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ORTHOPAEDIC
Physical Therapy Practice

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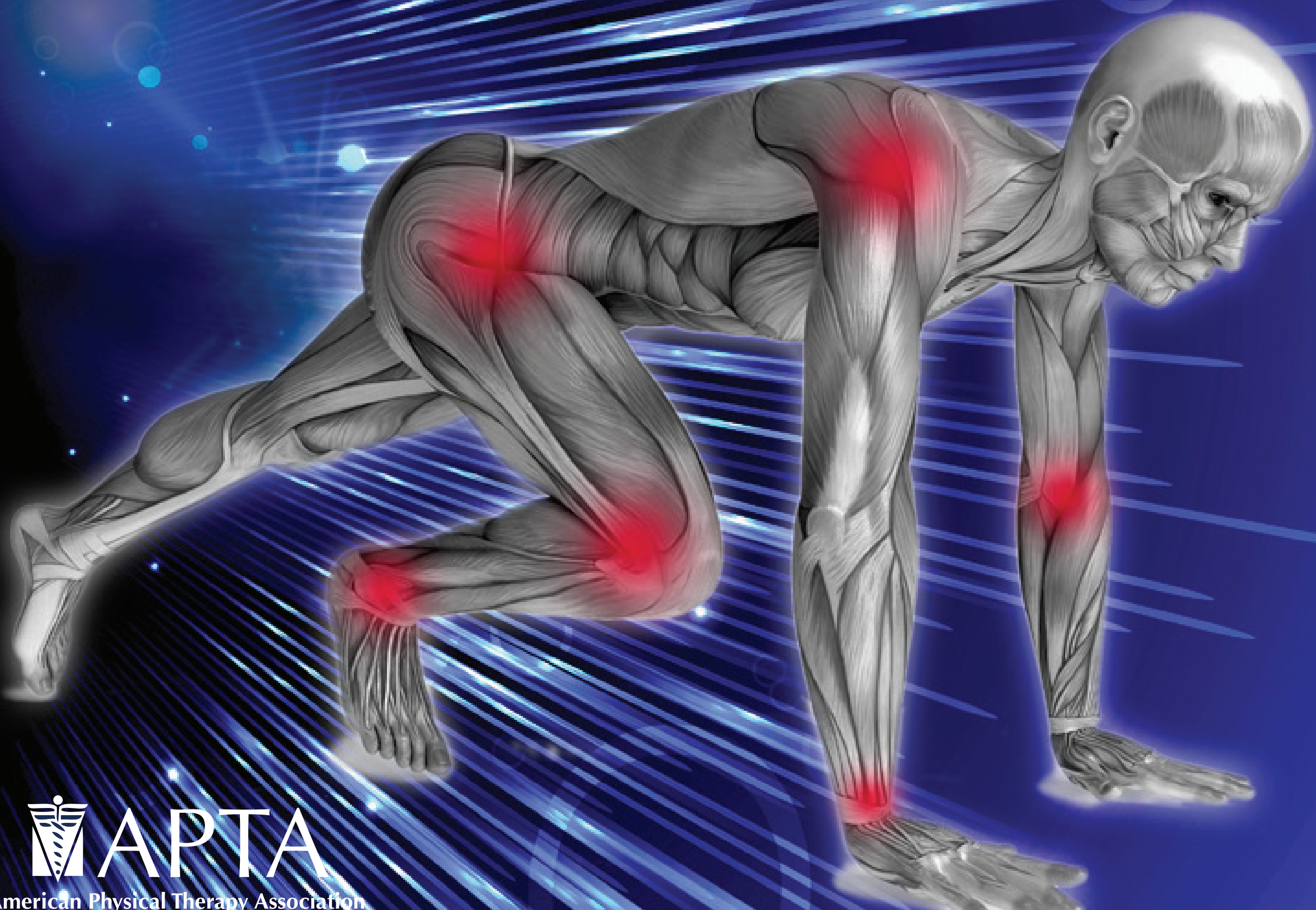
PRACTICE RESEARCH EDUCATION



APTA
American Physical Therapy Association

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ORTHOPAEDIC Physical Therapy Practice

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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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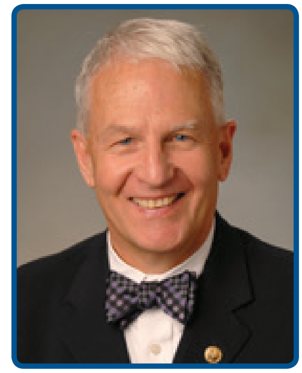
President's Message

Deriving and Providing Advanced Proficiency Standards for the PTA Scope of Work Within an Orthopaedic Practice Setting Are We There Yet? What's in the Future?

Stephen McDavitt, PT, DPT, MS, FAAOMPT



Since 2011 the Orthopaedic Section has worked to derive and develop advanced proficiency standards for the physical therapist assistant's scope of work within orthopaedic settings. I would like to take the opportunity in this President's Message to share a historical perspective on why we initiated this, how we investigated and derived the standards, and where the future is in this initiative. I believe sharing this information with the membership will be of value as we move forward with this initiative in providing not only advanced proficiency standards but educational opportunities and clinical mentoring to meet those standards.

HISTORY DEFINING SCOPE OF WORK FOR THE PTA

Physical therapists and physical therapist assistants have been working together to provide physical therapy services since 1969. To assist in clinical role delineation, APTA has provided a number of positions, standards, guidelines, and policies that describe and define the scope of work of the PTA and the level of supervision that the PT should provide under their scope of practice. Those documents embrace the following controlling assumptions.[1]

- The PT integrates and is solely responsible for the 5 elements of patient/client management-examination, evaluation, diagnosis, prognosis, and intervention in a manner designed to optimize outcomes.
- The PT directs and supervises the PTA consistent with APTA House of Delegates positions, including Direction and Supervision of the Physical Therapist Assistant; APTA core documents, including Standards of Ethical Conduct for the Physical Therapist Assistant, federal and state legal practice standards, and their respective institutional regulations.
- All selected interventions are directed and supervised by the PT. The PTA does not perform interventions that require immediate and continuous examination and evaluation throughout, as described in APTA House of Delegates position Procedural Interventions Exclusively Performed by Physical Therapists. Procedural interventions within the scope of PT practice that are performed exclusively by the PT include, but are not limited to, spinal and peripheral joint mobilization/manipulation (which are components of manual therapy) and sharp selective debridement (which is a component of wound management). The PT also is responsible for ensuring the PTA has the knowledge and skills required to safely and effectively complete the intervention.
- The PT remains responsible for physical therapy services provided when the PT's plan of care involves the PTA assisting with selected interventions.
- Selected intervention(s) include the procedural intervention, associated data collection, and communication including written documentation associated with the safe, effective, and efficient completion of the task.
- Decision processes are employed for either a patient/client interaction or an episode of care.
- Communication between the PT and PTA regarding patient/client care is ongoing.

CHALLENGES PERSIST IN ALIGNING SCOPE OF WORK WITHIN THE PT-PTA TEAM PATIENT CARE DELIVERY MODEL

Over the course of time, even though it is evident that APTA has strived to provide clarity on defining appropriate clinical roles and responsibilities for the physical therapist and physical therapist assistant, 3 basic challenges persist in the PT-PTA team patient management delivery model. Authorizing PTA clinical actions by PTs is affected by interpretations across various PT's and PTA's training and experience within their respective practice models; *who should determine and provide certain components of care, how care is communicated and who can and should make decisions throughout intervention implementation?* Those challenges in turn affect consistency across physical therapist practice in defining, sanctioning, and prescribing PTA clinical actions such as delivering procedural interventions within the plan of care. To add confusion, state practice acts are inconsistent in addressing role, scope of work, and supervision for both the PTA and untrained supportive personnel such as an aid in the physical therapy practice setting. This is further magnified from related actions by payer entities where there are inconsistencies in their regulations and opinions about PTA provision of physical therapy services and acceptable levels of supervision.[2]

APTA BOARD OF DIRECTORS DISCUSS FUTURE ROLE OF PTA TO BETTER ALIGN ADVANCED PROFICIENCY IN THE PT-PTA CARE DELIVERY MODEL

In 2008 those patient management delivery challenges were heard and appreciated by the APTA Board of Directors during their Mega Issue Discussion on the Future Roles of the Physical Therapist Assistant. I had the privilege of serving on the APTA Board of Directors at that time. During the fall of 2008 into the spring of 2009 we explored the PTAs' roles in education, practice, and within APTA. We derived many conclusions but the following were outcomes resolved from our deliberations addressing PTAs in education and practice.[3]

- PTAs in Education
  - The associate degree is the appropriate entry-level degree for the PTA.

- APTA supports measures to promote continuing competence of the PTA.
- There are further knowledge areas and skills within the realm of interventions that the PTA may obtain after initial licensure and in the context of ongoing regulation.
- PTAs in Practice
  - The PTA is the sole extender of the PT.
  - The PTA is directed and supervised by the PT.
  - The element/role of the PTA is exclusively within the intervention component of the patient/client management model.
  - Existing APTA policies and positions that specifically describe the role of the PTA in PT practice apply.

From this resolution, in March 2009 the APTA Board of Directors voted to establish a task force to determine appropriate post entry-level educational pathways for the physical therapist assistant. The Board mandated that the task force investigation be managed within the framework of current APTA positions, standards, guidelines, policies, procedures, and other appropriate APTA documents. The Board appointed 3 physical therapists and 3 physical therapist assistants to a task force entitled the Educational Pathways of the Physical Therapist Assistant Task Force.

APTA DEVELOPS PTA ADVANCE PROFICIENCY PATHWAY PROGRAM TO ADVANCE PTA COMPETENCY AND REFINE SCOPE OF WORK IN SPECIALTY PRACTICE

In 2010, as a strategy in response to a recommendation from the *Educational Pathways of the Physical Therapist Assistant Task Force,* APTA developed the *PTA Advanced Proficiency Pathway Program* to fulfill the Board's concerns in addressing appropriate post entry-level educational pathways for the PTA.[4] The *PTA Advanced Proficiency Pathways Program* was developed to:

- provide PTAs with clearly defined post-graduation educational curriculum that leads to advanced proficiency in a selected area of physical therapy (eg, geriatrics, pediatrics, wound management, orthopaedics)[4];
- promote PTAs career development by providing a self-initiated curriculum completion process that strengthens the PT/PTA working relationship and encourages life-long learning[4]; and
- assist physical therapists, employers, consumers, the health care community, and others in identifying PTAs with advanced knowledge and skill in a specified area of physical therapy.[4]

ORTHOPAEDIC SECTION DEFINES PTA ADVANCE PROFICIENCY SCOPE OF WORK IN AN ORTHOPAEDIC PRACTICE SETTING[5]

In moving forward from 2010, APTA had to embark on an effort to identify advanced proficiencies for the physical therapist assistants across multiple physical therapist practice settings. APTA then sought assistance across the relevant APTA Sections that reflected clinical specialty practice. The Orthopaedic Section was asked to identify advanced proficiencies for the PTA within the specialty area of orthopaedic physical therapy. The Orthopaedic Section leadership responded to this request by appointing a Task Force to explore this request. In January 2011 at the request of APTA, the Orthopaedic Section Board of Directors approved a *Task Force on Career Pathways for PTAs* that was charged to collaborate and complete an orthopaedic learning experience for the APTA *PTA Advance Proficiency's Pathway Program*. Its first task was to determine how to complete this charge by determining and appointing appropriate content experts. The next steps focused on defining resources that would reflect the current needs for the PTA in an orthopaedic clinical practice setting and following that, validate the advanced curriculum content.

Between January 2011 and the summer of 2013, the Task Force went through many challenging discussions and got off the ground with a solid direction in September, 2013. The Task Force members included:

- James Irrgang, PT, PhD ATC FAPTA (Chair)
- William Boissonnault, PT, DPT, DHSc, FAAOMPT, FAPTA
- Norman Johnson, PT, DPT, DEd, MSS, MBA (PTA Education)
- Aimee Klein, PT, DPT, DSc, OCS
- Stephen McDavitt, PT, DPT, FAAOMPT (Ex Officio)
- Jason Oliver, PTA (PTA in orthopaedic setting)
- Ken Olson, PT, DHSc, OCS, FAAOMPT
- Robert Rowe, PT, DPT, DMT, MHS, FAAOMPT
- Barbara Tschoepe, PT, DPT, PhD (Academic Counsel Consultant)
- Julie Whitman, PT, DSc, OCS, FAAOMPT

The Normative Model for PTA Education, the Guide to Physical Therapist Practice, CAPTE Standards/Criteria for PTAs, the APTA *Guideline of Minimum Required Skills of the PTAs* and the *Federation of State Boards of Physical Therapy Criteria of Essential Knowledge of the PTA* tested on licensure examinations were used as resources to identify entry-level skill sets for the PTA. It was evident to the task force that we were missing a critical component to the review of advanced proficiencies for PTA, because we did not have any resources that defined current practice trends of the PT/PTA team in the orthopaedic setting from the physical therapist's perspective.

As a result, the task force began its work by conducting a national survey to identify and validate current practice trends of the PT/PTA team. The survey questions were categorized according to the *CAPTE Standards/Criteria for PTAs (2013)*, the *APTA Board of Directors' Guideline on Minimum Required Skills of the PTA Graduate* (2011) and the *Guide for Physical Therapist Practice 3.0 (2014)* with specific emphasis on data gathering/tests and measures, interventions, and other relevant tasks and activities that are necessary to enhance the quality and safety of the physical therapist's care. Specifically, the survey was divided into the following areas.[5]

- Data gathering/test and measures
- Interventions:
  - Therapeutic exercise
  - Functional training in self-care
  - Functional training in community
  - Manual therapy techniques
  - Biophysical agents
  - Motor function training
- Implementation and progression of interventions within the plan of care
- Patient education
- Communication and documentation
- Practice management and regulatory issues

Within each area, specific tasks and activities were specified, including those that were not appropriate for performance by a physical therapist assistant as specified in House of Delegates policies and procedures. The latter were specifically included in the survey to determine, what if any tasks and activities that physical therapists are prohibited from assigning to a physical therapist assistant that should be included in the advanced proficiency program.

In reviewing the survey responses, the Task Force also identified tasks or activities that were considered entry-level skills that required further development for the physical therapist assistant to demonstrate advanced proficiency in an orthopaedic practice setting. These tasks or activities are recommended for inclusion in the advanced proficiency pathway.

Lastly, the Task Force identified tasks and activities that need to be reviewed by individuals representing one of the Orthopaedic Section's Special Interest Groups prior to final determination if the task or activity should be included or excluded in the advanced proficiency program for physical therapists. Additionally, the Task Force identified several tasks or activities that lie outside of the orthopaedic physical therapy practice area that should be reviewed by another APTA Section for determination if the task or activity is an advanced proficiency within that Section's area of practice.

ORTHOPAEDIC SECTION DEFINES AND EMBRACES FUTURE ADVANCE PROFICIENCY EDUCATION FOR THE PTA IN AN ORTHOPAEDIC PRACTICE SETTING

So, when considering the findings of the Task Force, where do we go from here? Like defining physical therapist scope of practice, defining the scope of work for the physical therapist assistant in an orthopaedic practice setting needs to be viewed as an evolution not a revolution. In appreciating this, the Orthopaedic Section must be resourceful and adaptable to meet the needs of daily orthopaedic practice especially as it pertains to efficacy and safety not only for the PT but also the PTA. At its July Board meeting, the Orthopaedic Section Board recognized the outcomes of the Task Force work and formally embraced a plan for PTA involvement in our annual meetings in accordance with those recommendations. Our 4th Annual Orthopaedic Meeting, May 5-7, 2016, in Atlanta, Georgia will reflect that appreciation. Additionally, in the near future the Board will be assessing resources directed at future education opportunities to enhance PTA Advance Proficiency Pathways learning experiences across collaborations with APTA, future independent study courses and integration of PTA education through the Orthopaedic Section PTA Education Interest Group.

WHAT'S THE RELEVANCE FOR THE PTA ADVANCED PROFICIENCY IN OUR FUTURE ORTHOPAEDIC PRACTICE?

In the future of health care models and policies, orthopaedic physical therapists must be recognized as a value added discipline. Creating practice paradigms from organized guidelines that identify best practice, adhering to best practice and providing a measure of provider performance will demonstrate value. Therefore efficacy, cost, patient outcomes, accessibility, and their resultant product defined as value are the crux of our future practice. This result must translate into PT-PTA team clinical practice collaborations as well. Augmenting PTA proficiency that addresses effectiveness, safety, and efficiency while in collaboration with the PT should enhance the framing of delivery for patient care, communication and proper assignment of the appropriate intervention, which in turn will deliver matching the right patient to the right providers and interventions. This can all be accomplished while still conforming to current APTA positions, standards, guidelines, and policies. Let's see where this next step in shaping the PTA scope of work as supervised and authorized by the PT in the orthopaedic practice setting takes us. I believe for those working in various PT-PTA team orthopaedic practice models, advancing the PTA proficiency within the current APTA positions, standards, guidelines, and policies. Additionally, in accordance with our recommendations from the work of the Task Force will take us closer to what is best for our patients, and furthermore, will support and advance our practice roles in the future of health care.

