-response bias of the current findings. It is unclear as to why 4 questions had at least one interpreter decline to answer. These questions, or the survey directions, may have been unclear to some interpreters.

CLINICAL APPLICATIONS

The American Physical Therapy Association's vision statement for the physical therapy profession is "transforming society by optimizing movement to improve the human experience."[9] It further explains, "The complex needs of society…beckon for the physical therapy profession to engage with consumers to reduce preventable health care costs and overcome barriers to participation in society.[9]" A strong link between physical therapists and sign language interpreters is in the best interest of both professions if there is any prevalence of WRMDs in these workers. This pilot survey study suggests that work-related musculoskeletal pain experienced by sign language interpreters may be a prevalent concern in this occupation. A major challenge for the rapidly growing sign language interpreter profession is how to mitigate the work-related risks associated with this occupation appropriately to help a healthy work force of interpreters maintain capability to handle an increasing workload. This survey is important in linking physical therapist practice with sign language, as it shows that ASL interpreters could benefit and are willing to participate in preventative interventions. Physical therapists are health care providers who not only treat WRMDs but also advise patients and their employers on safe work practices, including prevention. Physical therapists, as movement experts, can make a positive impact on their communities and society by developing and providing educational material, group workshops and individual treatment plans that instruct these workers on preventative strategies to protect their bodies.

ACKNOWLEDGMENTS

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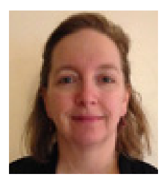

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PERFORMING ARTS

SPECIAL INTEREST GROUP

President's Letter

Annette Karim, PT, DPT, OCS, FAAOMPT

It is almost summertime! Below are updates from the PASIG leadership:

CSM 2017: We are pleased to announce our PASIG programming for CSM 2017: Out of Tune: A Guide to Upper Extremity Nerve Entrapment Syndromes in Musicians by Dr. Janice Ying, PT, DPT, OCS, our own Nominating Committee Chair, and Erin Hayden, PT, DPT, OCS. We hope you can join us and build your expertise in treating the musician!

Call for Citation Blasts: Past monthly citation blasts are available, with citations and EndNote file, listed on the website at http://www.orthopt.org/content/special_interest_groups/performing_arts/citations_endnotes

Please contact Laura Reising if you are interested in helping out with the monthly blasts. She can be reached at lbreising@gmail.com.

Call for Case Reports: If you have a brief, clinically-focused case report on a performing arts physical therapist patient, or a clinical commentary, please contact Annette Karim (neoluvsonlyme@aol.com) to submit your writing for the next issue of *Orthopaedic Physical Therapy Practice*.

Call for Leaders: In 2017, there will be 3 open PASIG positions: President, Secretary/Student Scholarship Chair, and Nominating Committee member. Please contact Janice Ying if you are interested in serving as a leader at JaniceYingDPT@gmail.com, or if you would like to be in any of the committees.

Dancer Screening: If you are interested in dancer screening for the young or pre-professional dancer, please contact Mandy Blackmon at MandyDancePT@gmail.com.

Social Media: If you have anything to share on social media, contact Dawn Muci. Our Twitter handle is **PT4Performers**. https://twitter.com/PT4Performers

Keep up with us on Facebook by contacting Dawn Muci It is a closed group, so you need to contact Dawn first.

Looking for Great Residency and Fellowship Opportunities? See below:

The Harkness Center for Dance Injuries Residency Program

The NYU Langone Medical Center (NYULMC) Harkness Center for Dance Injuries is a clinical site for NYU Steinhardt School of Education's Orthopedic Physical Therapy Residency (ORP). The ORP is a 12-month program that provides the resident with an intensive, individualized experience in orthopaedic physical therapy and dance medicine. The goal of the residency program, which follows the guidelines and accreditation standards of the American Physical Therapy Association (APTA), is to enable the resident to develop the advanced clinical skills necessary to provide a superior level of patient care. Upon completion of the residency program, the resident will have gained the knowledge and experience to be a competent advanced practitioner, and be qualified to sit for board certification in orthopaedics (OCS). Please note that all applicants must apply to New York University's Orthopedic Physical Therapy residency program and also be interviewed and accepted by the Harkness Center for Dance Injuries. Please visit http://steinhardt.nyu.edu/pt/opt and http://hjd.med.nyu.edu/harkness/healthcare-professionals for more information.

Interested in a Performing Arts Fellowship?

The American Board of Physical Therapy Residency and Fellowship Education (ABPTRFE) reviewed the revalidation practice analysis for the Description of Advanced Specialized Practice for Performing Arts Physical Therapy. The subspecialty area of Performing Arts Physical Therapy was approved for fellowship study! Many thanks to the project team members and those who participated in the national survey process. This was the first and possibly largest hurdle in laying the groundwork for fellowship programs in the field. The ABPTRFE will now take the practice analysis as well as consult with the Practice Analysis Coordinator/Fellowship Task Force Chair and project team while the ABPTRFE write the Description of Fellowship Practice. If you are interested in starting a fellowship program, there is a great online CEU course through the APTA Learning Center that explains the process and things you should take into consideration while you lay the framework for your potential program. It is titled "Residency and Fellowship 101." It is also a requirement of the application for candidacy for a new fellowship program. If you would like to meet during CSM 2017, or if you have any question prior, please contact Mariah Nierman at Mariah.Nierman@osumc.edu or Laurel Abbruzzese at La110@cumc.columbia.edu.