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Editor's Note

When Physical Therapy Doesn't Make it Better

Christopher Hughes, PT, PhD, OCS

I am sure all practicing therapists have been there at some point in their clinical practice. You perform a comprehensive evaluation and assessment of your patient and feel that you have a handle on the diagnosis and the patient limitations. When you discuss the intervention, you feel confident about how the program will resolve the patient's problem. Then…WHAM…you are blindsided…despite all your training, logic, and attention to detail this patient is not getting better! Like kryptonite to superman you are surprised, perplexed, and reflective. Initially all your powers of sound reasoning are shaken to the core! Could it be that despite your best efforts you can't help this patient get over his or her problem? Even more so, we might even be making them worse with the treatment? Mind you I am not talking about the noncompliant patient, I am talking about the patient that still worked incredibly hard, doing the PT program to the letter but isn't progressing. How dare this patient not get better with PT!

We as therapists don't give up that easily. We try to backtrack, reassess, and cover all bases…but even with this strategy, we may have to swallow our pride and realize that PT doesn't work for everyone. The prudent option is always to refer back to the physician or to another health care provider but sometimes this patient ends up in the cracks of the system and is labeled as a "poor outcome." Let's face it, the health care system isn't built for this type of event. Today care has to fit the paradigm of visits, cost, and outcome or else it is deemed an outlier. It's a long road ahead. Some patients do get funneled properly but many fall into the abyss and seek irrational options of care, are sent into chronic pain programs, and just simply told to live with it. Patients in this regard often cite feeling abandoned by MDs when their treatment plan doesn't pan out or even when the surgical outcome is less than optimal.

I recently experienced this with a friend who despite undergoing arthroscopic rotator cuff repair had the unhappy event of a re-tear of his surgically repaired rotator cuff. The treating surgeon said it was irreparable and left this very active middle-aged adult in a predicament of despair and did not even offer a referral to another colleague. After contacting me and providing a referral for a second surgical opinion, this individual not only had a second successful surgery but was able to meet his goal of performing in his annual bike ride for charity within 4 months of the second repair. Can you imagine if this person took the first surgeon's word as final? His quality of life would have been affected greatly. So even though PT was not the part of an unsuccessful procedure, a physical therapist's referral was able to help the patient manage his course of care. As you know, physical therapists still fulfill a vital role in providing advice on securing a proper and timely referral, continuing patient education, and being an advocate for the patient even when our direct care is unsuccessful. We as clinicians may feel a lack of success in our direct care but we routinely become the patient's best partner in finding a solution.

In the era of classification and standardization of care, the dreaded "outlier" patient commonly struggles. What happens to this patient when they don't fit the model of care? Be it no progress or the number of visits is outside the covered limits due to extenuating circumstances or that they are just progressing slowly. Often, physical therapists more than any other provider are willing to fight for additional visits especially when we know that particular patient will suffer without additional supervised care. Today we walk a fine line here. When PT is not working, then we need to do what's right and move this patient through the proper referral expeditiously. We also need to continue to advocate for the patient if we truly believe we can help. More importantly, we need to check our egos at the door and be critical of our own skills and judgement and recognize when more therapy just isn't going to help even if it is covered!

Efficiency in outcome is very important. Providing massages for 12 visits without anything else just because the patient likes the relaxation isn't going to cut it these days, nor should it. We are still directing the care and have to make sure the "tail doesn't wag the dog," even though the patient has the final consent. Our explanation of the logic behind the plan is vital. In contrast, we have to rationalize the intervention to the patient but not overpromise and try to ride in on a white horse all the time. We can let our passion for care get the best of us with some types of patients. Quality of care doesn't necessarily have the same meaning between health care providers and patients. Patients can love the attention we provide but let us not forget we are also in the business of allowing patients to become independent. What may make some patients happy isn't always in their best interest to solving the problem. Modalities are nice but there are many instances when exercise leads to a better or longer lasting outcome. Passive treatments have their place but physical exercise remains a staple in PT care.

By forming a partnership with the patient, we can be vested in their care but do not "own" them. Our responsibility can transcend mediocrity by offering an evidence-based approach. This approach should make sense to the patient and also represents the solution by a trained professional.

In summary, let's not forget that when patients allow us the privilege to care for them, we don't place our own needs and insecurities ahead of what really matters…solving the problem. I think our toolbox has many avenues to accomplish this even when we can't always ride in on the white horse!

The Effect of Thoracic Manipulation on Shoulder Pain: A Systematic Review

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ABSTRACT

Study design: Systematic literature review. **Purpose:** To investigate the evidence related to thoracic manipulation as an intervention for the treatment of shoulder pain. **Background:** Shoulder pain is a common complaint of patients seen in clinical practice. Thoracic manipulation is a technique used to treat patients of various orthopaedic diagnoses. The theory of regional interdependence provides a basis for thoracic manipulation as a treatment for shoulder pain. However, to our knowledge, there is no systematic review of the literature evaluating the effectiveness of thoracic manipulation on shoulder pain. **Methods:** Searches were performed for research studies between June 2004 and June 2014 using the databases CINAHL, Cochrane Library, PEDro, Pub Med, Scopus, and Sports Discuss. The quality of papers was assessed using the GRADE approach. **Results:** Six articles satisfied the inclusion and exclusion criteria (1 RCT, 5 observational studies). The level of evidence ranged from very low to moderate quality and recommendations for use ranged from weak recommendation for use to strong recommendation for use. **Conclusions:** There is evidence in the short-term that thoracic manipulation in treating shoulder pain appears to be of low risk and may have possible benefits. However, additional studies investigating thoracic manipulation and the effects on various diagnoses of shoulder pain with long-term follow-up are needed as there is no strong evidence in the current literature.

Key Words: manual therapy, spine, shoulder complex

INTRODUCTION

Shoulder pain and stiffness are common complaints that can lead to functional disability. These symptoms are estimated to have an incidence of 15 per 1,000 new patients seen in primary care settings[1] and accounts for 16% of all musculoskeletal complaints.[2] In a systematic review of the literature conducted by Luime et al,[3] the annual incidence of new cases of shoulder pain was reported as 0.9% to 2.5% through various age groups, with the 42 to 46 age range showing the highest incidence. Additionally, shoulder pain was reported to have a prevalence between 18.6% and 31% in the general population.[3]

Shoulder pain can be caused by a specific traumatic event, micro-trauma over time, or insidious onset including but not limited to: rotator cuff tendinopathy,[4-6] impingement,[7-9] acromioclavicular joint disease,[6,10,11] adhesive capsulitis,[6,12,13] and referred cervical pain.[14,15] In addition, a study by Ostor et al[16] found that 77% of subjects with shoulder pain had greater than one pathological condition when examined.

Signs and symptoms can vary depending on the pathology present. Common signs and symptoms of shoulder conditions besides pain can include weakness,[6,17,18] tenderness,[6,8,19] decreased shoulder range of motion (ROM),[6,8,13,18] instability,[6,20,21] and impaired function.[5,16] These conditions often have the capacity to impact quality of life (QOL) and functional capacity.[16,21] Physical therapy is often indicated for and helpful in addressing these impairments and loss of function.

The literature supports the use of physical therapy to treat impairments associated with shoulder pain. Several evidence-based approaches include strengthening,[17,22,23] neuromuscular re-education,[24,25] joint mobilization,[13,26,27] taping,[7,28,29] modalities,[21,23,24] postural education,[30,31] and ROM exercises.[13,17,23,24] However, patients with shoulder pain do not always achieve a full recovery[16] and often have a worse prognosis if they have a previous history of shoulder issues.[32]

Thoracic manipulation has been used as an intervention for several body regions. Cleland et al[33] defined manipulation as a high-velocity low-amplitude thrust and found immediate improvement in cervical pain after thoracic spine manipulation (TSM). Similarly, Fernandez-de-las-Penas et al[34] reported that TSM results in a significant reduction in neck pain immediately and at 48 hours post-manipulation. Cleland et al[35] found that subjects who received TSM had an immediate significant increase in strength of the lower trapezius muscle.

The mechanisms responsible for pain relief and restoring functional ability following spinal manipulative therapy (SMT) are unclear. Regional interdependence is a common explanation for these effects. This concept states that impairments in regions distant from the patient's area of perceived pain may have an effect on the primary complaint. This model encompasses a wide variety of possible contributors that could be addressed for a more holistic and complete treatment.[36] Regional treatment options using cervical manipulation in conjunction with thoracic and adjacent rib manipulations have shown promise in the management of shoulder disorders.[37]

It has also been theorized that neurophysiologic responses occur following SMT. These effects include inhibition of hypertonic muscles, reduction in pain, and enhanced functional ability.[38-40] Scapular position is influenced by the alignment of the thoracic spine through muscular and ligamentous connections with the spine, clavicle, and humerus. A goal of administering spinal manipulation could include restoring normal motion and biomechanics of the shoulder girdle including the thoracic spine.[41]

To date, we are not aware of any systematic review of the effects of thoracic spine manipulation on shoulder pain. Therefore the purpose of this systematic review was to evaluate the existing literature on the effects of thoracic manipulation on shoulder pain in the adult population.

METHODS

Search Strategy

The literature search for this review was performed in July 2014 using the databases CINAHL, Cochrane Library, PEDro, Pub Med, Scopus, and Sports Discuss. Our search terms were "manipulation" AND "shoulder pain." All searched articles were stored and organized using the program, RefWorks.[42]

Selection Criteria

Among the specific inclusion criteria were articles published between June 2004 and June 2014 in the English language and human subjects aged 18 and older who received a manipulation of the thoracic spine and/or manipulation of the cervicothoracic junction as a treatment for shoulder pain. All publications including surgical interventions of the head, neck, or thoracic spine, or history of cancer, or interventions using cervical manipulations were excluded.

The results of the literature search are presented in Figure 1. The initial search of 6 databases yielded 504 articles. After discarding 97 duplicates, 407 articles were reviewed by title, abstract, and screened for inclusion and exclusion criteria. Six articles met all inclusion and exclusion criteria.

Article Assessment

Six reviewers met to discuss and assess each paper. The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach was selected as the assessment tool. The GRADE is used to investigate the effectiveness of interventions in order to recommend best practice.[43-46]

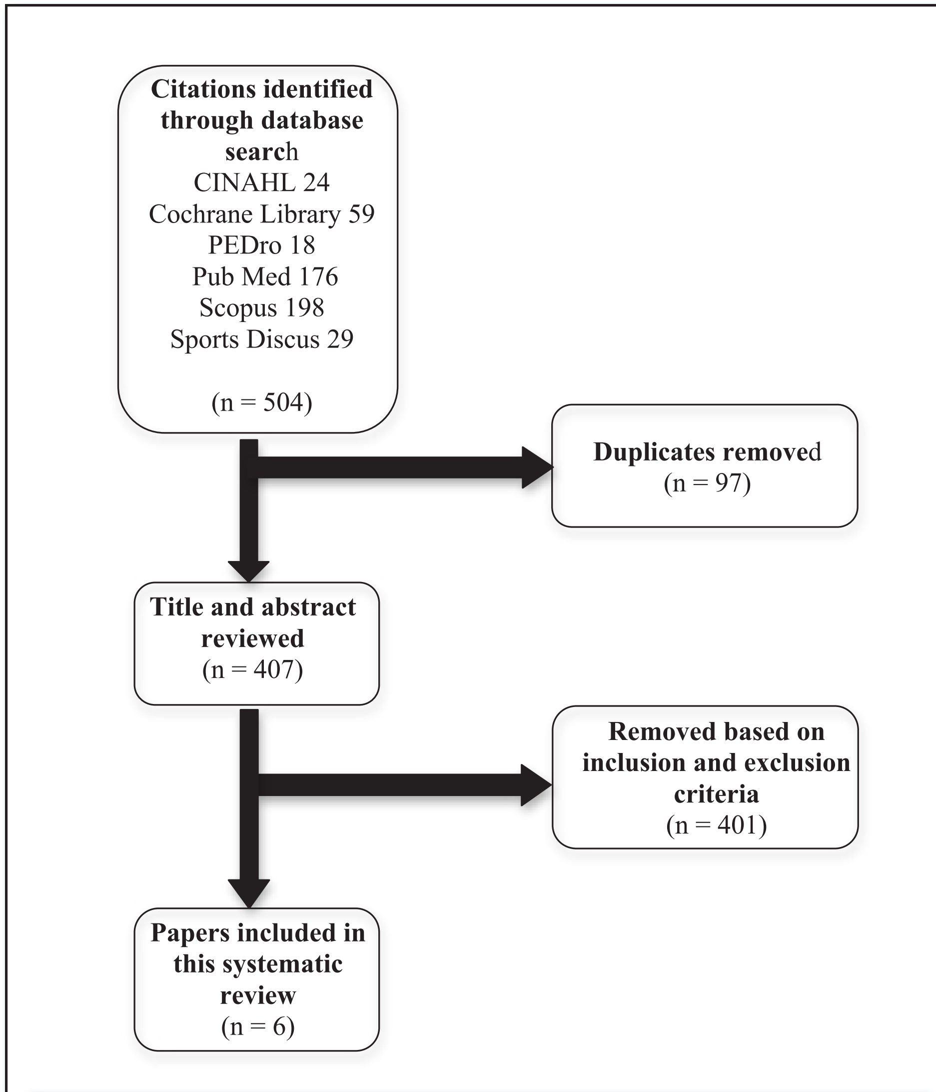

Figure 1. Flow diagram for paper identification, screening, and selection.

RESULTS

The 6 selected papers included one randomized controlled trial (RCT) and 5 observational studies. Evidence to support the various interventions ranged from very low quality to moderate. Recommendations for use of a particular intervention ranged from weak recommendations for use to strong recommendations for use. Individual grades and relevant assessment criteria are presented in Table 1. The authors uniformly agreed on all article assessments. A summary of combined patient demographics and type of thoracic manipulation used for the selected papers can be found in Table 2. Outcome measures used included: numerical pain rating scale (NPRS),[47-51] Penn Shoulder Scale (PSS),[51] Sports/Performance Arts Module of the Disabilities of the Arm, Shoulder, and Hand (SPAM-DASH),[51] Shoulder Pain and Disability Index (SPADI),[47,50] global rating of change scale,[47,52] Disabilities of the Arm, Shoulder, and Hand (DASH),[48] Western Ontario Rotator Cuff index (WORC),[48] the short version of the Disabilities of the Arm, Shoulder, and Hand (QUICK-DASH),[49] modified Fear-Avoidance Beliefs Questionnaire (FABQ),[50] Tampa Scale for Kinesiophobia (TSK),[50] and visual analog scale (VAS).[52] Follow-up ranged from a single treatment session to 19 visits.

Interventions presented in these articles included various forms of thoracic, cervicothoracic, and rib manipulations including seated mid-thoracic,[47,48,50,51] seated cervico-thoracic junction (CTJ),[47,50-52] supine rib,[47,52] prone mid-thoracic,[49,50,52] prone upper thoracic,[49] supine CTJ,[50,52] supine upper-TSM,[50] and supine mid-TSM.[50]

Each study examined the effects of TSM on shoulder pain. Muth et al[51] showed statistically significant improvements in pain and on the self-reported PSS and SPAM-DASH. Boyles et al[47] demonstrated statistically significant improvements in NPRS during provocative tests and a statistically significant decrease in SPADI scores at 48-hour follow-up. Haik et al[48] was the only RCT discussed, and this study showed a statistically significant decrease in shoulder pain in the symptomatic group immediately following manipulation; however, it was not clinically significant. McCormack's case study[49] showed improvements in NPRS, QUICK-DASH score, and improved ROM in all tested planes of shoulder active and passive ROM. Mintken et al[50] identified 5 prognostic variables to establish a clinical prediction rule for thoracic spine manipulation in the treatment of shoulder pain. The 5 prognostic variables were: painfree shoulder flexion of at least 127°, shoulder internal rotation

Table 1. GRADE Evidence Profile: Shoulder Pain Treated with Thoracic Manipulation

A	B	C	D	E	F	G	H	I	Summary of Findings J	K	L
Muth et al[51]: The effects of thoracic spine manipulation in subjects with signs of rotator cuff tendinopathy											
1	O	Yes (-1)[a,b]	No	No	No	No (U)	30	0	Post-manipulation there were no kinematic changes in the observed joints. Twenty-four of the 30 subjects demonstrated a minimum two point change in Jobe's empty can, Neer's impingement, and Hawkin's-Kennedy tests (P < .001). Loaded arm elevation improved (P < .001).	VL	(+)
Boyles et al[47]: The short-term effects of thoracic spine thrust manipulation on patients with shoulder impingement syndrome											
1	O	Yes (-1)[a,b,c]	No	No	No	No (U)	56	0	Post-manipulation there was improvement of statistical significance in all clinical outcomes at 48-hour follow up (P < .001-.008). Change did not reach level of clinical significance.	VL	(+)
Haik et al[48]: Scapular kinematics pre- and post- thoracic thrust manipulation in individuals with and without shoulder impingement symptoms: a randomized controlled study											
1	RT	Yes (-1)[b,c]	No	No	No	No (U)	49	48	Post-manipulation there was a decrease in pain level of statistical significance (P < .01) that was not clinically significant. Scapular kinematics did not change post-manipulation.	M	(+)
McCormack[49]: Use of thoracic spine manipulation in the treatment of adhesive capsulitis: a case report											
1	O	Yes (-1)[a,b]	No	No	No	No (U)	1	0	Patient experienced significant improvements in all clinical outcomes after TSM was added to treatment plan beginning visit 11.	VL	(+)
Mintken et al[50]: Some factors predict successful short-term outcomes in individuals with shoulder pain receiving cervicothoracic manipulation: a single-arm trial											
1	O	No	No	No	No	No (U)	80	0	Identified five prognostic variables to establish a clinical prediction rule for cervicothoracic manipulations for patients experiencing shoulder pain. Probability of success was 100% if patients met at least four prognostic variables. No control group was used due to nature of study.	M	(++)
Strunce et al[52]: The immediate effects of thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain											
1	O	Yes (-1)a	No	No	No	No (U)	21	0	Immediate improvement in visual analog scale and shoulder range of motion following manipulation (P < .01).	VL	(+)

A. Number of Studies
B. Design - RT: Randomized trial; O: Observational
C. Limitations - No: No serious limitations; Yes: Serious. [a]Lack of randomization, blinding, and control group. [b]Cannot generalize due to patient population [c]Patients began with low pain scores
D. Inconsistency - No: No serious inconsistency; Yes.
E. Indirectness - No: No serious indirectness; Yes.
F. Imprecision - No: No serious imprecision; Yes: Small sample size.
G. Publication bias - U: Undetected.
H. Number of tested patients
I. Number of controls
J. Summary of findings
K. Quality - H: High; M: Moderate; L: Low; VL: Very low.
L. Recommendation - (++): Strong for; (+): Weak for; (-): Weak against.

Table 2. Patient Characteristics and Thoracic Manipulation Techniques Used

Authors, year	Number of patients (% female)	Age range (years)	Mean age (± SD)	Mean pain duration (± SD, months)	Thoracic manipulation technique(s)
Muth et al[51] 2012	30 (46.7%)	22.7-38.5	30.6 (±7.9)	4.2	Seated mid-TSM, Seated CTJ
Boyles et al[47] 2009	56 (28.6%)	18-50	31.2 (±8.9)	Not Listed	Seated mid-TSM, Seated CTJ, Supine rib
Haik et al[48] 2014	97 (53.6%)	20.6-46.0	33.8 (±12.2) SIS group receiving TSM	49 (± 96) SIS group receiving TSM	Seated mid-TSM
McCormack[49] 2012	1 (100%)	59	59	3	Prone mid-TSM and upper-TSM
Mintken[50] 2010	80 (60%)	18-65	40.4 (±13.5) Success Group	15.85 (±53.7)	Seated mid-TSM, Supine CTJ, Supine mid-TSM, Supine upper-TSM, Prone mid-TSM
Strunce[52] 2009	21 (52.4%)	21-62	47 (±12.6)	4.2 (± 4.8)	Prone mid-TSM, Seated CTJ, Supine rib, Supine CTJ

Abbreviations: TSM, thoracic spine manipulation; CTJ, cervico-thoracic junction; SIS, Shoulder Impingement Syndrome

of at least 53° at 90° of abduction, negative Neer test, not taking medications for shoulder pain, and symptoms of less than 90 days. Probability of a successful intervention was 100% if 4 of these 5 variables were met. Strunce et al[52] demonstrated statistically significant improvements in VAS pain scores and ROM in tested planes immediately following manipulation.

DISCUSSION

The purpose of this systematic review was to evaluate the effects of thoracic manipulation on shoulder pain. Existing research on this topic is limited. Six articles addressing the use of thoracic manipulation on shoulder pain were evaluated and graded. Although thoracic manipulation may be a valuable intervention for shoulder pain, due to the low levels of evidence and limitations of the articles reviewed, a strong recommendation cannot be made. Nonetheless, the results from this review are important for patient care and provide a basis for future research.

The articles in this review include patients with a primary complaint of shoulder pain secondary to various diagnoses such as shoulder impingement syndrome, adhesive capsulitis, and rotator cuff tendinopathy. Both Strunce et al[52] and Mintken et al[50] included subjects with a primary complaint of shoulder pain without a specific diagnosis. Strunce et al[52] showed immediate improvements in pain and shoulder ROM following a thoracic spine and upper rib manipulation (GRADE: very low, weak for recommendation). The authors hypothesized that these results supported the theory of regional interdependence. Lack of a control group, randomization, and blinding led to this article being downgraded. Mintken et al[50] identified 5 prognostic factors for patients with shoulder pain that would likely benefit from cervico-thoracic manipulation (GRADE: moderate, strong for recommendation). While this article lacked a control group due to the design of the study, it was not deemed to be a significant limitation. Furthermore, based on this study's results of identifying variables that successfully identify patients with shoulder pain who benefit from spinal manipulation and the lack of serious limitations, it was upgraded on the grading scale. It should be noted that in Mintken et al[50] the nonsuccess group reported greater baseline pain scores. This result may support the notion that outcomes may be less favorable for patients with a previous history of shoulder involvement[32] and could be a reason why some subjects in this study had unsuccessful outcomes. Manipulation technique and number of times manipulated varied across the studies, thus impacting generalizability.

Two articles looked at individuals with a diagnosis of shoulder impingement. Boyles et al[47] reported statistically significant decreases in pain and disability at a 48-hour follow-up post-TSM; however, these results did not meet the minimum clinically important difference of the NPRS (GRADE: very low, weak for recommendation). Also, Boyles et al[47] did not report duration of symptoms; therefore, we were unable to determine if the symptoms were acute versus chronic. The authors hypothesized that these findings may have been due to the decreased severity of the patients' baseline symptoms, possibly contributing to a floor effect. Lack of a control group, randomization and blinding, a sample of convenience, and patients having low baseline pain scores all threaten internal validity of this study, thus this paper was downgraded. Results from Haik et al[48] showed a decrease in pain immediately following TSM in subjects with shoulder impingement syndrome, as well as changes in scapular kinematics (GRADE: moderate, weak for recommendation). However, the authors deemed these kinematic changes not to be clinically relevant. It is important to note the decreases in pain reported by those with shoulder impingement syndrome were statistically significant, but did not meet the minimum clinically important difference of the NPRS. In addition, a younger population and decreased baseline pain scores contributing to a floor effect may have influenced the results of this study.

Muth et al[51] reported a decrease in pain and an improvement in shoulder function in those with rotator cuff tendinopathy immediately after receiving TSM (GRADE: very low, weak for recommendation). However, these findings are not likely to be a result of changes in scapular kinematics or shoulder muscle activity as seen with electromyography monitoring EMG but instead may be explained by neurophysiologic processes. Although improvements in outcomes were observed, patient demographics in this study make it difficult to apply these results to the clinical setting. Muth et al[51] used subjects who were young physically fit athletes.

McCormack[49] showed improvements in pain, ROM, and function following TSM in a patient with adhesive capsulitis (GRADE: very low, weak for recommendation). Although results were significant, the nature of a case report makes it difficult to generalize the results to a larger population. However, the demographics of the patient coincide with patients that typically present with a diagnosis of adhesive capsulitis.

Limitations

A recurring issue in many of the papers reviewed was the low levels of pain reported by subjects prior to intervention.[47,48,50,51] Low levels of pain could have contributed to a floor effect influencing statistical outcomes and decreasing generalizability. Also, convenience sampling and patient demographics in several papers were limitations.[47,48,51] Another limitation of the papers reviewed was lack of long-term follow-up. All articles assessed immediate and/or short-term effects of the intervention. In order to increase the applicability of these findings to the clinical setting, long-term follow-ups should be implemented in future research. Additionally, duration of symptoms varied among the articles ranging from a mean of 3 months to over a year. This review was also limited to only articles published from June 2004 to June 2014. Lastly, any article that used cervical manipulation as part of the treatment was excluded; consequently all the articles available using thoracic manipulation in the treatment of shoulder pain may not have been included.

Despite these limitations, all 6 articles reported favorable outcomes with thoracic manipulation, and no adverse effects were mentioned. Future research should focus on including a patient population more representative of those patients likely to be seen in clinical practice, including patients with higher reports of pain and decrease in function. Only one RCT was found in our search. More RCTs would be helpful in adding to the body of literature on this topic. Also, studies with long-term follow-up regarding the effects of this manipulation are needed.

CONCLUSION

In the short-term, thoracic manipulation in treating shoulder pain appears to be of low risk and may have possible benefits. However, additional studies investigating thoracic manipulation and the effects on various diagnoses of shoulder pain with long-term follow-up are needed.

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Learning Objectives

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

3-monograph bundle

- Define glenohumeral instability and laxity and describe incidence, prevalence, pathomechanics, and mechanism of injury for each.
- Describe the active and passive restraints about the shoulder and describe classification systems for shoulder instability.
- Determine the role of diagnostic testing.
- Determine and perform an examination using appropriate tests and measures to accurately assess shoulder instability and the associated impairments and functional limitations.
- Identify patients most appropriate for nonoperative management of shoulder instability and implement an evidence-based rehabilitation program.
- Understand anatomy and biomechanics of the anterior cruciate ligament and common mechanisms of injury.
- Describe the evidence governing clinical and imaging tests for diagnosing anterior cruciate ligament tears.
- Understand current surgical procedures for various populations and how they impact rehabilitation and recovery.
- Understand the rationale for anterior cruciate ligament prevention programs.
- Identify predictors of anterior cruciate ligament tears and proper testing for risk assessment as supported by research.
- Discuss the biomechanics and pathomechanics of the patellofemoral region and identify movement patterns that may contribute to patellofemoral pain.
- Discuss physical therapy classification of patients with patellofemoral pain.
- Provide evidence-based review of functional tests for the lower extremity.
- Identify and discuss tests and measures that can be used in the identification of pain generators of the patellofemoral region.
- Review current surgical interventions for treatment of patellofemoral pain.

6-monograph bundle

Includes the learning objectives listed above and the following:

- List the risk factors associated with osteoporosis and how such risks are measured.
- Recognize the most common risk factors associated with falls in the elderly.
- Identify self-report measures and clinical tests used to ascertain fall risk and strength.
- Discuss strategies that may be used to reduce fall risk in this population.
- Prescribe and adjust an appropriate exercise program for the patient with osteoporosis.
- Discuss the etiology and prevalence of obesity and list disease risks associated with increasing body mass index as supported by research.
- Identify the genetic, cultural, educational, and age-related characteristics that influence the plan of care for the patient with obesity.
- Review evidence related to the association between increasing weight and painful conditions (ie, low back pain, osteoarthritis) and how they decrease quality of life.
- Explain the evidence-based modifications that should be made when treating patients who are obese.
- Understand the imaging principles of musculoskeletal ultrasound.
- Be familiar with basic scanning methods and normal sonographic anatomy.
- Understand the clinical indications for musculoskeletal and therapeutic ultrasound interventions in orthopaedic physical therapy.
- Be familiar with the appearance of select pathologies using ultrasound.
- Be familiar with invasive and noninvasive ultrasound-guided therapies.

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The Effects of Manual Lymphatic Drainage on Postoperative Pain and Ambulation Distance Following Unilateral Total Knee Arthroplasty

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ABSTRACT

Background and Purpose: Manual lymphatic drainage (MLD) is indicated for treating pain and edema. We investigated its effect on postoperative pain and ambulation distance after total knee arthroplasty (TKA). **Methods:** We compared numeric pain rating, daily postoperative narcotic use, and longest ambulation distances between 34 patients who received MLD (plus conventional treatment) in the 72 hours after unilateral TKA and 51 who did not. **Results:** Manual lymphatic drainage patients reported 32% to 68% intermittent reduction in pain after MLD treatment, but higher, non-statistically significant, mean daily pain levels when compared to non-MLD patients (5.6 ± 2.2 vs 4.9 ± 2.4, p = 0.19). Change in pain was not statistically significant, but met minimal detectable change and minimally clinically importance difference values for the Numeric Pain Rating Scale. Neither narcotic use (600 ± 293 vs 721 ± 336 mg, p = 0.09) nor ambulation distance (138 ± 77 vs 159 ± 67 feet, p = 0.43) differed significantly between groups. **Clinical Relevance:** Manual lymphatic drainage did not appear effective in managing postoperative pain following TKA, but may be a useful adjunct for short-term relief. **Conclusion:** Future research should investigate MLD's impact on other outcomes, such as range of motion and post-discharge pain and mobility.

Key Words: manual lymphatic drainage, knee replacement, lymphedema, knee surgery

INTRODUCTION

Postsurgical edema and pain are common adverse symptoms following a total knee arthroplasty (TKA) surgery. These symptoms often last for several days to weeks following surgery. Some individuals are more greatly affected by these symptoms than others, which can negatively affect their rehabilitation and quality of life.[1] Much of the pain experienced after TKA is caused by excess fluid in the interstitium (edema).[2] The pathophysiology of postsurgical edema is multifactorial, with a dynamic component caused by the inflammatory process that follows tissue trauma, and with a mechanical component caused by physical damage to the local lymphatic vessels.[3-6] Manual lymphatic drainage (MLD) is used to treat edema that involves impairment of the lymphatic system.[4-6] It is a manual technique that comprises of very light, superficial strokes that stimulate lymphatic vessels for the mobilization of fluid out of interstitial tissues and back to the circulatory system. Manual lymphatic drainage is widely used for the treatment of chronic lymphedema. However, it is indicated for the treatment of any edema that is both dynamic and mechanical in nature, as well as for pain. It is suggested that MLD is effective for pain management because the manual techniques used during treatment directly stimulate the parasympathetic nervous system, which promotes relaxation and secretion of pain-inhibiting endorphins.[9-11] Additionally, in any case where edema is present, the manual stimulation of the lymphatic vessels that is characteristic of MLD transports excess fluid away from the affected tissues, thereby believed to relieve internal tissue pressure, resulting in pain reduction.[3]

There is limited evidence that MLD may be effective for swelling and pain experienced in conditions other than lymphedema. However, all of the existing studies have shown benefits. To date, the conditions that have been investigated include posttraumatic edema,[11-13] fresh scar tissue,[6] pain and edema following TKA,[14,15] fibromyalgia,[9] and reflex sympathetic dystrophy.[16] There is only one research study[14] examining the effects of MLD on post-TKA edema, pain, and functional outcomes in the acute stage (the first few days immediately following surgery or trauma), when these symptoms are often at their worst. This study found that patients who received MLD on post-op days 2, 3, and 4 had a greater improvement in active knee flexion than the control group, but no significant differences in subjective resting pain rating were observed between the MLD and non-MLD groups. However, this study did not investigate immediate changes in pain level associated with MLD treatment, nor did it take into account pain medication usage between the two groups. Additionally, although multiple functional outcomes such as performance of activities of daily living (ADLs) and quality of life were examined in this study, ambulation distance was not included in the investigation.

The purpose of this study was to examine the effects of MLD on acute postsurgical pain and ambulation distance following TKA, in conjunction with conventional treatments and modalities. We hypothesized that MLD following TKA in the postoperative period would be associated with a decrease in postoperative pain and narcotic use, and an improvement in ambulation distance.

METHODS

Study Population

This was a retrospective observational study consisting of a convenience sample of patients admitted to a large, urban, not-for-profit hospital. Approval for this study was obtained through the local institutional review board. Inclusion criteria consisted of inpatients following unilateral primary or revision TKA surgery between July 1, 2012, and July 1, 2013. Patients were divided into the MLD and non-MLD groups based on whether or not they received MLD in the postoperative period during their hospital stay. The patients who received MLD were chosen based on surgeons' orders. A number of patients with orders for MLD did not receive MLD during their stay mainly due to practical factors such as time constraints, therapist availability, or early discharge. The MLD group included patients who received at least one MLD treatment during their postoperative stay in the hospital. The non-MLD group was selected from the remaining pool of patients who did not receive any MLD treatment. Patients were followed for the duration of their hospital stay, divided into postoperative days based upon 24-hour periods following surgery.

Patients with any of the following conditions were excluded from this study: history of severe trauma to either lower extremity with resulting physical impairment existing prior to TKA surgery, significant or severe preexisting neurological or orthopaedic deficits that affect mobility, limited mobility status prior to surgery (bedbound or wheelchair-bound), postsurgical complications, bilateral TKA, occurrence of adverse events or serious decline in medical status during the patient's hospitalization (such as acute congestive heart failure, acute infection, acute deep venous thrombosis), transfer off of the orthopaedic unit to a different unit/service of hospital (eg, telemetry, intensive care unit), previous severe cognitive impairment, complex surgery with unusual weight-bearing or range of motion (ROM) restrictions, and death.

A total of 136 patients were screened for the study. Of these, 51 were excluded for the following reasons: bilateral TKA (36), post-surgery medical complications (3), removal of infected TKA or some other procedure that was not a total joint replacement (7), complex TKA revision with unusual weight-bearing or ROM restrictions (3), previous cognitive impairment/dementia (1), and prior mobility impairment (1). The remaining 85 patients were included in the study, out of which 34 patients were in the MLD group and 51 were in the non-MLD group.

Study Treatments

Both groups received conventional medical (pain medications, compression bandages, cryotherapy) and rehabilitative interventions (gait training, ADL training, therapeutic exercise). One group received MLD in addition to the conventional medical and rehabilitation interventions listed above.

The MLD treatment sequence used was adapted from Zuther[6] and was completed as follows on the ipsilateral limb: (1) at the inguinal lymph nodes, (2) the anterior thigh, (3) the medial thigh, and (4) the lateral thigh. Following treatment on the thigh, the fluid around the knee was directed away from the incision proximally, laterally, and medially. To complete the MLD treatment, the sequence was repeated in the opposite direction ending at the lymph nodes. Each session lasted 25 to 30 minutes.

Primary Outcomes:

(1) Narcotic use
   a. The total amount of narcotic pain medication used by each patient for each postoperative day of hospitalization, starting from the day of surgery when the patient arrived from the operating room to the recovery unit.
   b. To account for different types of narcotic pain medications, all opiates were converted to a Morphine equivalent dosage in milligrams using an opioid conversion calculator.

(2) Measurement of pain
   a. Subjective pain ratings were obtained using the Numeric Pain Rating Scale (NPRS), which is a Likert scale of 0-10. A zero rating was indicative of no pain, while a 10 indicated the worst possible pain.
   b. In the MLD group, pain ratings were obtained before and after MLD treatments. Pain ratings were obtained no more than two hours before or after the treatment. The majority of pain levels were obtained immediately before and after treatment.