For Membership questions, please contact Liz Chesarek at echesarek@gmail.com.

Current PASIG members, please remember to update your membership at https://www.orthopt.org/login.php?forward_url=/surveys/membership_directory.php.

For Independent Study Course committee interest or author opportunities, please contact Julie O'Connell at Connell@athletico.com.

FOOT & ANKLE

SPECIAL INTEREST GROUP

News from the FASIG Research Chair

Karin Grävare Silbernagel

Hello FASIG! As the new-this-year FASIG Research Chair, I would like to share a summary from the 17th ESSKA Congress that I recently returned from.

I have attended the ESSKA Congress 5 times since 2006 and must say it is one of my favorite meetings due to the interdisciplinary focus, good organization, and wonderful people. They also host the conference in great locations. This year's conference, in Barcelona, was no exception.

The European Society of Sports Traumatology, Knee Surgery & Arthroscopy (ESSKA) consists mainly of Orthopedic Surgeons, but Physical Therapists can also hold a conditional membership. The ESSKA consists of 3 sections, the Ankle and Foot Associates (AFAS), European Knee Associates (EKA), and European Shoulder Associates (ESA). Biannually, they organize a congress with a scientific program consisting of 6 concurrent sessions. For 3 out of the 4 days, there is also a physical therapy track organized by physical therapists. As part of the physical therapy track, there are also practical workshops for smaller groups. This year in Barcelona there were 4000 delegates.

The official clinical journal of ESSKA is the *Knee Surgery Sports Traumatology Arthroscopy* (KSSTA). The April issue this year was focused on the ankle and had the title "There is no simple ankle sprain." Twenty-five articles were on the lateral ankle ligament, 5 on peroneal tendons, 6 on syndesmotic ligament, 12 on talar osteochondritis dissecans, and 2 on osteoarthritis. The AFAS section had several scientific sessions based on the articles in this special issue during the congress. Hot topics were discussions on whether lateral ankle ligament reconstruction should be performed as an open or arthroscopic procedure, and the importance of anatomical reconstruction of the lateral ankle ligaments.

Other interesting sessions were called debates where the presenters were tasked with talking about their most challenging case. My favorite was the debate, "My worst Achilles case" where 5 orthopaedic surgeons, who are experts on Achilles tendon, presented. Often we just hear about success, but understanding the challenges raises both good clinical and research questions. The session provided for an interesting and informative discussion among the panel.

My favorite event of the week was a 1.5 hour session titled, "Peroneal tendon pathology-update from anatomy to surgery." There were 7 different presentations coupled with time for discussion. Again the session was partly based on articles published in the recent issue from KSSTA. Here I have summarized some of the sessions/articles on peroneal tendons from the KSSTA issue that I found of interest.

Peroneal Tendon Anatomy

Dr. Madirolas Alonso started the session with an excellent presentation of the peroneal anatomy based on a cadaveric study published in the KSSTA ankle issue.[1] The background to the article was the premise that peroneal tendon tears are relatively common and described to have poor healing tendencies. It has been assumed that the peroneal tendons have avascular zones in the area of the tears and this would explain the poor healing. For this study, dissections of 10 fresh frozen cadavers were performed. To visualize the blood vessels, the femoral artery (at the level of knee) was injected with natural colored latex. This study found that the peroneal tendons are well vascularized by distal branches of the peroneal artery. It was also described that the blood was supplied through a common posterolateral vincula connecting both tendons. The authors therefore recommended that the surgeons should aim for leaving the vincula intact to maintain the blood flow to the tendons. No avascular zones could be found in the peroneus brevis tendon.

Peroneal Tendon Dislocation

Dr. P. van Dijk presented their findings from a systematic review evaluating the return to sports and clinical outcomes in patients treated for peroneal dislocation.[2] The background for this study was that the majority of peroneal dislocations occur in the athletic population as part of a traumatic ankle event. The literature reports numerous surgical treatment strategies but there is no consensus how to best treat this condition. Since return-to-sport is of importance for an athlete, the authors wanted to compare the rates of return to sports and clinical outcomes between different surgical techniques. The eligibility criteria for inclusion were (1) diagnosis of peroneal subluxation or dislocation confirmed during surgery, (2) the AOFAS or return-to-sports was described, (3) the surgical technique was well described, and (4) full texts were available in English. A total of 13 studies were included in the study. All the included studies were rated as having low quality. The return-to-sports rate ranged from 55% to 100%, and the time-to-return was 1.2-12 months. Surgical treatment that combined repair of the superior peroneal retinaculum and groove deepening of the retro-malleolar groove had higher rate-of-return to sports compared to solely repairing the retinaculum. The authors concluded that surgical treatment provided good outcomes, high satisfaction, and a quick return to sports; however, remember that this is based on low quality studies. The rehabilitation was also not mentioned.