Secondary Outcome:

(1) Longest ambulation distance for each postoperative day of hospitalization. This distance was measured in feet and was determined via medical record review of the distances recorded by Physical Therapists during treatment. These bouts of ambulation were consistent with standards of practice with estimated distances based on the length of the general ward hallway.
   a. The longest ambulation distance that each participant achieved each postoperative day was used for data analysis.

Retrospective Data Collection

Data were collected retrospectively from the electronic medical record for each included participant over a 3-month period of time from September 2013 to November 2013 using a standardized and pretested data collection sheet. Following training of the coinvestigators by the primary investigator on the use of the data collection program and data collection protocols, the data were collected by the primary investigator (SCL) and two coinvestigators (VP, MC) and were validated for accuracy by the primary investigator.

Statistical Analysis

Data were summarized using means and standard deviations for continuous variables, and counts and percentages for categorical variables. Comparisons of the demographic and clinical data between the MLD and non-MLD groups were performed using t-tests, chi-square tests, or Fisher's tests, as appropriate. For each patient, the average maximum pain score for each day was calculated, as well as the average daily opiate dosages and the maximum ambulation distance. Analysis for all outcomes was also performed controlling for age, gender, and surgeon. The adjusted p values were obtained using linear or logistic regression, as appropriate. Effect sizes were calculated using Cohen's d for quantitative variables and Cramer's V for qualitative variables. Additional analyses looked at reported pain before MLD treatment and the change in pain after treatment by summarizing the data with medians and interquartile ranges. The average daily opiate dosages were also summarized with medians and interquartile ranges, and comparisons between groups were performed using Wilcoxon tests. SAS 9.3 were used for all analyses and a p value of < 0.05 was considered to be statistically significant.

RESULTS

Table 1 summarizes the demographic and clinical data for MLD and non-MLD groups. Manual lymphatic drainage was associated with a lower total amount of opiate use but did not reach statistical significance (Figure 1). In the MLD group, the total amount of opiates consumed was 65 mg to 240 mg lower than in the non-MLD group. This difference was the largest during the second 24-hour period, when the non-MLD group consumed a median of 240 mg more than the MLD group. The median amount of opiates consumed by the MLD group was slightly higher during the 4th 24-hour period, but this data reflects only one patient in the MLD group. Manual lymphatic drainage treatment was associated

Table 1. Patient Demographic, Medical History, and Procedures

	All (N=85)	No MLD (N=51)	MLD (N=34)	p-value
Age	67.0±10.0	65.9±11.3	68.7±7.6	0.17
Male Gender	26 (31%)	22 (43%)	4 (12%)	0.00
Body Mass Index	33.5±8.6	33.5±8.9	33.5±8.3	0.99
Minority Race/Ethnicity	23 (27%)	13 (25%)	10 (30%)	0.69
History of Ortho Trauma to Surgical Limb	5 (6%)	4 (8%)	1 (3%)	0.64
History of Neurological Impairment	8 (9%)	4 (8%)	4 (12%)	0.71
Congestive Heart Failure	1 (1%)	0 (0%)	1 (3%)	0.40
Kidney Disease	7 (8%)	6 (12%)	1 (3%)	0.23
Liver Disease	3 (4%)	1 (2%)	2 (6%)	0.56
Cancer	11 (13%)	6 (12%)	5 (15%)	0.75
Chronic Pain Disorder	11 (13%)	6 (12%)	5 (15%)	0.75
Prior Total Joint Replacement	35 (41%)	24 (47%)	11 (32%)	0.18
Surgeon	30 (35%)	12 (24%)	18 (53%)	0.01
Procedure				0.10
Right Primary TKA	35 (41%)	24 (47%)	11 (32%)	
Left Primary TKA	44 (52%)	22 (43%)	22 (64%)	
Right TKA Revision	2 (2%)	1 (2%)	1 (3%)	
Left TKA Revision	4 (5%)	4 (8%)	0 (0%)	
Participated in Group Therapy	28 (33%)	10 (20%)	18 (53%)	0.00
Abbreviations: TKA, total knee arthroplasty; MLD, manual lymphatic drainage				

with a 32% to 68% reduction in pain (Table 2), which translates into a drop in pain level by half a point to 4 points on the NPRS.

Table 3 provides a summary of outcomes for overall hospital stay by group. Despite the immediate drop in pain levels experienced with MLD treatment, patients in the MLD group reported higher pain than the non-MLD group (5.6 ± 2.2 vs. 4.9 ± 2.4, p = 0.19). In addition, significant differences were found in gender, surgeon, and group therapy participation between the MLD and non-MLD groups. All study participants had at least two postoperative days and no more than 4 postoperative days in the hospital. Over half the MLD patients received MLD during only one postoperative day. Manual lymphatic drainage was provided for 6 patients on day 1, 27 patients on day 2, 17 patients on day 3, and one patient on day 4 of the postoperative period. The median number of sessions received by each patient in the MLD group was two (range 1-5 sessions). Finally, there was no significant difference in maximum ambulation distance between the two groups.

DISCUSSION

The aim of this study was to investigate the effects of MLD on pain, use of narcotics, and ambulation distance in the immediate postoperative period following unilateral TKA. The findings suggest an immediate reduction in pain with MLD based on within-subject comparisons in the MLD group. Although reduction in subjective pain level posttreatment was not analyzed for statistical significance, raw change scores and percent change reached minimal detectable change (MDC) and minimally clinically importance difference (MCID) values. According to Stratford and Spadoni,[7] a raw change of 3 points or 27% indicates a meaningful change in pain. Furthermore, a 35% reduction on the NPRS indicates "minimal relief" and a 67% reduction indicates "moderate relief."[8] These results did not appear to indicate any long-term effects of MLD on pain level outside of treatment sessions, however.

There was also no statistically significant difference in average pain level between the MLD and non-MLD groups. There was greater reduction in opiate use for the MLD group, but this did not reach statistical significance. Furthermore, there was no association between MLD treatment and ambulation distance in the immediate postoperative period on patients with TKA.

Previous studies have found that MLD reduces pain for both short-term[9,16] and long-term[9] periods in patients with other diagnoses. In this study, the reduction in pain associated with MLD was noted only immediately following the treatment in the MLD group and may have been reflected in the trend towards lower opiate usage in this group, as the changes in pain level met MDC and MCID values for the NPRS. However, the differences in opiate use did not reach statistical significance in either group and could have been attributed to other factors not included in this investigation. Regarding the effects of MLD on pain, our findings are more consistent with those of Ebert et al,[14] who also did not find any significant effects of MLD on pain level with TKA patients in particular. Manual lymphatic drainage reduces pain through multiple mechanisms.[6,10,11] One is reduction in edema and, therefore, a reduction in inter-

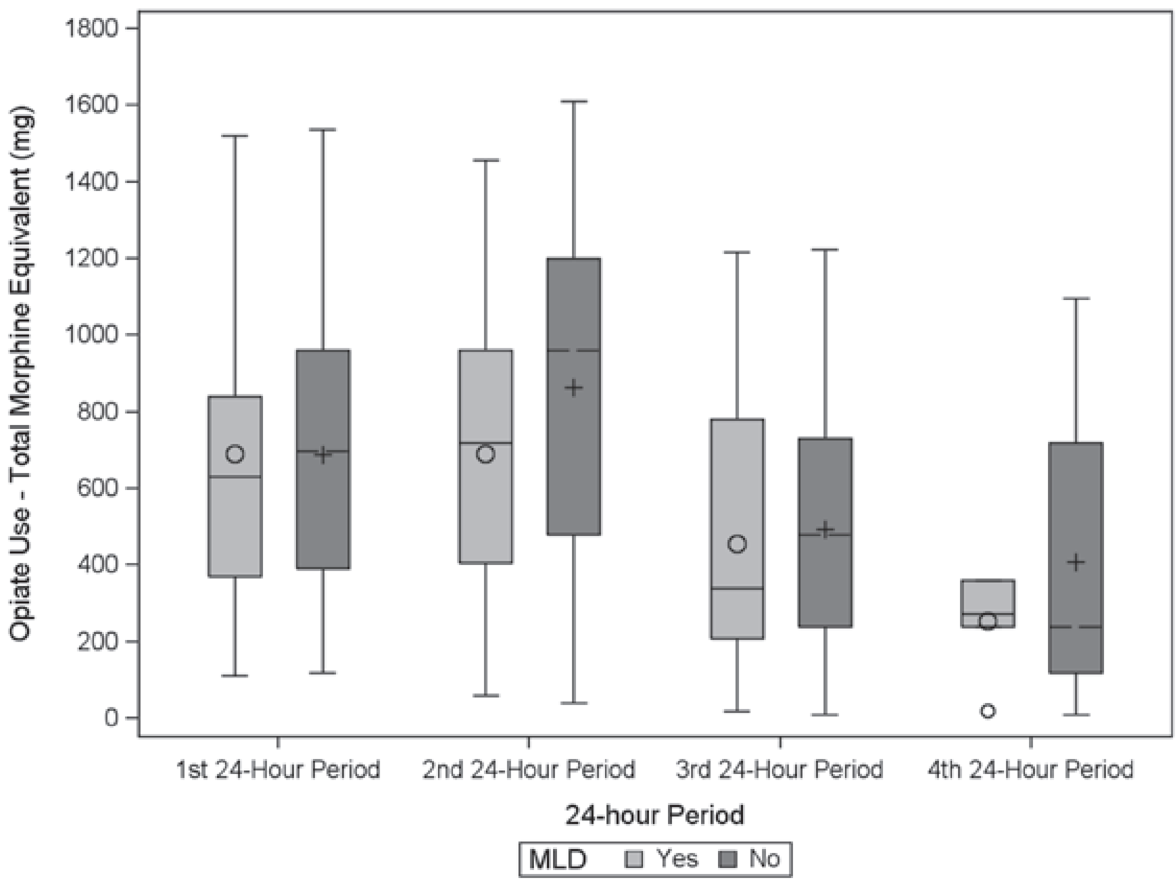

Figure 1. Opiate use—total morphine equivalent (mg) for each 24-hour period. Wilcoxon tests comparing MLD groups resulted in the following p values: p = 0.98 for the 1st 24-hour period, p = 0.06 for the 2nd 24-hour period, p = 0.67 for the 3rd 24-hour period, and p = 0.96 for the 4th 24-hour period.
Abbreviation: MLD, manual lymphatic drainage

stitial tissue pressure. However, edema was not measured in this study.

The results of this study suggest that MLD may be a useful adjunct treatment for immediate pain reduction only, at best. Patients with significant resting pain in particular may benefit from this intervention as it seems to reduce resting pain levels for a short duration. Manual lymphatic drainage is safe, well-tolerated by patients, takes little time to perform, and is easy for practitioners to learn and to teach to patients, which makes it a practical complementary intervention to apply alongside conventional pain management measures.

This study did not demonstrate any benefit in ambulation distance. It is possible that other factors may impact the ambulation distance, such as differences in age, gender, and surgical technique. It is highly doubtful that the lower ambulation distances in the MLD group were related to the fact that they received MLD, as the differences in ambulation distance were not significant. It is also possible that the first 2 to 3 days following surgery is too early to determine functional outcomes. A few studies have found improvements in functional outcomes in patients who received MLD,[13-15] but others did not.[16]

Finally, the short term benefit in pain demonstrated in this study may not predict long-term benefits of MLD on pain levels or opiate usage as we do not have follow-up data following discharge.

Study Limitations

This study had several limitations. The main limitation of this study was the retrospective study design, which influenced the overall findings of the study. Different results may have been found had this study followed a prospective design or had been a randomized control trial similar to Ebert et al.[14] Second, the sample size was relatively small and based on a sample of convenience without control of age, gender, surgical technique, or other physical characteristics. A larger sample size may have resulted in greater statistical power. Third, data on other important measures such as knee range of motion or limb swelling were not available or were not obtained, respectively. Previous research has found that MLD increases knee active ROM.[14] Fourth, due to the retrospective design of this study, missing data for elements such as pain ratings was an uncontrollable limitation. Pain ratings were subjective and were missing for a few patients (4 of 85 for the first 24-hour period, 5 of 80 for the second 24-hour period, 17 of 69 for the third 24-hour period, and 16 of 28 for the fourth 24-hour period). Fifth, all patients in the study did not receive the same number of MLD sessions, with some patients receiving multiple treatments while others received only one treatment. This was due to the timing of discharge from the hospital.

Table 2. Pain Rating Associated with Manual Lymphatic Drainage (Median and Interquartile Ranges)

	Pain Before MLD	Change in Pain After MLD*	Percent Change in Pain After MLD
1st 24-hour period	7 (5.0, 9.5)	-4 (-5.0, 0)	-45.3% (-50.0, -40.6)
2nd 24-hour period	5.5 (4.0, 7.0)	-1.5 (-3.0, -1.0)	-34.2% (-50.0, -14.3)
3rd 24-hour period	4 (2.5, .05)	-0.5 (-2.5, 0)	-32.5% (-65.0, -3.6)
4th 24-hour period	6 (6, 6)	-4 (-4, -4)	-67.7% (-67.7, -67.7)

*Negative sign indicates a reduction in pain after MLD.

Abbreviation: MLD, manual lymphatic drainage

Table 3. Summary of Outcomes for Overall Hospital Stay by Group

	No MLD (N = 51)	MLD (N = 34)	p-value	adjusted p-value
Average daily max pain	4.9 ± 2.4	5.6 ± 2.2	0.1947	0.4582
Average daily opiate dosage (mg)	721 ± 336	600 ± 293	0.0928	0.8584
Max ambulation distance (feet)	159 ± 67	138 ± 77	0.1856	0.4347
150 feet ambulation distance reached	37 (73%)	19 (56%)	0.1123	0.8378

Abbreviation: MLD, manual lymphatic drainage

CLINICAL APPLICATIONS

In patients undergoing unilateral TKA, MLD did not appear to be a significantly effective treatment for postoperative pain, although we did observe what appeared to be an immediate reduction in postoperative pain and a slight trend toward lower opiate use. At best, MLD may be a useful adjunct in the immediate, short-term management of postoperative pain in this patient population. More research needs to be done to further determine MLD's effectiveness on postoperative pain and functional outcomes. Future studies should include a stronger study design, a larger sample size, data on knee ROM, data on edema, and post-discharge follow-up.

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Cost Efficiency of Direct Access Physical Therapy for Temple University Employees with Musculoskeletal Injuries

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ABSTRACT

Background and Purpose: Evidence suggests that direct-access physical therapy (PT) can decrease costs and improve outcomes for individuals with musculoskeletal conditions. The purpose of this study was to observe the outcomes of a direct access PT entry portal for Temple University employees with workers' compensation injuries or private insurance <3 months after onset. **Methods:** Consecutive patients who met eligibility criteria and gave consent were included. Outcomes assessed pre and post-treatment included total episode cost and patient-important functional outcomes. Two tailed-independent t-tests were used to determine significance ($p < .05$). **Findings:** Ten employees were included and received PT over a 3-week period (mean visits 3.7 (SD 1.06). Mean total episode cost was $435 (SD $140) and Patient Specific Functional Scale scores increased from 5.7 to 9.3 ($p = .005$). **Relevance:** This was the first study to investigate direct access PT for a worker's compensation/employee health population. **Conclusion:** Direct access PT management was associated with positive outcomes and low episode cost.

Key Words: occupational health, orthopaedic, worker's compensation

BACKGROUND AND PURPOSE

Musculoskeletal disorders affect more than one out of every two adults in the United States with total expenditures of $796.3 billion in 2011, more than the burden of cardiac diseases and diabetes combined.[1] Health care costs for certain musculoskeletal conditions such as spinal pain, have increased 65% from 1997 to 2005, with a concomitant trend of greater percentage of individuals limited by physical function during this period.[2] These statistics suggest that current management is not only inefficient, but could be suboptimal.

It is possible that these current trends are in part due to increasingly guideline discordant management, with a rising rate of narcotic prescriptions,[2] advanced imaging,[2] and surgeries performed for profit.[3] Although the relative effectiveness of physical therapy compared with other alternative or medical interventions is questioned, it seems as if early and direct physical therapy is associated with reducing medical utilization and containing overall episode costs.[4-6] Potential reasons could be higher guideline adherence among physical therapists compared to physicians,[7] incorporation of bio-psychosocially oriented approaches used in client education and interventions,[8] or reliance on clinical examination[9-11] versus imaging to guide differential diagnosis and further work-up.[10,12]

Despite the advanced training physical therapists receive in the neuromusculoskeletal system,[13-15] it seems that physical therapy services are underutilized, especially during the acute timeframe. Fritz et al[4] reported that for patients with low back pain, only 7% of patients received physical therapy in the first 90 days of presenting to primary care. Another large national survey suggested that only 6% of patients presenting to medical providers for musculoskeletal pain saw a physical therapist at any point during their care. Most of these patients sought care from primary care physicians, physician specialists, or chiropractic providers as entry points into the medical system.[16]

In addition to containing cost, recent evidence suggests that early or direct access physical therapy (PT) episodes are associated with greater improvement in outcomes at conclusion of care, particularly in the worker's compensation population,[7,18-20] yet this population currently is managed by a physician gate-keeper model in the United States. The emphasis for clients with worker's compensation injuries should be on improving function for early return to work, and it is sensible for physical therapists to be positioned early in the episode. A retrospective study by Zigenfus et al[21] reported that a delay of initiation of PT services of only 6 days was associated with a mean of 2 additional absent work days and 4 additional restricted work days per episode. Finally, there might be a role for physical therapists to screen clients to identify those potentially at higher risk for delayed return to work, using self-report questionnaire tools such as the STarT Back Screening tool,[22] Pain Catastrophizing Scale,[23] or Orebro Musculoskeletal Pain Screening Questionnaire.[24]

Based on the emerging literature on this topic, the purpose of this prospective observational pilot study was to measure the outcomes of early direct access PT for Temple University (TU) employees with and without worker's compensation injuries. A secondary purpose was to perform an initial exploratory comparison with retrospective worker's compensation claim data from employees who were all initially managed through physician care.

METHODS

Screening and Eligibility Criteria

All TU employees who reported to the Temple Employee Health front desk were screened for eligibility criteria. Selection criteria included (1) Temple University employees who spoke English sufficiently to understand informed consent, (2) had a primary complaint that was potentially of neuro-musculoskeletal etiology, (3) age greater than 18 years old, and (4) employee's primary complaint began ≤ 3 months before initial study screening. Employees were excluded if (1) they met with another medical provider for the condition prior to study enrollment, (2) had a medical history of surgery for that region, (3) had a history of major psychiatric disease in their past medical history, or (4) presented with red flags that suggested a potentially serious or life threatening condition could be causing the presenting symptoms. All employees were screened, including those with and without worker's compensation injuries (either had private insurance or were worker's compensation).

Baseline Assessment and Outcomes

Self-report questionnaires were used to assess outcomes and were given to the patient by the primary author (HO) and filled out by the patient behind a closed door. The therapist (HO) remained available to clarify any questions or concerns and ensure that the paperwork was completed in entirety. Data extraction was completed by the primary author as well; however, since the type of data collection was chart extraction, bias was minimized.

The following self-report measures with acceptable reliability, validity, and responsiveness for patients with musculoskeletal disorders were given at baseline: the shortened Orebro Musculoskeletal Pain Screening Questionnaire (0-100, 0-50 representing low risk and 51-100 representing high risk),[24] the Pain Catastrophizing Scale (score from 0-52 with lower scores representing less catastrophizing),[23] the Pain Self-Efficacy Questionnaire (score ranges from 0-60 with high scores representing greater perceived self-efficacy),[25] and the Patient Specific Functional Scale (PSFS, which is a self-report measure for functional tasks the patient chooses and rates from 0 = not able to perform self-selected activities to 10 = fully functional).[26] It was hypothesized that the Orebro score would be a moderator of outcomes and the Pain Self-Efficacy Questionnaire (PSEQ) score and Pain Catastrophizing Score (PCS) would each be a mediator of outcomes (greater self-efficacy and lower catastrophizing associated with improved outcomes). Various region-specific measures were also used to assess the subjects' function and included the Lower Extremity Functional Scale (score 0-80 with higher score representing greater function),[27] the modified Oswestry Disability Index (score 0-100%, with lower scores representing less disability),[28] the quickDASH (0-100% with lower scores representing less disability),[29] and the Neck Disability Index (0-100%, with lower scores representing less disability).[30]

Discharge Outcome Assessment

At conclusion of physical therapy care, outcomes assessed included all of the baseline questionnaires in addition to the following information extracted from the chart: total cost of the episode of care (estimated using reimbursed amounts for both prospective and retrospective cohorts), medical utilization (injections performed, imaging ordered, and specialty physician visits required, the dosage of over-the-counter and prescription medication, and if the patient received prescription medication), and the number of absent and restricted work days in the TU system. Finally, the Patient Acceptability Symptom State (PASS), as used in previous literature,[31,32] was assessed by asking the subjects the following question, "Taking into account all the activities you have during your daily life, your level of pain, and also your functional impairment, do you consider that your current state is satisfactory?" to which subjects could respond "yes" or "no," and to assess satisfaction at discharge, the subjects were asked to rate their satisfaction with care using a 0-10 Likert scale (0 = extremely dissatisfied and 10 = extremely satisfied).[33] Similar to assessment of the baseline outcomes, the primary author (HO) gave the patient the outcome forms and extracted relevant information from the subjects' charts. The outcomes were not extracted at the same point for all subjects since they were discharged after varying number of days (ranged from 10-18 days).

Physical Therapy Triage and Management

Employees who passed eligibility criteria and gave consent were enrolled in the study. After filling out baseline assessment questionnaires, the subjects received direct access physical therapy evaluation and intervention based on the protocol outlined in Table 1. The physical therapist who provided the care (HO) held a Doctor of Physical Therapy, and was an Assistant Professor at TU with prior residency and fellowship training. The physical therapist served autonomously in the sense that any imaging was ordered directly from the imaging center without requiring a physician visit. Patients were screened for red flags and also were stratified with their Orebro score. Patients at high risk were treated primarily with skilled education and patients with a low risk score were treated with an impairment-based approach using manual therapy and exercise (see Table 1). If patients reported their outcomes at discharge from PT, they were given a $75 gift card to incentivize their participation and increase retention.

Statistical Analyses

Two tailed-independent t-tests were used to detect differences between the prospective and retrospective cohorts and nonparametric statistics supplemented these analyses when normality could not be assumed. WiIcoxon signed rank test for paired samples were used to compare pre- versus post-values of ordinal level outcome measures in prospective group. Significance was set at alpha ≤ 0.05.

FINDINGS

Over a 1-week period, 10 subjects (1 worker's compensation patient, 9 non-worker's compensation patients) with musculoskeletal pain were enrolled in a single group clinical study and received direct access PT provided by a single therapist (HO) in accordance with the planned treatment protocol (Table 1). The average period of time for the PT episode from initial evaluation to discharge was 14 days (SD 3.09) and the subjects were treated on an average of 3.7 visits (SD 1.06). The following subsections list the results at discharge from PT.

Activity Limitations/Participation Restrictions

The mean PSFS functional score increased by 3.6 points, from 5.7 to 9.3, p = 0.005 (Figure 1). None of the employees took absence from work. The one worker's compensation patient that was treated in this study was on light duty for 13 days, per work status form written by the PT, and then continued working full duty without restrictions. Although it was difficult to pool region-specific outcomes to average for all subjects, 9 out of 10 subjects improved their region-specific score surpassing a clinically meaningful change, except for 1 patient who increased their LEFS from a 73 to an 80 (80 = full function, ceiling effect).

Medical Utilization/Referrals

Of the 6 subjects using over-the-counter medication, all reported they were no longer taking medication upon discharge (Figure 2). There were no referrals made for prescription medication or injections, and no referrals to the Employee Health physician or specialty services were required. Only one patient needed a plain radiograph to rule out fracture of the knee (negative for acute fracture).

Cost

Total episode cost for each subject ranged from $205 to $705 (mean=$435, SD=$140, median= $437, see Figure 3), and in all cases at least two visits were required, which led to a minimum cost of $205. However, the cost rarely exceeded $500 in billable amounts. This amount included the PT billed and the

Table 1. Intervention Protocol

Low Risk (Orebro score ≤50)	High Risk (Orebro score>50)
~25% of the time will be spent on education. Education to inform patients of diagnosis, prognosis, and intervention plan. A bio-psychosocial approach will be utilized to provide reassurance and decrease concern when clinical exam or imaging/further work up has ruled out serious diagnoses. If only a consultative visit is required, the patient will be scheduled for 1 visit but outcomes will be collected on follow-up without receiving a billed visit.	**75-100% of the time will be spent on education and cognitive behavioral strategies.** Education to inform patients of diagnosis, prognosis, and intervention plan. Stem and leaf questions and Orebro answers will be utilized to pinpoint the patient's personal and lifestyle factors that could be perpetuating the problem. Education will specifically target patient beliefs, expectations, and increase understanding of their pain (ie, that pain is an output)
~75% of time will be spent on mechanical interventions. Key reliable impairments (such as range limitation) will be identified in examination related to functional problem(s). Identified impairments will be treated with manual therapy/exercise interventions. Test-retest will be emphasized to determine relevance to the patient's functional problem. Treatment based classification or any evidence on specific diagnoses will be utilized when available. If the patient does not improve with asterisk retest after 3 distinct interventions, cognitive impairments/ education will be emphasized vs manual therapy.	**0-25% of time will be spent on mechanical interventions.** Reliable impairments hypothesized to be perpetuating the problem will be treated (if any); however, instead of assessing and reassessing with a functional asterisk, the PSFS will be utilized to identify change over time. Graded activity and graded exposure will be utilized as appropriate. Emphasis will be on monitoring function vs. monitoring pain.

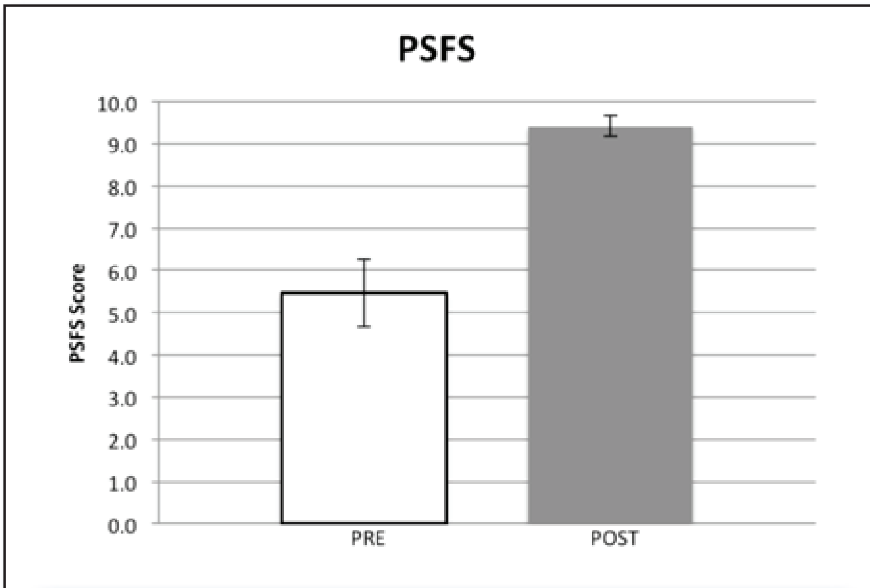

Figure 1. Means with error bars showing patient-specific functional scale (PSFS) scores at pre- and postintervention (at discharge) from physical therapy.

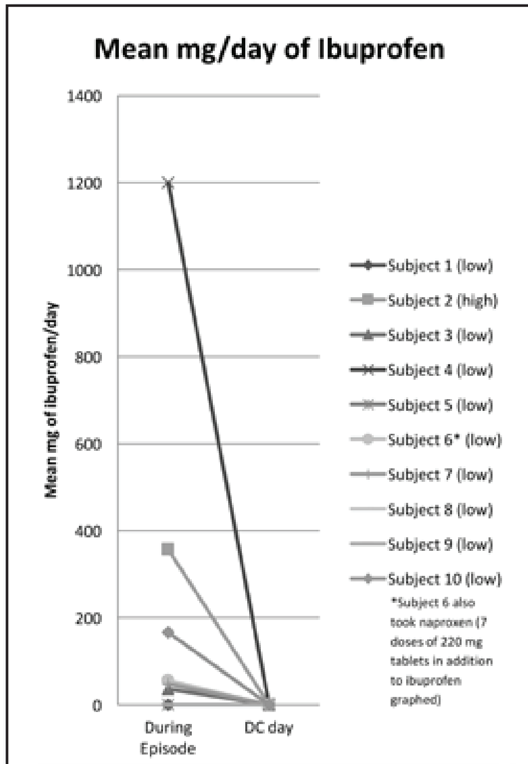

Figure 2. Over-the-counter medication usage. The patient was not instructed to take medication during the visit; however, some patients were taking medication on their own volition throughout the study. By discharge (DC), all patients had discontinued taking ibuprofen.

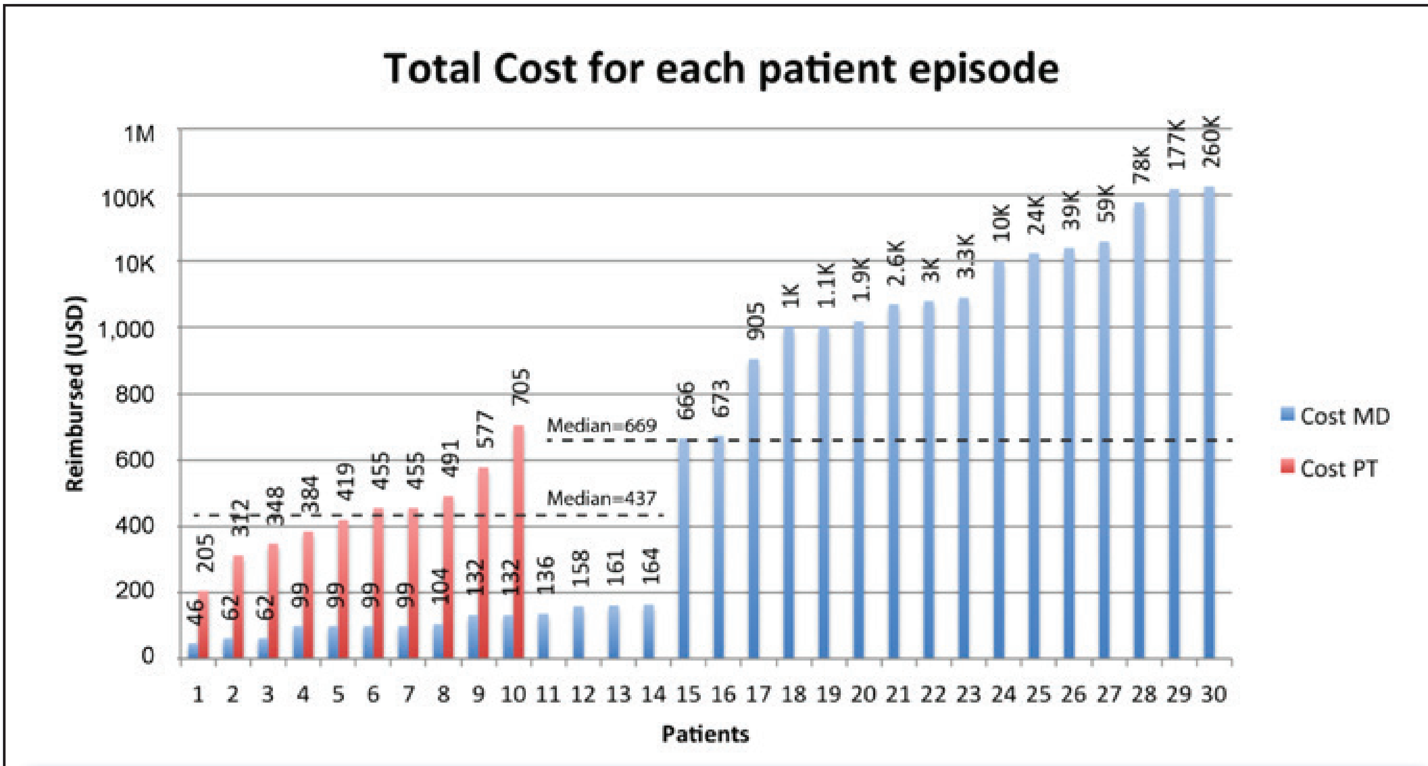

Figure 3. Total reimbursed episode cost for PT portal of entry compared with MD portal of entry (~33% received physical therapy via MD portal of entry). The PT portal of entry demonstrates costs associated with the 10 prospective subjects. The MD portal of entry demonstrates costs associated with the 30 retrospective claims.

one subject who required a plain radiograph of the knee.

Patient Satisfaction and Acceptable Symptom State

All subjects reported high satisfaction with treatment outcome Likert scale = 9.8 out of 10, and 10/10 subjects responded "yes" to current state being satisfactory on the PASS scale.

Treatment Moderators and Mediators

We hypothesized that the Orebro Musculoskeletal Pain Screening Questionnaire would be a moderator of outcomes. One subject scored high risk (> 50) on the Orebro (worker's compensation patient), and the others scored low risk (≤ 50). Based on previous literature, we assessed PSEQ and the PCS as mediators of outcomes. The mean PSEQ score increased by 11 points ($p = .012$) and the mean PCS score decreased by 9 points ($p = 0.038$), suggesting improved self-efficacy and decreased catastrophizing (see Figures 4 and 5).

Initial Exploratory Comparison

In order to get an initial exploratory comparison with physician portal of entry costs that are typically incurred when treating TU employees with musculoskeletal injury, we were provided data from the files of the most recent 30 closed medical claims from the office of TU workers' compensation for the physician at the study site. We excluded any previous claims that began in the emergency room visit since these patients would not have been eligible for the study and it would artificially inflate episode cost. Two-thirds of the patients (20/30) were treated without being referred to PT. The total episode cost ranged from \$49 to \$261,244 (mean = \$21,500, SD \$57,778, median = \$669, see Figure 2). Taking into account the heteroscedasticity of this variable, cost was still significantly greater than the PT portal of entry cost that we found in our pilot study ($p < 0.05$, 2-tailed, independent groups, unequal variance). A statistical comparison of median cost was also significant ($p = 0.007$, Wilcoxon Signed Rank Test for One-sample). This result was expected since only one patient from the PT portal of entry cohort exceeded the median cost of the physician portal of entry patients (Figure 3). Although almost half of the physician portal of entry patients incurred less than \$200 total reimbursed cost per episode, no patient outcomes could be obtained to determine level of satisfaction of treatment, no record of how much medication was prescribed, or whether there was episodic recurrence after the file was closed. However, we were able to determine that mean absent work days were 57.9 days (SD = 127) and mean restricted work days were 8.5 days (SD = 24) as compared to 0 (SD = 0) absent work days and 1.3 restricted days (SD = 3.9) in our PT portal of entry pilot subjects.