Rehabilitation After Surgical Treatment of Peroneal Tendon Tears and Ruptures

The presenters at this session were all orthopaedic surgeons; I really missed a good presentation on rehabilitation. I did, however, find an article in the special issue of KSSTA addressing rehabilitation after surgical treatment of peroneal tears and ruptures.[3] This was a systematic review and a total of 47 studies were included. The authors found that the rehabilitation protocols varied in number of weeks of nonweight bearing, partial weight bearing, and when range of motion were allowed. In summary the median duration of total immobilization after primary repair was 6 weeks (range 0-12), after tenodesis 7 weeks (range 3-13), after grafting 6 weeks (range 3-13), and after end-to-end suturing 8 weeks (range 6-11). The authors pointed out that in recent years there seem to be a trend towards starting range of motion and rehabilitation within 4 weeks after surgery. The authors proposed a rehabilitation protocol in this article based on the reviewed articles and personal clinical experience. My disappointment with this program is that it is another protocol where the progression of the rehabilitation is mainly guided by the time since surgery. Since patients recover at a different pace, it is also of importance to evaluate if the patient can safely progress to the next stage of rehabilitation. It would have been nice if the authors had included suggestions for outcome measures to evaluate recovery and function, and described important milestones for each phase of the rehabilitation. Seems to me that there is a need for physical therapy research to evaluate the outcome of early mobilization and rehabilitation compared to the more conservative postoperative regimes.

In summary, this was another great conference but I think more research is needed in the area of physical therapy guided treatment and rehabilitation for patients with peroneal tendon injury. Hope to see you at the 18th ESSKA Congress May 9-12, 2017 in Glasgow, Scotland, UK.

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IMAGING

SPECIAL INTEREST GROUP

President's Letter

Charles Hazle, PT, PhD

This is a dynamic, eventful time for the Imaging Special Interest Group (SIG). As of this writing, the SIG lists 253 members with membership on the rise. The SIG is becoming an increasingly visible entity within the profession. This is quite remarkable given the organization's recent inception in 2010. Now on to the most prominent issues:

1) We now have a social media presence on Facebook and Twitter. The Facebook page is closed to members only and can be accessed at https://www.facebook.com/groups/1534624566841610/. Then, click "Join Group." Once your Imaging SIG membership is verified, you will be added to this private Facebook page. Additionally, our Twitter handle is @PTImgSIG; please follow and contribute with posts directly related to imaging. With so much happening with the SIG and the steady stream of imaging information available, these two accounts may help you stay abreast of current events and perhaps allow you to contribute to others' knowledge. We plan to help keep you informed of SIG activities and imaging in PT news through these media in addition to occasional e-mails.
2) We have published and are disseminating a position paper on imaging in physical therapist practice, tentatively entitled "Diagnostic and Procedural Imaging in Physical Therapist Practice." This paper advocates for physical therapists to gain diagnostic imaging privileges as a natural extension of clinical practice. The document also supports systematic changes for physical therapist reimbursement for ultrasound imaging.
3) There is also an effort underway for passage of a resolution pertaining to imaging in the 2016 House of Delegates in Nashville. Perhaps by the time you read this, the resolution will have passed and APTA will be establishing an effort in support of systematic changes in institutional and payment mechanisms toward imaging as a part of physical therapist practice.
4) You have probably heard by now, but the news bears repeating that Wisconsin has enacted legislation to include physical therapists in imaging. Wisconsin Act 375 was signed into law by Wisconsin Governor Scott Walker with language that adds physical therapists to the list of medical professionals who may order radiographs and allows a physical therapist to use radiograph results to determine a course of care or to determine whether a referral to another health care provider is necessary.
5) A call for involvement and member contributions of effort. The SIG has ambitious undertakings planned and we need your involvement. As you read the items in the strategic plan described below, please contact me at crhazl00@uky.edu (6th character is lower case letter "L" followed by two zeros), if there is an area in which you are confident of your ability to contribute. Not only to accomplish these rather ambitious undertakings, but also the need to build involvement in the SIG for development future leadership—we need your contribution of time and effort. This SIG will be integral in the effort that will very likely impact future clinical practice and you can be part of that.

STRATEGIC PLAN

In February, the Imaging SIG established a strategic plan for immediate and future activities, promoting expansion of imaging in physical therapist practice. Some of those are in the process of being achieved or have been achieved already, such as the social media presence and the position paper. These objectives have been placed into 3 categories: research, education, and practice. These are described below:

Research

Overall Goal: Increase the visibility of physical therapists (PTs) using imaging and the influence their products have on health care.

- Create a culture to increase number of publications by PTs using imaging.
- Create a culture to increase number of presentations by PTs in non-physical therapy conferences.
- Encourage participation of PTs in development of practice guidelines.
- Inform researchers how to become editorial review board members for manuscripts/grants for imaging journals.
- Create opportunities to seek and secure a seat at table of Center on Health Services Training and Research (CoHSTAR) and other large groups.
- Establish a collaborative relationship between the Imaging SIG and the Orthopaedic Section Research Committee to review publications and grant applications.
- Ensure appropriate reviewers for all physical therapy–rehabilitation journals.
- Develop short-course/intensive fellowship opportunities to financially support seed funding.
- Create an "Expert Mentors" webpage with names listed of content experts in specific areas of imaging (linking to specific labs).
- Encourage the inclusion of imaging for exploration at research intensive programs in physical therapy and federally funded research projects.

Education

Overall Goal: Educate relevant stakeholders about the role of imaging in PT practice.