CLINICAL RELEVANCE

Although this study provides preliminary evidence that a direct access pathway for musculoskeletal conditions could be an efficient pathway for employees to optimize outcomes and reduce episodic cost, there are clear limitations in making this conclusion. Musculoskeletal pain generally has a favorable prognosis and given that most of these patients were considered low risk on the Orebro for progressing to chronic pain, it is possible that these patients would have improved even without receiving physical therapy. Further, when conducting the exploratory analysis to compare physical therapy versus physician management, confounding variables could have affected the

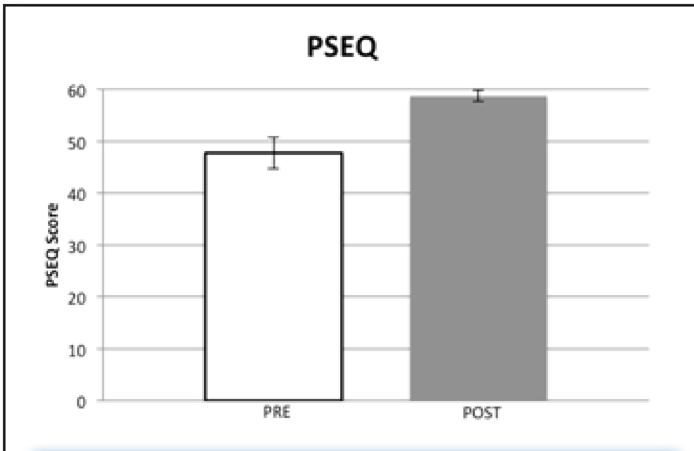

Figure 4. Mean and error bars show Pain Self-Efficacy Questionnaire (PSEQ) at pre- and postintervention (at discharge), with higher scores indication greater self-efficacy.

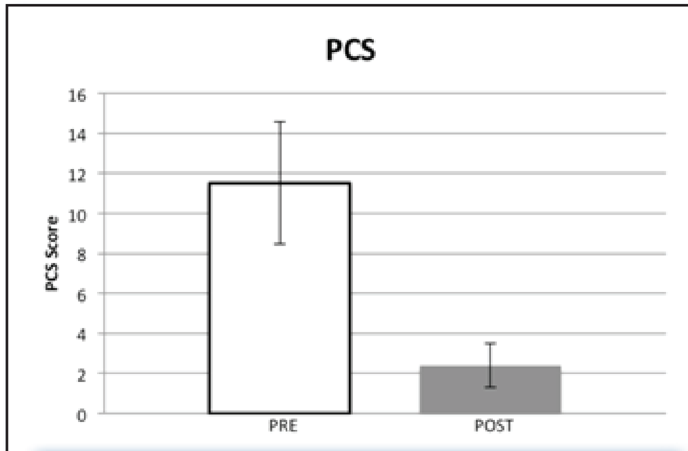

Figure 5. Mean and error bars show Pain Catastrophizing Score (PCS) at pre- and postintervention (at discharge), with lower scores indicating less catastrophizing.

outcomes more than the initial provider. In the prospective analysis, 1 out of 10 subjects were worker's compensation patients versus all of the patients in the retrospective claim data were patients with worker's compensation injuries and the retrospective group of patients were treated by a different physical therapist than the study physical therapist (10/30 patients were referred to physical therapy).

It is interesting that the one patient who scored high risk on the Orebro was the patient with the worker's compensation injury. Using a primarily education-dominant approach, she showed the largest improvement on the PSFS and reached a 10/10 score within a 17-day time period. It is possible that this patient would have progressed to develop chronic pain or delayed return to work if she had received a standard approach to care.

Most patients were categorized as low risk on the Orebro and initially received a mechanical physical therapy approach. However, a subset of these subjects did not show clinically meaningful improvements within session using this mechanical test retest model. Based on the study protocol, the intervention was modified to a predominant education-based (versus mechanical) approach for these individuals. Further literature should be reviewed to explore cut-off scores on the Orebro to best identify patients who might be at high risk for development of chronic pain or delayed return to work.

Another limitation of this study is that the authors advertised through word of mouth to recruit subjects for the pilot study; thus, these patients may not have presented to the medical system if they were not aware of the study. Furthermore, future studies should use outcome measures that can be pooled across all subjects such as the Patient Reported Outcome Measurement Information System (compared with using region-specific measures). Future prospective studies should also include a comparison group (for example a group of patients managed by physician care) and consider using higher quality designs such as a concealed randomized approach.

CONCLUSIONS

A direct access PT portal of entry was associated with positive outcomes and low total episodic cost in this small pilot study. Limitations include lack of a prospective comparison group and dissimilar characteristics between patient injury type/insurance. The primary author was the physical therapist administering treatment, which introduces potential bias. Although all 10 patients were Temple University employees, only one was an empoyee with a worker's compensation injury. The population studied limits generalizability of these results to the worker's compensation population. Given the rising cost of managing musculoskeletal disorders in the United States, there is a clear need for high quality health services research to further investigate clinically and cost-effective health care delivery pathways.

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A Novel Approach to Treatment of Over-pronation Dysfunction

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ABSTRACT

Traditional over-pronation treatment using orthotic posting of a forefoot varus emphasizes a support under the defect rather than correction of the defect. The theory behind this orthotic treatment has been controversial with regard to the role the subtalar joint neutral plays during normal gait. There has also been controversy as to the treatment benefit. A correction of a forefoot varus by an intervention to increase forefoot eversion is absent in the current literature. As a result, this author undertook an independent self-study to assess the hypothesis that a forefoot varus defect can be reduced, with improved efficiency of gait. The study took place over a 2-month period in 2013 using a rehabilitation regime emphasizing muscle balance and a rigid musculoskeletal scaffolding device developed by the author. The study involved the author's right foot, inflicted with a moderate to severe over-pronation with an associated forefoot varus, and a moderate to severe great toe bunion formation. The measured variables were ankle and first metatarsal phalangeal joint pain, one legged standing balance time, forefoot eversion passive range of motion, and gait observation. Results following the intervention showed reduced ankle and first metatarsal phalangeal joint pain, increased one legged standing balance, an increase in forefoot eversion, enhanced supinated lateral heel strike and medial forefoot push-off during gait-confirmed with shoe wear pattern. The conclusion of the study supported the technique and training used to correct a forefoot varus. The author proposed a predictable realignment of his foot to a curve-lasted shape that enhanced the pulley and windlass mechanisms during the push-off phase of gait. Further study is recommended, with a more detailed analysis, to determine patient efficacy.

Key Words: pes planus, muscle, balance, rehabilitation

BACKGROUND AND PURPOSE

Purpose/Need for an Enhanced Function Treatment

An over-pronation of a foot and ankle associated with a forefoot varus etiology leads to a fallen arch and splayed foot, described as pes planus, or a partial medial dislocation of a talus on a calcaneus. This may result in a dysfunctional foot, which may cease to use a normal biomechanics. During walking a normal heel strike initially involves an inverted rearfoot, with a normal push-off provided by a rigid first ray and great toe. These are periods of a supination during the gait cycle. The dysfunctional gait may thus be limited to a pronated "loose-bag-of-bones." Consequently, this dysfunction may lead to an additional compensation and dysfunction such as a progressive pain and injury brought on by a potential hallux valgus formation, progressive valgus knees, anteverted hips, as well as a back dysfunction. This condition affects many thousands of people.

Treating this foot condition can become expensive, with some costs in conflict with a reasonable outcome. Therefore, a beneficial conservative rehabilitative treatment for this foot dysfunction is in the best interest of those affected.

Normal Gait Cycle and Function

The gait cycle is comprised of a stance and a swing phase. The stance phase is further subdivided into heel strike, midstance, and propulsion phases. On heel strike to early midstance, the foot pronates. This causes adjustments in a person's midfoot to slacken a specific muscle (peroneus longus) from a mechanism, described as a midfoot pulley. The reduced tension on the peroneus longus thus provides for a release of foot bone rigidity, resulting in a "loose-bag-of bones," in order for the foot adapting to a terrain. Pronation also involves the talus to adduct and plantar flex while the calcaneus everts. This action provides for a torque converter, or change in force transmission, which enables a longitudinal force to be transferred through an inwardly rotating lower leg. These forces are dispersed through triplanar motion of the subtalar joint, providing for shock absorption.[1]

From midstance to propulsion, the return of a supinated foot occurs by creating rigidity to the foot, ankle, and lower leg through tightening of the peroneus longus muscle by the midfoot pulley mechanism.[1] A mechanical tightening of the plantar aponeurosis also occurs from heel off to toe off through the windlass mechanism. This action causes forefoot plantar flexion and eversion of the first ray, often termed pronator twist.[2] Thus, the return to supination is provided with a rearfoot inversion, abduction, and dorsiflexing of the talus, and an external rotation of the lower leg. These actions result in a plantar flexion and eversion of the first ray for a rigid push-off of the forefoot and specifically the first ray and first metatarsal phalangeal joint (MTP).

Dysfunction/Pathology of the Ankle and Foot

A forefoot varus occurs when the medial metatarsal heads of the foot are raised in relation to the lateral heads, in reference to a transverse plane of an inferior aspect of a calcaneus. With a forefoot varus condition, the lateral heads initially contact the terrain surface before the rest of the forefoot. An over-pronation compensation must then occur, during weight-bearing stance and gait, when the medial heads contact the surface.[1]

Over-pronation is a compensatory dysfunction due to alterations in normal foot alignment. The literature supports that a forefoot varus compensation is the most frequent adaptation to over-pronation.[3] Another study reports forefoot varus as being responsible for the greatest amount of biomechanical pain and dysfunction in the lower extremity for his patients.[4] The causes of an over-pronation dysfunction were studied by Ramig et al.[5] He lists the most common cause as forefoot varus, with other causes listed in order of frequency as rearfoot varus, short leg syndrome, leg length discrepancy, and external limb rotation.

Halbach[6] reports that a muscle imbalance between the pronator and supinator musculature of the foot as a cause of a forefoot varus. He indicates a weakening of the ankle supinator muscle as a reason for an over-pronated condition, resulting in a hypermobile over-pronated foot due to a weakened and lengthened musculature.

Over-pronation may cause a failure for the foot to resupinate on early midstance.

This condition may result in a dysfunctional pulley mechanism, whereby there is an inability to create a rigid, stable forefoot push-off on the propulsion stage of gait. Thus, the peroneus longus tendon does not tighten around the pulley provided by the midtarsal joint, nor is there a rigid push-off as the tendon that crosses the foot cannot stabilize the first ray of the great toe.[1] This will result in an inability to properly weight bear through the first ray and MTP, resulting in a hypermobile first ray. The dysfunction leads to anatomical pathology of the foot, as increased stress to the metatarsal heads results in a splaying of the foot with formation of a hallux valgus (bunion) of the great toe.[7]

The pathological conditions brought on by over-pronation are many. Faulty foot mechanics may stress the musculoskeletal joints and structures of the foot, leg, and back. Ramig et al[5] reports over-pronation may cause a prolonged internal rotation of the leg, leading to chondromalacia, as well as internal tibial torsion that stresses the medial knee. D'Amico and Rubin[8] determined over-pronation causing internal rotation produces malalignment syndrome, stressing the lateral knee. They also report over-pronation may result in femoral anteversion, which may result in genu valgus, or a "knock knees" condition. Another study by Botte[9] reports a significant correlation between over-pronation and low back pain due to pelvic asymmetry.

Traditionally, correcting a forefoot varus defect uses "posting" by an orthotic. Whereby a rear-foot post may or may not be used, a forefoot post corrects a forefoot varus by filling in the gap underneath the anatomical defect. This is accomplished by placing the post under a medial portion of the forefoot region, tapering laterally. Traditional orthotic correction also involves posting the foot in a subtalar joint "neutral" (STJN) position. This neutral position is not pronated or supinated and occurs at the midstance phase of gait. Some authors consider a STJN position as the most efficient position of the gait cycle.[1]

The placement of the post supports the foot in the STJN position, thereby preventing over-pronation of the subtalar joint of the ankle. The theory behind this forefoot posting is that it allows the foot to function in a more efficient position, rather than the over-pronated position.[1]

Conventional posting using a foot orthotic involving a "filling in the gap" underneath the defect, used by Root et al,[1] has been questioned in the literature. Rodgers and LeVeau[10] performed a study to assess the effectiveness of orthotics in runners. Their results show there was not a significant difference in the amount of pronation with or without orthotic use. D'Ambrosia and Douglas[11] report constant orthotic wear may lead to disuse of muscles and ligaments.

One study by McPoil and Cornwall[12] used a videotape on each lower extremity of 50 healthy adults to determine the relationship between the rearfoot with subtalar joint neutral during walking. They report a discrepancy in STJN and the rearfoot position during normal gait, reporting the typical "neutral" position of the rearfoot being resting standing foot posture rather than subtalar joint neutral.

Another study by McPoil and Cornwall[13] videotaped 31 healthy adults in each lower extremity for assessing the relationship of the static rearfoot angle between single leg standing, relaxed standing, and subtalar joint neutral during walking. They report the average rearfoot static angle during 60% of the walking cycle (prior to weight-bearing heel strike and following heel off) includes relaxed standing, greater than one standard deviation from the subtalar joint neutral rearfoot position. They also report single leg standing as clinically significant for maximum rearfoot eversion during walking.

From the above, it is evident the STJN position is controversial concerning the functional role it plays during the stance phase of gait. The author theorizes a STJN posting, or building up the gap under the medial forefoot, compromises normal biomechanics of the foot involving the pulley and windlass mechanisms, as the effective rigid push-off of supination may be lost with STJN. It is for these reasons the author hypothesized that a return of functional rigidity must be attained by placing the foot into supination rather than STJN.

A question is asked in an internet article (forefoot varus and over-pronation, Can the (forefoot) varus angle be changed?) by Speck who proposes exercise, rather than fitting orthotics to fill in the gap under the defect, as a more reasonable way to manage the problem. Speck suggests an effective exercise has been stretching by slightly inverting the heel, while bringing the big toe to the floor (emphasis to avoid curling or gripping of the toes).[14]

METHOD/MODEL DESCRIPTION AND EVALUATION

Principle of Treatment

Halbach[6] reports over-pronation may occur due to muscle imbalance between the dynamic pronators and supinators of the foot. Therefore, rehabilitation needs to address this muscle imbalance for return of function. Kendall & McCreary[15] report exercises that strengthen weakened muscles, and exercises that stretch shortened muscles, are the means by which there is a return of muscle balance. Therefore, rehabilitation should not contain exercises that strengthen the shortened, stronger muscles, or put stretch on already stretched weak muscles.

Model description

In accordance with this theory, a stretch/strength therapy device has been devised and is comprised of a foot platform with abutments and wedges for a counter-pressure, and a tensioner strap for urging pressure application, with additional members for employing rehabilitative exercise. Figure 1 shows a view of the stretch/strength splint and Figure 2 shows a view with the foot donned.[16]

An interactive member displayed in Figure 3 (138, 142) affixed (136, 140) to the undersurface of the stretch/strength splint platform (100) was used in conjunction with exercises developed and performed by the author.[16]

Method Description and Evaluation

Theory of treatment

One must understand the principle behind use of this author's device(s) to correctly employ the intervention. As an example of a dysfunction, compare normal foot function to a foot with pes planus. As illustrated in Figure 4 of the stance phase of the gait cycle, a normal foot begins to pronate at heel strike (228), so the foot may adapt to terrain, and ends with early midstance (230). Supination then occurs following a neutral midstance (230) with a maximum supinated rigidity provided at propulsion (232).

With a severe pes planus foot, pronation may occur throughout the stance phase of gait (228, 230, 232). The foot becomes a "loose-bag-of-bones" without a normally cushioned heel strike and return to rigidity during push-off. The pulley and windlass mechanisms are thus compromised. Exacerbation of compensatory movements further leads to deleterious effects to include hallux valgus, valgus knees, etc.

Evaluation for benefit with treatment

The author recommends the following test to determine whether the device and suggested rehabilitation would be of a benefit for an individual with an over-pronated flatfoot, or pes planus. The afflicted individual should voluntarily plant the forefoot onto a nonskid surface and externally rotate the leg in the transverse plane. If the flatfoot disappears with a full arch observed, the device may be of benefit to this person. However, clinicians must consider the influence of muscle tone dysfunction, osteoporosis, diabetes, skin integrity compromise, blood flow dysfunction, sensation changes, and leg asymmetries to be included with precautions not limited by this listing.

A rigid rehabilitative scaffolding

The author suggests the above positioning places an individual's leg in a musculoskeletal position for push-off from the gait cycle. The top right view in Figure 5 illustrates a medial ankle urging pressure application (124,126) with a heel wedge (116), forefoot wedge (114), and lateral heel abutment (120) counter-pressure required for locking the foot into a push-off alignment.

The author suggests rehabilitation involve a lower leg, rearfoot, and forefoot. These areas should be "locked" with an end range of motion in the following foot positions: a rear-foot inversion with a lower leg external rotation (talar abduction and dorsiflexion), and forefoot eversion (weight bearing toward the 1st MTP/great toe during push-off). The forefoot is "locked" with a pronator twist, described by Hicks.[2] The forefoot twisting occurs around a stable third metatarsal axis, resulting in plantar flexion eversion of the first ray, while the fifth metatarsal dorsiflexes and everts to a slighter degree. This pronatory twist occurs with a subtalar joint supination, with the action employing the windlass mechanism of the foot, resulting in foot rigidity during push-off.