- Provide educators, instructors, and learners resources to assist with learning objectives.
- Synthesize imaging applications from across practice pat-

terns (sections) to expand effectiveness of modality use across diverse patient populations.
- Expand resource list on Orthopaedic Section SIG page.
- Develop representative case(s) that demonstrates application of imaging in PT practice illustrative of educational foundations at entry level, clinical practice, residency, fellowship and subspecialist levels.
- Develop tools to identify learners' strengths and challenges related to imaging need (yes/no), modality selection, interpretation, and evaluation associated with patient presentation.

Practice

Overall Goal: Support the development and distribution of resources that promote optimal utilization of imaging in PT practice.

- Advocate for appropriate inclusion of PTs in the American Institute of Ultrasound Medicine official statements.
- Develop a toolbox for achieving ordering privileges in medical staff bylaws.
- Develop and deliver educational content for clinical integration of imaging:
  - case modules,
  - CSM proposals,
  - technology applications,
  - PTNow, and
  - other offerings.
- Develop content for residency and fellowship programs on imaging.
- Develop visiting fellow programs in imaging.
- Advocate for inclusion of imaging and appropriate valuation in APTA payment reform.
- Identify and develop patient-centered imaging education materials.
- Promote the accessibility of imaging studies and reports in interoperative electronic medical records.
- Increase the number of expert witnesses in medical legal cases related to imaging.

CALL FOR IMAGING SUBMISSION

The Imaging SIG is soliciting submissions for publication in the imaging column of *OPTP*. Types of submissions can include the following:

- Case Report: A detailed description of the management of a unique, interesting, or teaching patient case involving imaging. Case reports should include: Background, Case Description including Imaging, Outcomes, and Discussion.
- Resident's Case Problem: A report on the progress and logic associated with the use of imaging in differential diagnosis and/or patient management. Resident's Case Problem should include a Background section; Diagnosis section that details the examination and evaluation process leading to the diagnosis and the rationale for that diagnosis, including a presentation of imaging studies; Interventions section used to treat the patient's condition and the outcome of treatment; however, the focus of the resident's case problem should be on the use of Imaging in the diagnostic process and patient management; the Discussion section offers a critical analysis of how the Imaging guided the management of the patient.
- Clinical Pearl: Clinical pearls are short papers of free standing, clinically relevant information based on experience or observation. They are helpful in dealing with clinical problems for which controlled data do not exist. Clinical Pearls should describe information pertaining to Imaging that help inform clinical practice.

Submissions should be sent to: Joel Fallano, jfallanopt@verizon.net

Cord Compression in a Patient Referred to Rehabilitation Services for Lower Extremity Weakness and Carpal Tunnel Syndrome

Edward J Boudreau, PT, OCS, FAAOMPT
Spaulding Rehab Network, Boston, MA

A 65-year-old male presented to outpatient physical therapy (PT) services with a referral for lower extremity weakness and an altered gait pattern. In addition, the patient was also being referred from his primary care physician to occupational therapy for carpal tunnel syndrome.

While escorting the patient back at the beginning of the PT exam, the physical therapist observed the patient was using a rolling walker and ambulating with an ataxic gait pattern. The patient reported a 3-month history of insidious onset, rapidly progressing lower extremity (LE) weakness, and unchanging LE pain. Due to the ataxic gait observation and the subjective report of symptoms involving the bilateral lower extremities, the subjective exam included red flag screening questions for upper motor neuron injury. Questioning regarding numbness and or tingling of bilateral upper or lower extremities revealed gross numbness of the bilateral hands. The patient also revealed having difficulty buttoning shirts, tying shoes, and feeling uncoordinated when ambulating. The patient denied any bowel or bladder changes, and numbness or tingling of the genital area and saddle region.

A hypothesis of upper motor neuron injury was developed from the subjective exam. Consequently, a central nervous system (CNS) screening was performed as part of the objective exam. The CNS testing revealed a positive Babinski on the left, 3+ patellar reflexes bilaterally, plantar flexor clonus bilaterally, and negative Hoffman's. Motor and sensory testing further showed significant gross motor loss of the LE and sensory loss upper extremities.

Collectively, the subjective and objective findings supported the hypothesis of an upper motor neuron injury. The patient was referred back to his primary care physician with the recommendation of imaging and a consult with a specialist.

Imaging revealed multi-level moderate to severe cord compression at C4, C5, and C6 (Figure 1), with the worst occurring at C5/6 resulting in cervical spondylotic myelopathy. Lumbar imaging revealed lumbar stenosis at L3, L4, and L5 (Figure 2). It was believed that the lumbar stenosis was the origin of the patient's LE pain.

The patient was advised to undergo cervical decompression

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Figure 1. T2 Sagittal multilevel cervical degenerative changes resulting in spinal cord compression and impingement, most prominent at C5/6.

Figure 2. T2 Sagittal L4/5 disc herniation along with facet and ligamentum flavum hypertrophy resulting in moderate to severe lumbar spinal stenosis.

surgery to prevent further progression of the myelopathy and was informed a second procedure for the lumbar stenosis symptoms may be necessary. The patient opted to undergo a combined cervical and lumbar decompression procedure.

Myelopathy is a pathological disease process that results in compression or ischemia of the spinal cord. Patients often report clumsiness as the first symptom to be present in cervical myelopathy.[1] Even though cervical myelopathy is the most common form of spinal cord injury in people over age 55, there is evidence that less than 5% of primary care physicians routinely screen for findings of cord myelopathy.[2-4] Therefore, it is imperative as direct entry care providers to be able to identify the signs and symptoms of cervical myelopathy.

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Musculoskeletal Ultrasound Imaging Case Study: Knee Baker's Cyst in a Triathlete

Theodore Croy, PhD, PT, OCS
US Army-Baylor University DPT Program

The patient was a 33-year-old male triathlete and family practice physician who sought the evaluation of a physical therapist due to a self-diagnosed plantaris strain or rupture. The patient stated that he developed knee pain 3 months prior to the encounter during mile 3 of a 26-mile full triathlon. He denied a traumatic event and stated that he felt the onset of a sharp pain in the popliteal area of the right knee. The patient completed the race but had pain with every step through the 26-mile run. He had moderate to severe post-race knee pain and loss of motion for 2 to 3 days. He was unable to run more than 1 to 2 miles for the next 3 months because of popliteal knee pain and pressure that he rated as 5/10. He hypothesized that he had strained or torn his plantaris muscle. The treating physical therapist sought requested musculoskeletal ultrasound imaging because the physical therapy examination did not support that hypothesis.

Upon examination, the patient had a normal gait, a painful deep squat, no pain with resisted plantar flexion or standing heel raises. The pain was reproduced with passive and active knee flexion that worsened from 100° to 130° of knee flexion. There was no effusion prominent on the anterior view of the knee but the popliteal fossa of the right knee was slightly larger both visually and palpably between the heads of the gastrocnemius. Resisted knee flexion and passive hamstring stretching reliably reproduced the patient's pain and there were no signs of instability. Joint line tenderness was negative but McMurray's test was equivocal. The therapist reasoned that the most likely differential diagnosis was a Baker's cyst and potentially a tear of either the medial or lateral meniscus.

The therapist considered two possible diagnoses, the patient's self-diagnosis of a plantaris rupture and a symptomatic Baker's cyst.

Ultrasound imaging of the popliteal fossa was performed

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bilaterally in short and long axis with the asymptomatic knee imaged first. Dual screen view of the asymptomatic and symptomatic popliteal fossae demonstrated an asymmetrical appearance that was shared with the patient. Short axis imaging of the popliteal fossa demonstrated a compressible, C-shaped fluid collection concave laterally wrapping around the medial head of the gastrocnemius. The collection communicated with the posterior knee joint. The patient was educated that the pain in his knee was more likely from pressure and irritation from the Baker's cyst and less likely due to a plantaris injury. He subsequently underwent magnetic resonance imaging and the results confirmed the clinical and ultrasound suspicion of a Baker's cyst, which the patient treated conservatively for 3 months and the cyst spontaneously resolved.

This case demonstrates the value of bilateral imaging, image review with the patient, and subsequent advanced imaging in the confirmation of the ultrasound diagnosis. The patient's self-diagnosis was incorrect and the musculoskeletal ultrasound exam later revealed the correct diagnosis confirmed by magnetic resonance imaging.

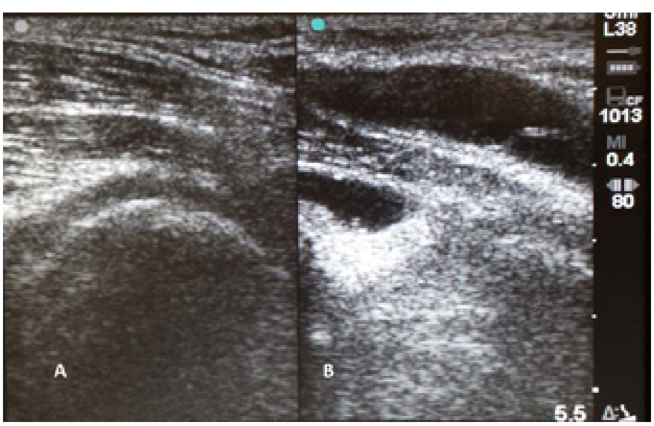


Figure 1. Long axis ultrasound imaging of popliteal fossa. Asymptomatic knee (A) and symptomatic knee (B) in same imaging plane. Fluid collection noted deep and superficial to the semimembranosus tendon (open arrow).

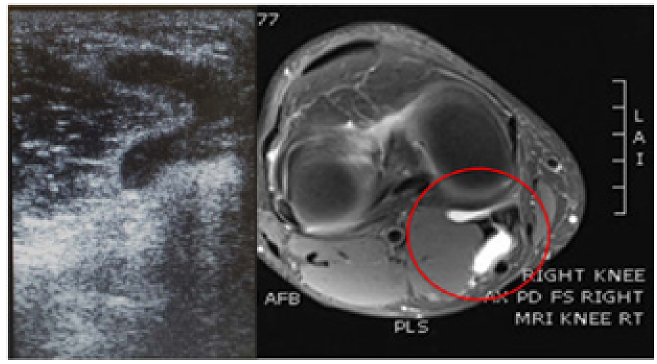


Figure 2. Short axis imaging of popliteal fossa with C-shaped fluid collection consistent with a Baker's cyst. Proton density fat suppressed magnetic resonance imaging in axial plane with confirmatory finding.

ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

President's Message

Kirk Peck, PT, PhD, CSCS, CCRT

APTA Combined Sections

Mark your calendars now for February 15-18, 2017, and join us for the APTA Combined Sections Meeting in San Antonio, Texas. The Combined Sections Meeting is a key venue for the ARSIG to support members with educational opportunities in animal rehabilitation so your presence is greatly desired. Last year the SIG unfortunately had to cancel an outstanding preconference event on canine manual therapy of the cervical spine due to low early registration numbers. However, the two-hour programming on elite equine show jumping was accepted for the conference and achieved great success in attendance numbers with multiple questions from the audience.