This author suggests when stabilized with a counter-pressure, these positions may "lock" a heel/ankle/lower leg and a forefoot into a rigid scaffolding, for a rehabilitative correction of a specific dysfunction.

Correction of a muscle imbalance

An over-pronated flat foot, or pes planus, is illustrated in Figure 5 (top and bottom left views). These posterior views for a right ankle and foot demonstrate pes planus, as the talus (216) partially dislocates from the calcaneus (118). Figure 4 (bottom left)

FIGURES WITH REFERENCE NUMERALS

Drawings-Reference Numerals

100	platform member	102	lateral forefoot abutment
104	lateral heel abutment	106	aft heel abutment
108	platform slotted cutout	110	lateral forefoot slotted cutout
112	aft heel slotted cutout	114	forefoot wedge
116	heel wedge	118	lateral forefoot cushion
120	lateral heel cushion	122	strap
124	supinated thermoplastic ankle member	126	ankle cushion
128	hook-and-loop fastener	130	supinated thermoplastic forefoot member
132	forefoot cushion	134	toe alignment strap
136	recessed female screw member	138	interaction member
140	fixation screw	142	dense closed cell foam
144	clear silicon caulk	146	user's shoe insole shape
148	molding of user's supinated foot	150	burlap upper surface
152	heel wedge shape tapers laterally	154	forefoot wedge shape tapers medially
156	medial to lateral taper transition zone	216	talus
218	calcaneous	220	weakened supinators
222	stronger pronators	224	balanced supinators
226	balanced pronators	228	stance phase- heel strike
230	stance phase- mid-stance	232	stance phase- propulsion
234	forefoot varus deformity	238	author's forefoot wedging

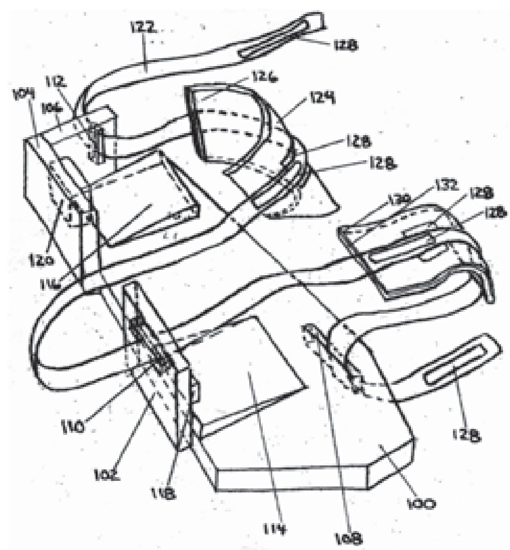

Figure 1. Shows a superior, anterior, and lateral perspective view of a right foot stretch/strength splint with platform, abutments, and adjustable tensioner strap members.

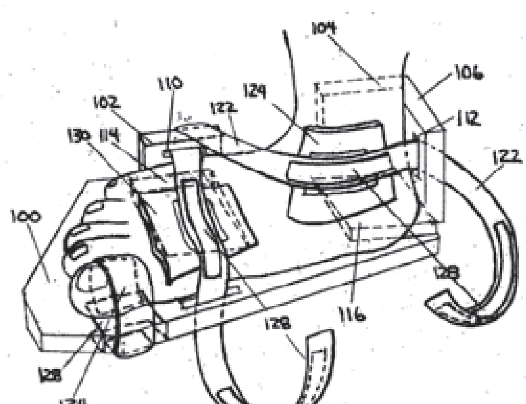

Figure 2. Shows a perspective medial view of a user's right foot correctly placed within a stretch/strength splint.

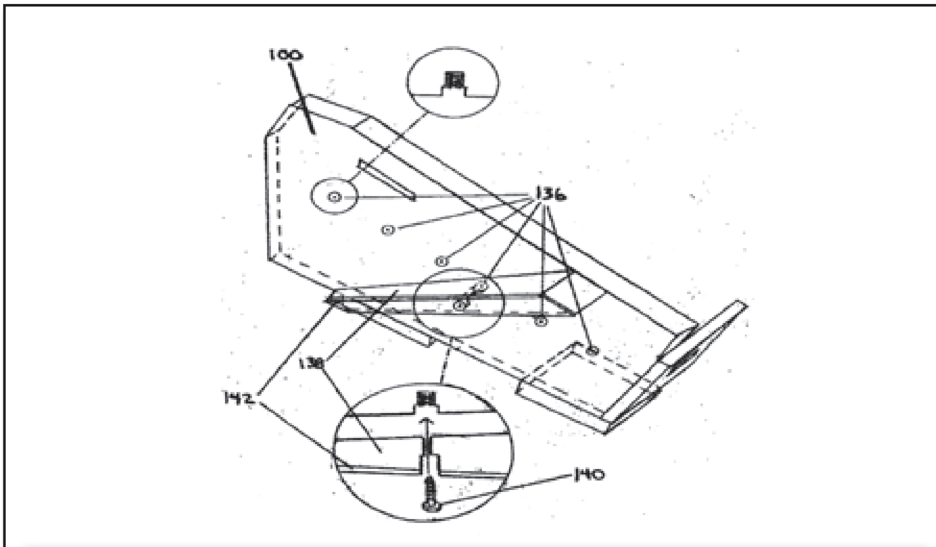

Figure 3. Shows a perspective medial and underneath view of a right stretch/strength splint with an exercise interaction member, with top and bottom blow-ups showing a fixation sight and an interactive member with a fixation screw/sight respectively.

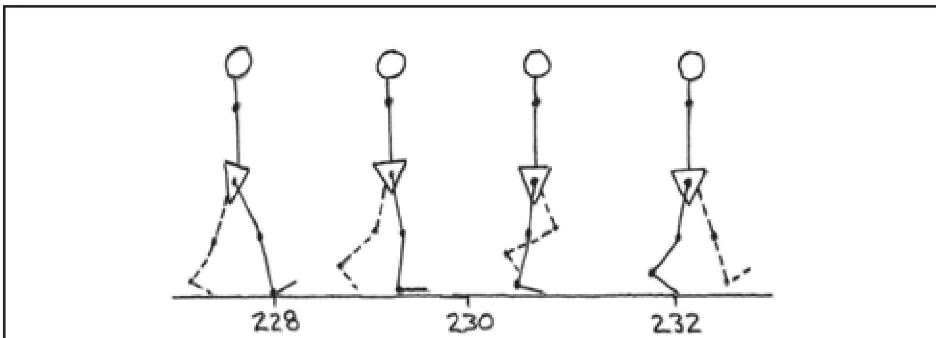

Figure 4. Illustrates the stance phase of the gait cycle.

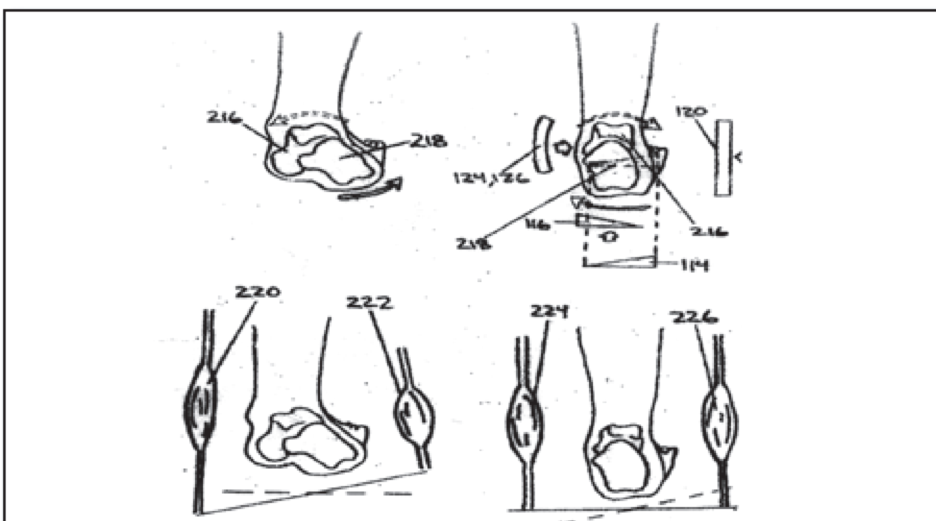

Figure 5. Illustrates perspective posterior views of a right foot, with the top left view showing the direction of forces leading to pes planus and the bottom left view depicting the muscle imbalance with pes planus. The top right view shows the direction of forces necessary for a return of supination, with a return of muscle balance illustrated in the bottom right view.

illustrates a posterior view of a user's right foot with a muscle imbalance that developed with pes planus. The medial supinator muscles become weak and lengthened (220) whereas the lateral pronators become shortened and stronger (222).

Figure 5 (bottom right) illustrates return of muscle balance with a balanced supinator (224) and pronator (226) muscle function. Muscle balance is advocated by Halbach[6] and Kendall.[15] Therefore, the author suggests one can selectively stretch the stronger and tightened pronator muscles (222) into a lengthened position (226) by use of this rigid scaffolding. One can also selectively strengthen the lengthened and weak supinator muscles (220) into a stronger, shortened position (224) with the goal being a return of supinator function.

Correction with return of foot mechanics by providing a curve-last foot shape

An observed return of the longitudinal arch of the foot occurs with planting the forefoot on a nonskid surface, with a simultaneous external rotation of the lower leg and a dorsiflexion of the ankle. The author (DW) suggests this occurs due to a realignment of the foot with a tightening of the plantar aponeurosis. This author theorizes the windlass mechanism is employed in this action, resulting in a pronation twist of the forefoot and a return of the arch. In addition, the author suggests the pulley mechanism involving the peroneus longus and midfoot has an improved effectiveness in this position. Therefore, this curve-lasted shape of the foot causing a midfoot correction provides for a rigid great toe push-off (a curve last normally refers to the shape of a shoe, as shoes made from this kind of last move the foot toward toe-off with the great toe). The author hypothesized muscle balance rehabilitation enhances the rigid mechanisms for supinated push-off to an individual suffering from a severe over-pronation condition. The author proposes that the more one can change an over-pronator to be supinated at push-off, the better the client's prognosis for limiting the deleterious effects of over-pronation. Consequently, the author theorizes maximal supinated push-off also allows for improvement toward a lateral heel strike from an over-pronated condition, due to the intimate connections between the rearfoot and forefoot. Thus the cushioning through enhanced triplane subtalar movement should follow a supinated push-off.

Figure 6 (top left) is a perspective medial view and Figure5 (bottom left) a superior view of a straight lasted foot, with no forefoot/rear-foot deviation in the transverse plane. Figure 6 (top right) provides a perspective medial view, and Figure 6 (bottom right) a superior view of a curve-last shaped foot, following several weeks of rehabilitation with the stretch/strength device by the author. Figure 7 shows the forefoot has a 20° inward rotation in the transverse plane in relation to the heel.

Therefore, this author's findings suggest a predictable change takes place in the foot with rehabilitation, whereby in achieving a correction of a forefoot varus defect, one must alter the structures of the foot. Thus, a diminished forefoot varus with a maintained longitudinal arch develops a curve-last shape to the foot. This may allow for enhanced windlass and pulley mechanisms on push-off.

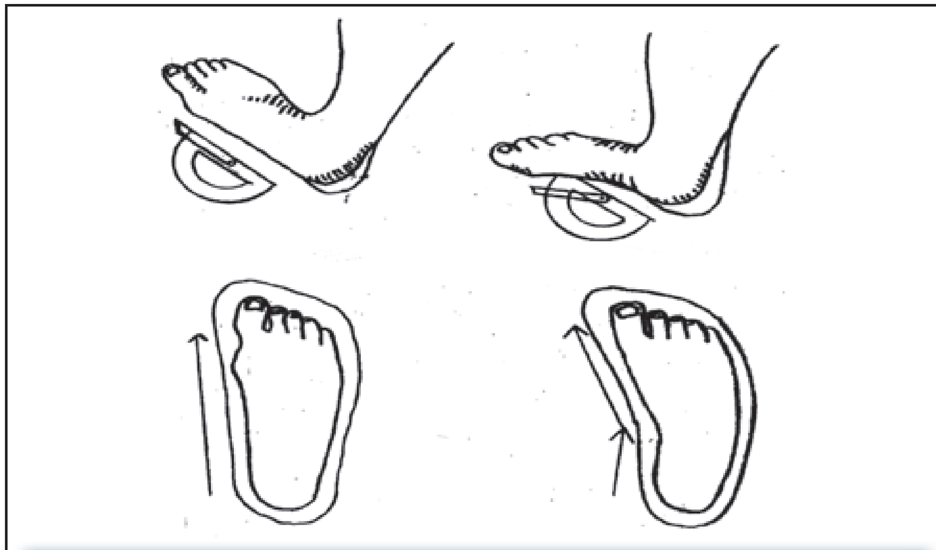

Figure 6. The top left, bottom left show a perspective medial and a superior view of a straight last shaped foot respectively, while Figure 5 (top right, bottom right) shows a perspective medial and a superior view of a curve-last shaped foot respectively.

Medial toe alignment strap

The optional medial toe alignment strap (128, 134) is used in treatment of a hallux valgus (bunion) condition. This condition is thought to develop from an over-pronated foot, which may lead to a hypermobile first ray, resulting in a bunion.[7] The author theorizes that rehabilitation may be accomplished by stabilizing the great toe in a forward direction, as well as additional medial toes as necessary, with a pressure from the cushioned forefoot thermoplastic members (130, 132) and a forward aligned great toe with the alignment strap (124, 134). This alignment allows for rigid, supinated weight bearing of a hypermobile first ray.

The author hypothesizes that a realigned great toe will also result in a corrective realignment of the windlass mechanism, through reorientation of the sesamoid bones inferior to the 1st MTP. This realignment may result in a reduction of a bunion dysfunction by providing a stabilized first ray and an aligned great toe. Thus, the return of muscle balance through rehabilitation of a tibialis posterior, tibialis anterior, and peroneus longus, which have insertions into a first metatarsal of the forefoot,[15] may limit bunion dysfunction. Enhanced weight-bearing propulsion off the great toe is the effect for the author, with a reduction of bunion pain.

Use of the Stretch/Strength Device Donning

The stretch/strength splint is donned by placing a corresponding foot onto the platform/wedge surface and against the abutments, as shown in Figure 2. The adjustable tension strap is pulled until snug to allow for assisting pressure alignment into supination. Tension is adjusted for comfort.

Rehabilitative exercise

A variety of exercises incorporated use of the stretch strength device during this author's rehabilitation of his over-pronation dysfunction. Figures 8 through 14 list some of these exercises.

Rehabilitation with use of custom shoe inserts

Figure 15 shows one of 3 customized shoe inserts developed by the author. The view is a singular combination insert, with a curve-lasted shape of the upper surface with a wedge shaped lower surface, tapering laterally at the heel and medially at the forefoot. This was developed to assist with functional return of lateral heel strike with great toe push-off. All 3 inserts were used by the author during and after his rehabilitation.[16]

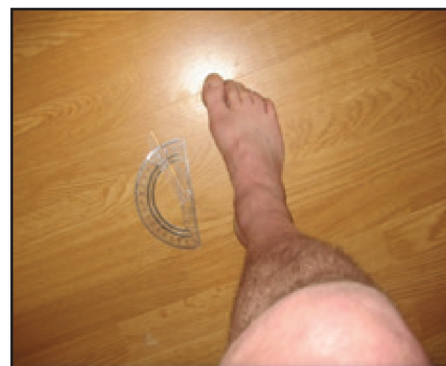

Figure 7. Following rehabilitation with the device, a curve-lasted shape developed. This shape is generally considered optimal for push-off of the great toe during gait.

Study introduction and observation

The author's own account with a lower extremity dysfunction first occurred with an eversion sprain of the ankle due to an accident when he was 30 years old. Now 54 years of age, inadequate muscular support at the talus caused it to sublux. Later measurements document that a forefoot varus defect was present.

In this case, a moderate to severe over-pronation was the compensatory dysfunction due to an unstable talus and a forefoot varus. The foot began to splay with formation of a bunion on the great toe, accompanied by internal rotation of the lower leg. This author experienced moderate to severe pain at the subtalar and 1st metatarsophalangeal (MTP) joints, as well as occasional sharp knee pain. The dysfunction was compounded by a lack of ability to supinate the foot throughout the stance phase of gait. This further increased the bunion formation, pain, and an inwardly rotated lower extremity.

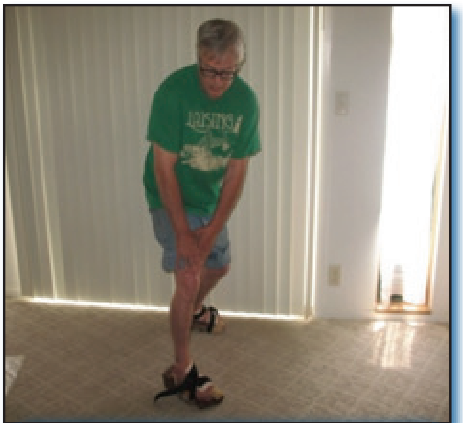

Figure 8. A stretching exercise with the stretch/strength splint. The intensity of stretch is voluntarily controlled by the individual, with the user dorsiflexing the ankle and externally rotating the lower leg an amount necessary to provide the stretch. Stretches from 30 seconds to 2 minutes were held during rehabilitation. A wedge taper may be increased or reduced on either forefoot or rear-foot dependent on the comfort and intensity of the stretch.