So why is CSM so important to the SIG? Well basically it is the most widely attended event where thousands of PTs and PTAs come together to learn from others in the field and to facilitate new ideas. It is also an invaluable venue to network with others often leading to new adventures in physical therapist practice. Basically it is the place where the Animal Rehab SIG has the greatest potential to capture the largest number of individuals to learn about a very exciting and ever-growing area of PT practice. In other words, CSM is currently the life-blood for the SIG, which many of you know was organized historically to specifically provide therapists who treat animals a voice on a national scale.

Practice Analysis Update

The ARSIG Practice Analysis survey continues to move forward albeit with a slight delay since January. Task Force members recently met and will be finalizing the survey tool to be used for data collection on the current state of animal practice in the United States. A pilot study of select members will be conducted shortly before launching the survey to all SIG members, and as many non-SIG practitioners that can be reached. It will be important to get a high return rate on completed surveys to generate a well-rounded view of animal practice.

California Veterinary Medical Board

The latest update from California is that an Animal Rehab Task Force has been organized to address issues and concerns regarding physical therapists (PTs) practicing on animals. For the first time ever the Task Force will include the voice of PTs at the table to encourage a more "collegial" approach to language negotiations. The goal is for the committee to generate proposed regulatory language by January 2017. In addition, the California PTs formed an "Animal Physical Therapy Coalition" and hired a separate lobbyist to handle additional legislative activities involved in the process.

Due to the high cost of spearheading these important endeavors, the coalition formed a GoFundMe campaign. If you wish to donate to the fund, you may do so at https://www.gofundme.com/mqzmtu3g. A "must see" video was also posted on the same link demonstrating the value of including skilled physical therapy services as part of rehabilitating a canine patient who suffered a spinal cord injury from a car accident. Spare 4 ½ minutes of life and watch the video when you get a chance.

Unlicensed Individuals and False Advertising

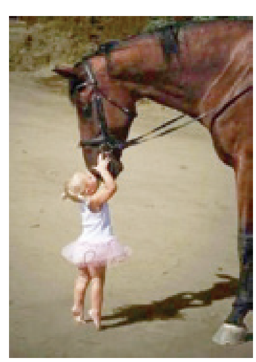
In the last edition of *OPTP,* I spoke to the value of engagement in the profession, and especially in the ARSIG, such as running for an elected office and participating in activities associated with political advocacy. In this edition, I would like to address the topic of skilled PT care being provided by appropriately educated professionals.

Over the past several months I have witnessed a few unfortunate cases where individuals, who were not appropriately credentialed or educated in animal rehabilitation, were treating animals nonetheless, and boldly calling themselves PTs or Physiotherapists. Adding to the frustration is that although authorities in charge of care for these particular animals were notified of the observed behaviors, no action was taken to address the issue.

In the human world, PTs generally frown upon uneducated or non-credentialed personnel treating individuals using techniques that took PTs years to learn through formal education. In fact, there are formal reporting mechanisms in most, if not all, states to alert regulatory authorities regarding questionable health care practice situations rendered by unlicensed individuals. Therefore, I can only surmise that all PTs and PTAs share my sense of personal duty to actively uphold the integrity of delivering quality rehabilitation when such care is classified as "physical therapy or physiotherapy."

Contributory Acknowledgment

In this edition of *OPTP*, Cheryl Riegger-Krugh PT, ScD, MS, provides an outstanding article on the canine cranial cruciate ligament in comparison to the human anterior cruciate ligament. Her contribution to advancing the knowledge of all therapists who treat animals in this edition of *OPTP* is exemplary…so thank you Cheryl for sharing your expertise with the profession.



Get To "The Pointe"

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Relative Risk of Cranial Cruciate Compared to Anterior Cruciate Ligament Injury

Cheryl Riegger-Krugh PT, ScD, MS

The canine cranial cruciate ligament (CCL) is at high risk for injury and is an important focus in canine rehabilitation.[1] In addition, with CCL injury there is risk of deficiency to the contralateral CCL, due to compensatory overuse.

The anterior cruciate ligament (ACL) is the analogous ligament in humans to the CCL in dogs. Knowledge and clinical skills of physical therapist professionals provide a foundation for applying and modifying intervention for ACL injury to intervention for CCL injury in dogs. Physical therapists, who are adequately trained in canine rehabilitation, provide a unique contribution in evaluating and managing dogs with CCL dysfunction. Rehabilitation includes the continuum of CCL deficiency, disease, laxity, injury, rupture, postsurgery, and prevention.

The primary function of the CCL and ACL is preventing *displacement* or excessive translation of the tibia in a cranial (toward the head) direction in dogs[1] and an anterior direction in humans,[2] respectively. While the joint motions restrained by the CCL and ACL are the same in dogs and humans, a number of factors, such as the magnitude of the degrees of freedom at the canine stifle/human knee and adjacent joints, characteristics of bones, joints, muscle action, type of stance, and functional movement modify the level of risk for injury of the CCL versus the ACL.

The purpose of this article is to present some of the *differences* in the anatomy and biomechanics of the CCL and ACL with the goal of developing a foundation for rehabilitation for CCL deficiency.

JOINTS

- Canine: The stifle joint consists of the medial and lateral femorotibial joints, the femoropatellar joint, and the proximal tibiofibular joint[3] (Figure 1). While there is no absolute convention, bones in canine joints often are named by the proximal bone first and distal bone second, eg, the femorotibial joints. Because there is significant constraint to normal canine tibiofibular motion, function of the stifle joint with and without inclusion of the proximal tibiofibular joint likely would be the same as motion of the femorotibial and femoropatellar joints alone.

  The coxofemoral (or hip) joint, distal tibiofibular joint, tarsal (or tarsocrural or talocrural or ankle) joint, and the hock are critical to normal stifle function. The term hock includes the distal tibia, distal fibula, and some of the proximal tarsal bones.[3] Because the distal tibiofibular joint and joints between the tarsal bones and the distal tibiofibular joint normally are very constrained, normal motion of these joints plus the tarsal joint likely would be very close to motion at the tarsal joint alone.
- Human: The knee joint consists of the medial and lateral tibiofemoral joints and the patellofemoral joint.[2,4] (Figure 2). While there is no absolute convention, bones in human joints often are named by the distal bone first and the proximal bone second, eg, the tibiofemoral joints.

  The hip; proximal, middle and distal tibiofibular joints; ankle (or talocrural) joint; and distinct inter-tarsal joints, such as the subtalar (or talocalcaneal) joint and transverse tarsal (or mid-tarsal) joint; are critical to normal knee function, with each joint contributing in a distinct and significant way. Analogous human joints to those included in the hock have less constrained motion due to shapes of bony surfaces, axes of rotation, and less-constraining ligaments. Motion at these collective joints is not representative anatomically or functionally of motion at the ankle joint.

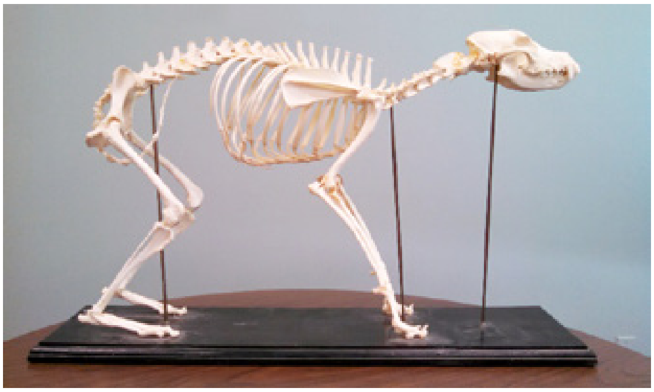

Figure 1. Anatomic position - canine stifle.

Photos courtesy of Kirk Peck

Figure 2. Anatomic position - human knee.

Stifle/Knee Bony Characteristics Relevant to CCL and ACL Function

Relevant characteristics of bones are those preventing cranial/anterior displacement of the tibia on the femur, or equally stated, restraint of caudal/posterior displacement of the femur on the tibia.

Shape of the Femoral Condyles

Canine femoral condyles are flatter than human femoral condyles. Normal cranial/anterior translation of the tibia occurs during stifle/knee extension. Flatter canine femoral condyles provide for normal cranial translation of the tibia during stifle extension but in turn allow a greater tendency for cranial displacement of the tibia. In comparison, human femoral condyles are more convex allowing for anterior translation during knee extension but with less tendency for anterior displacement of the tibia.

Tibial Plateau Angle

In dogs, a tibial plateau angle (TPA) or tibial plateau slope that is oriented more craniodistally than normal increases the tendency for cranial displacement of the tibia and is a risk factor for CCL disease.[5,6] Cranial displacement occurs with inadequate restraint from the CCL and also surrounding muscles. The normal craniodistally angled TPA promotes cranial translation of the tibia. In one study,[1] average craniodistal TPA in dogs with CCL injuries was 23.8°-24.7°, significantly greater than average TPA of 18.1° in dogs without CCL injuries. In normal canine stance, the tibia tips more craniodistally. During gait, especially at end stance time, the tibial plateau tips even more craniodistally.

The TPA is structural and not modifiable without surgery. The tipping factor is positional and could be modified, eg, by bracing.

In humans, a posterior or posterodistal TPA has been identified as a risk factor for posterior displacement of the femur, ie, anterior displacement of the tibia, in ACL injury.[7-9] The posterior TPA promotes posterior translation of the femur. In one study,[9] average posterior TPA on the lateral tibial condyle in people with ACL injury was 6.7° and significantly greater than average 5.6° in people without ACL injury. Average posterior TPA on the medial tibial condyle in people with ACL injury was 5.5° and significantly greater than average 4.7° in people without ACL injury. Normal human stance does not tip the tibia more posterodistally. However, at initial contact and loading response during normal gait, the tibial plateau appears to tip slightly more posterodistally than in static stance.

In dogs, the TPA and additional craniodistal tipping appear to produce a larger magnitude composite, constant shear force, and constant tendency in the direction of cranial translation of the tibia. The constant shear force is one mechanism of injury that could result in CCL laxity or strain. In humans, the TPA and additional posterior tipping in gait appear to produce a small magnitude composite and slightly increased but intermittent shear force in the direction of posterior translation of the femur. Multiple limb stance in dogs versus single limb stance in humans would enter into the overall effects of the TPAs.

There are other stifle/knee bony characteristics that are relevant to CCL risk of injury, but they have not been studied as much. They include femoral anteversion angle, which is excessive internal torsion of the femur distal to the lesser trochanter,10 and is analogous to human femoral anteversion or antetorsion or torsion.

MUSCLE FUNCTION AND FUNCTIONAL MOVEMENT

There are some significant differences in muscle function. The implications of the differences include (1) avoiding assumptions about muscle function based on the analogous muscle actions for humans, (2) interpreting electromyographic findings on the basis of muscle function for dogs, and (3) using surface palpation and other assessments to verify and interpret muscle activity, including variation from the norm, the same as you would for humans.

In hind limb digitigrade stance, the moment arm from the ground reaction force (GRF) is very large for tarsal flexion, large for stifle flexion and digit extension, and medium for coxofemoral flexion. Visualize the line of the GRF starting at the contact of the ground with the digits and extending proximally to a position that is just cranial to the coxofemoral joint. The position of this line results in resistance or demand moment (torque), which would appear to be very large for tarsal flexion, large for stifle flexion and digit extension, and medium for coxofemoral flexion. In human stance, the moment arms from the GRF at the analogous joints are minimal to none.

The GRF during stance on a normal stifle joint produces a joint reaction force that not only compresses the femur and tibia but also produces cranially directed shear or translation force on the tibia. Additional craniodistal tipping during walking and running produces more cranial shear force and promotes more cranial translation of the tibia.

The most important muscles to prevent CCL deficiency in canine stance would be those that produce combinations of needed muscle strength and adequate caudal shear force on the proximal tibia. Therefore, net (or total or overriding) muscle strength (or muscle moment) must be very large for tarsal extensors, large for stifle extensors and digit flexors, and medium for coxofemoral extensors. Net caudal shear force on the proximal tibia must be greater than net cranial shear force on the proximal tibia. Factors producing or promoting shear forces at the stifle joint include the TPA, positional tipping, GRF, muscles and other internal and external forces.

Muscle attachment sites can be found in many resources.[4,12,13] With knowledge of muscle attachment sites, lines of muscle pull, moment arms of muscles, joint surface shape, ligamentous restraint, etc, muscle joint actions and translations can be determined. Physical therapists are skilled at this process and can apply these concepts to determine joint and translational motions produced by canine muscles, as well as those from external and other internal forces.

There are some notable differences in joint and translational motions produced by stifle and knee muscles. Published charts link direction(s) of translation to joint motion but not to muscle pull. Note how many muscles produce cranial translation. After CCL laxity, joint and translational motions and shear forces likely change.

The modifiable components of posture and movement with coordinated muscle activity would be targets for rehabilitation. Coordination requires muscle activity that is well timed and with the right balance of forces. This dynamic coupling of muscle activity emphasizes the importance of neuromotor factors related to movement function.[11]

A few examples of significant differences in muscles, muscle function, and functional movement are:

- Muscles included in the canine calcaneal tendon (or Achille's tendon), which are primarily the gastrocnemius and flexor digitorum superficialis (or superficial digital flexor) and secondarily the gracilis, the caudal head of the biceps femoris, and the semitendinosus. All of these muscles are tarsal extensors, which are needed in large magnitude and consistently in canine weight bearing. All 5 are stifle flexors, indicating the need for additional stifle extensor strength than that needed to overcome the effect of the GRF. The gracilis, the caudal head of the biceps femoris, and the semitendinosus produce caudally directed force on the tibia. The gastrocnemius and flexor digitorum superficialis produce caudally directed force on the femur, ie, cranially directed force on the tibia.
- Dogs do not have a soleus. If dogs had a soleus with comparable human soleus anatomy, it would produce tarsal extensor force in stance, but at a shortened length.

- Dogs weight bear on hindpaw digits II-V. The canine flexor hallucis longus (or lateral digital flexor) is attached to the dog's dewclaw. It loses the importance of the human flexor hallucis longus during lateral to medial weight shift on the foot at terminal stance in gait.
- From the digitigrade posture, the caudal sartorius, gracilis, and semitendinosus appear to produce a sling to support the proximal tibia and spare the CCL.
- With CCL laxity and due to the attachment sites and angle of pull on the tibia, the semitendinosus could produce craniodistal tipping of the tibial plateau, in combination with or instead of stifle flexion and caudal translation. The caudal translation might become caudal motion of the tibia distal to the tibial plateau while the tibial plateau tips craniodistally.
- The canine gracilis is a coxofemoral extensor, as is the human gracilis but only when the hip is positioned in flexion.
- Tilt of the canine pelvis increases the leverage of the hamstrings in dogs, which increases their importance as coxofemoral extensors. The canine superficial gluteal, structurally analogous to the human gluteus maximus, is comparatively very, very small.
- Palpation of the caudal head of the biceps femoris can represent muscle activity needed at the tarsal and/or stifle joints, but would not indicate muscle activity needed at the coxofemoral joint.

Future research to investigate when comparing relative risk of CCL injury to ACL injury may include comparison of limb alignment, physical activities, surgical techniques, out of sagittal plane mechanisms of injury, and outcomes of rehabilitation interventions. The modifiable aspects of all factors would appear to be the best targets for rehabilitation intervention.

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