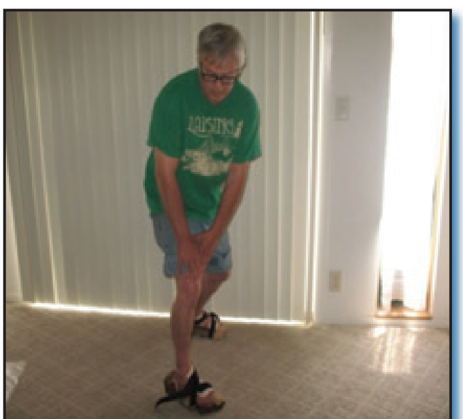

Figure 9. Mobilization of musculoskeletal structures of the user. One such mobilization exercise involves a user's voluntary weight bearing placement of their foot and ankle onto the platform complex, with the user providing a predetermined time and intensity of a voluntary weight bearing pressure. This is termed a mobilization grade pressure ranging from grade 1, with minimal mobilization, to grade 4 with mobilization to end range of motion. Grade 2 and 3 self-mobilization pressures were performed during rehabilitation.

Figure 10. Elastic band resistance strengthening. Plantar flexion, dorsiflexion, and inversion strengthening were performed using the stretch/strength splint.

Figure 11. Lunge exercises that assisted in rehabilitation of the lower extremity. Care for adequate mobilization prior to use was emphasized.

Figure 12. A heel lift exercise. This can be made more or less resistive with placement of an interactive member fore or aft onto the undersurface of the device respectively (the reverse for toe lift exercise).

The first indication this author had observed for potential rehabilitation with the use of stretching and strengthening devices was during a period when the pain of the subtalar and 1st MTP joints were profound. These pains subsided when the foot was stabilized on a nonskid floor, with the right leg externally rotated in relation to the ankle/foot and the ankle maximally dorsiflexed. This movement provided significant relief of the bunion and ankle pain. On observing the great toe, the bunion had disappeared, the arch of the foot had returned, and the talus was fully locked into supination; "It felt good." The observation led this writer to theorize one could return the foot toward an improved mechanical advantage by placing the foot and lower leg into this rigid position. The locked rigid structure would give the advantage for selective strengthening of appropriate muscles through adaptive shortening. The selective stretching of the muscles was also emphasized for recapturing supination and return to a more functional biomechanics.

Procedures and data collection

Following several trials of splinting devices, this writer developed a stretching/strengthening splint that provided the necessary pressure and mobilization on the ankle/foot/lower leg to lock the lower extremity into a rigid position. Figure 16 illustrates this author's initial concept.

The stretch/strength splint provided for various exercise. This included stretching of forefoot varus and the soft tissues/structures. Strengthening of specific muscle groups in a more functional range to include peroneus longus, tibialis anterior, and posterior tibialis was also performed.

This writer undertook a self-study to provide information on potential treatment of a patient population with the devices. Therefore pre- and post-rehabilitation parameters thought to be most beneficial for this assessment were included. They are one legged standing balance, pain level, forefoot eversion, and gait observation. This writer determined at least 6 weeks of rehabilitation was necessary to elicit change. The study was performed on the right lower extremity. Goniometric data collection was assisted by an aide instructed in accurate measurement. A log was also kept by the author to keep track of notable changes during this rehabilitation, which started May 1, 2013. Post measurements were taken July 3, 2013. The exercise program is displayed in Figure 17.

Figure 13. One-legged balance exercise was performed during rehabilitation. The rehabilitation required use of this device due to a potential for injury due to instability of the ankle.

Figure 14. Aerobic conditioning exercise using bilateral stretch/strength splints. Undersurface interactive members were used to orient the forefoot onto the pedals.

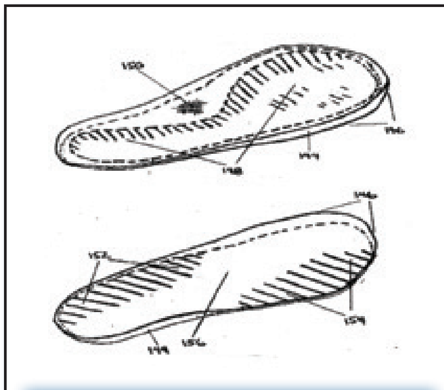

Figure 15. Top and bottom view show a perspective singular right shoe insert, with the top viewed posterior, superiorly, and laterally as an upper insert surface providing a curve-last biased shape and bottom a perspective viewed posterior, medially, and inferiorly showing an underneath surface providing a wedge shape. A separate upper surface curve-last biased insert and a wedge insert, tapering laterally at the heel and medially at the forefoot, were also developed for use in a conventional shoe.

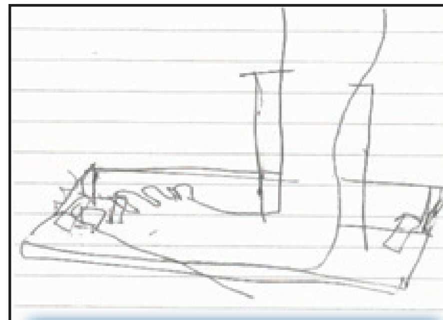

Figure 16. Initial conception of a forefoot varus stretch splint. This illustration depicts the angulated forefoot platform inclining lateral to medial, along with a lateral ankle abutment. The stretch/strength splint was developed, in part, by kinesthetic awareness.

Outcomes

Results for the above rehabilitation regime are as follows:

One legged standing balance

One legged standing time was trained with the stretch splint donned, as there was potential for injury due to the instability of the ankle. However, pre- and post-rehab measurements were taken without the splint, with two trials each. Pre-rehabilitation balance time was 1 minute and 4 seconds with post-rehabilitation balance time improving to 6 minutes and 13 seconds.

Pain

Pain in the right medial ankle was 5/10 on the 1 to 10 pain scale measured by a 0 to 10 pain scale.[17] Pain was described as "intermittent with sharp, stabbing episodes with movement" and 6/10 in the right great toe MTP, described as "constant burning with sharp stabbing pains with movement" prior to the rehabilitation regime. Posttreatment pain yields 0/10 pain in the medial ankle and 0-1/10 pain in the right great toe MTP, described as "very occasional episodes of tenderness with movement." All pain in the knee was absent by the end of the study.

Gait observation

The following are gait observations by this writer with footwear: pre-rehabilitation gait with heel strike on medial calcaneus, failure to resupinate on early midstance, flat foot throughout stance, internally rotated lower extremity through stance, and failure to push-off the great toe.

Post-gait rehabilitation observations using bilateral footwear with custom curve-last bias inserts, wedge inserts, and combination inserts placed in above-the-ankle boots or below-ankle tennis shoes: heel strike on lateral heel with weight bearing through the great toe on push-off. Knees observed mildly externally rotated in relation to the forefoot.

Forefoot eversion

The forefoot and rearfoot have an intimate connection with a singular muscle, the tibialis posterior. This muscle has distal attachments sights at the talus, midfoot, and bases of the 2nd through 4th metatarsals.[15] As a result, there is a conflict in muscle pulls with restoring supinated functional biomechanics from a forefoot varus. For example, the tibialis posterior inverts the heel, increasing heel supination on heel strike, yet inverts the forefoot limiting first ray (talar supination) weight bearing during push-off.

Therefore, in achieving greater forefoot eversion range of motion from a forefoot varus defect, altered foot dynamics must occur to maintain a rearfoot inversion. This author suggests a stretching of the soft tissues and mobilization of bony structures with rehabilitation allows for this.

The author's right foot was measured by goniometry to be: passive range of motion -6° forefoot eversion pre-rehabilitation. This was in a STJN position using the palpation method in nonweight-bearing prone. Post-treatment PROM forefoot eversion was measured, as per pre-rehabilitation, with a +6° finding, a 12° difference.[18]

Post-rehabilitation rearfoot and forefoot dynamics was also assessed by visual gait observation and shoe wear pattern. Visual gait observed with an inverted rearfoot on heel strike with the first ray bearing weight during push-off of gait. This was confirmed by shoe wear pattern, with increased wear on the lateral heel and medial forefoot.

Stretch/Strength Splint- 5 to 6 x's/week for 10 minutes; Grades 2 to 3 mobilization pressures were used during stretching.
Stretch/Strength Splint- one legged standing balance 2x's/week x 2 trials each
Stretch/Strength Splint- lunges 2 x 25 reps 2 x's/week
Stretch/Strength Splint- Schwinn Airdyne® aerobic conditioning 1 to 2x's/week for 20 minutes
Strength Splint- 50 to 100 reps x 2 to 3 sets of dorsiflexion and plantarflexion for the forefoot, rearfoot, and forefoot/rearfoot with adequate resistance via elastic strength cords 3 to 4 x's/week.
(Addendum: The Stretch/Strength Splint was sometimes used in place of the Strength Splint (Fig. 20) using resistance bands; inversion strengthening using the Stretch/Strength Splint was performed frequently although the frequency was not recorded)

Figure 17. Outlines the program used during this author's rehabilitation.

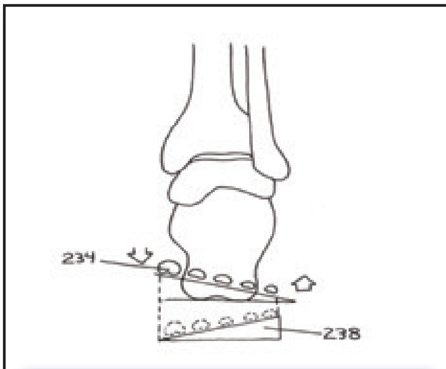

Figure 18. A posterior view of wedge placement used in the devices for stretching of a forefoot varus.

Figure 19. Wedging placement for devices developed by this author for treatment of a forefoot varus dysfunction, a common cause for over-pronation.

DISCUSSION AND CONCLUSIONS

Advantages

This author has determined that the rehabilitative regime provided for a significant pain reduction of his ankle and bunion, increased proprioception of his lower extremity, a reduction in his forefoot varus, with an enhanced supinated gait. Lateral heel strike and medial push-off was confirmed by gait observation and shoe wear pattern.

Accordingly, several advantages of one or more aspects of the author's rehabilitation are as follows: the treatment premise is to improve forefoot eversion, or "bring the foot down to the floor," addressing the poorly studied correction of a forefoot varus. Supination is emphasized with retention of the pulley and windlass mechanisms. Therefore, the author concludes this treatment and device(s) are a paradigm shift from conventional orthotic treatment, as the author's rehabilitation address anatomical correction of the problem, without filling in the gap underneath the defect. Figure 18 illustrates the device concept and the reduction in forefoot varus that rehabilitation involves, improving push-off function and efficiency of foot mechanics. Figure 19 highlights the forefoot lateral to medial wedging of the devices.

Muscle balance rehabilitation is a concept that might also treat an individual afflicted with pes cavus, or a rigid foot. If the wedges were reversed, it may be possible to reduce foot rigidity and enhance shock absorption with mobilization/stretching of the tightened supinator and strengthening of the associated pronator muscle.

Conclusions

The author believes it is possible to stretch a forefoot varus defect by use of muscle balance techniques applied to the foot, ankle, and lower leg. Furthermore, it may be possible to improve rigid push-off mechanics of an over-pronated foot with a forefoot varus etiology, and that rehabilitation of the above defects yields an improved efficiency of ambulation with a curve-last shaped foot correction to his condition.

The author acknowledges the limitations of a single case report design and recommends further study to determine efficacy of treatment with a patient population. Further study may involve ROM goniometric measurements in the fully supinated ankle position, as this is the desired position during push-off. In addition, inclusion of pre and post active ROM great toe abduction measurements due to hallux valgus may be functionally significant for weight bearing push-off of the great toe.

Clinical Applications

The reduction or reversal of some pathologic conditions may be provided with the author's rehabilitative regime and devices. They include:

- reduction or elimination of pain from pes planus, and associated pain from hallux valgus, chondromalacia, malalignment syndrome (including valgus knees), anteverted hips, and low back;
- an improvement in functional supinated dorsiflexion AROM during the push-off stage of gait;
- a reduction, or reversal of, an over-pronation dysfunction;
- a reduction, or reversal of, hallux valgus formation;
- a reduction, or a reversal of, a chondromalacia arthritic condition;
- a reduction, or reversal of, a malalignment syndrome;
- a reduction, or reversal of, an anteverted hip;
- a reduction, or reversal of, a back dysfunction.

The device(s) and rehabilitation may provide an appealing conservative treatment to many afflicted with the above foot dysfunctions. The poorly studied correction to an actual dysfunction is the focus of treatment, with a significant cost savings when compared to surgical intervention.

The scope of this concept may include elite athletic performance as another example of possible uses. Training with certain athletic events may be beneficial, as a rigid musculoskeletal structure provides the best scaffolding for muscular propulsion with certain athletic events. Thus, the range of uses may extend from treatment of injury to enhanced performance.

(Continued on page 242)

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Book Reviews

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ISBN: 9783131746412, 230 pages, Soft Cover

Editor: Hueter-Becker, Antje; Doelken, Mechthild

Description: This book outlines the evaluation and examination of patients by physical therapists and includes free online access to patient assessment forms. Originally written for a German audience, it was recently translated into English. **Purpose:** The purpose is to assist physical therapy students in developing the evaluation techniques and examination procedures necessary to create a physical therapy diagnosis and a plan of care. **Audience:** Physical therapy students are the intended audience for this book. The authors are both instructors in physical therapy educational programs in Germany. **Features:** Initial chapters discuss the importance of the examination and evaluation of the patient. A retrospective assessment is included to assist novice clinicians gain insight and help them become expert clinicians. The general assessment, including range of motion, muscle and neural tissue, posture, and muscle balance, is covered. The inclusion of the calculation of body mass index and the use of skin calipers is unique. Examination of patients who present with pain as their main complaint is detailed in a separate chapter. Another chapter focuses on cardiopulmonary function evaluation. Evaluations such as blood pressure measurement, examination of nails, etc., and other measures that can be done in an office are reviewed. The photographs throughout the book are high quality and demonstrate the examination techniques well. Case studies are presented throughout to illustrate key points. **Assessment:** Although this book is written for physical therapy students, it would appeal more to this audience if the chapters were organized by body part. This would allow for more detail about special tests for specific pathologies and evaluation procedures. However, the book does a good job of describing and illustrating the various neural tests and some provocation tests.

Jeff Yaver, PT
Kaiser Permanente

Recognizing and Reporting Red Flags for the Physical Therapist Assistant, Elsevier, 2015, $69.95
ISBN: 9781455745388, 233 pages, Soft Cover

Author: Goodman, Catherine Cavallaro, MBA, PT, CBP; Marshall, Charlene, BS, PTA

Description: This easy-to-read reference provides physical therapist assistants (PTAs) with useful tools to detect patient situations that require a physical therapist's (PT) attention and possible reevaluation. Each chapter includes realistic case examples, boxes with quick snapshots of clinical presentations and guidance, and a relevant section titled PTA Action Plan, which guides the PTA/PTA student toward the next appropriate step and documentation required in specific clinical situations. **Purpose:** The purpose is to provide a resource for PTAs and PTA students to help them recognize situations that may warrant further evaluation either by a PT or another healthcare professional. These are certainly worthy objectives in the current healthcare climate, where patients either bypass physicians altogether when being evaluated by a PT, or get only minimal time with their physician during an office visit. The authors effectively meet their objectives in this well-organized, comprehensive book. The approach steers the PTA's mindset to consider systemic, visceral, and/or other sources of patients' symptoms. **Audience:** While this book is intended for PTAs and PTA students, it also can serve as an effective refresher and quick reference guide for PTs. It provides accurate tips on care to help PTAs initiate and engage in effective communication with a PT when further evaluation may be necessary. It also provides valuable information about appropriate documentation. **Features:** This is a comprehensive, well-organized book with the primary purpose of enabling PTAs to recognize inconsistent pain patterns, referred pain, and yellow and red flags. It also is effective in helping PTAs determine what is and is not within the scope of their ability, and what requires additional, further evaluation by a PT. The book is divided by body regions, which makes it a practical guide and enables PTAs to use it as a quick reference while in the clinic. The photographs and illustrations are well done and enhance the quality of the text. Case studies in each chapter enable PTAs to exercise critical thinking. **Assessment:** Each chapter includes useful reference tables with lists of symptoms, clinical presentations and pathologies, risk factors, and guidelines. This is the first book that provides PTAs with pivotal information to help them recognize a patient's need for further PT evaluation.

Sunita Mani, PT, DPT, MBA
University Medical Center of Princeton at Plainsboro

Manual Physical Therapy of the Spine, 2nd Edition, Elsevier, 2016, $97.95
ISBN: 9780323263061, 419 pages, Soft Cover

Author: Olson, Kenneth A., PT, DHSc, OCS, FAAOMPT

Description: This book and accompanying website covers the evidence-based evaluation and application of manual therapy treatment of the spine and temporomandibular joint (TMJ). The previous edition was published in 2009. Purpose: The stated purpose is to provide thorough instruction in the manual therapy examination and treatment of the spine and TMJ. With the rapidly evolving research about orthopedic manual physical therapy, this update is a worthy reference for students and practicing clinicians. Audience: The audience includes physical therapy students and faculty, but the book can be useful to experienced clinicians looking to remain up-to-date with the evidence and techniques. Dr. Olson is a board-certified orthopedic specialist, Fellow of the American Academy of Orthopedic Manual Physical Therapists, and adjunct assistant professor at Marquette University. His experience and skill in spinal manipulative treatments is evident from the thorough coverage of examination and treatment techniques in the book and demonstrations in the videos online. **Book Content/Features:** The book starts with a history of manipulative therapy, moves on to scientific theories of manipulation and screening for appropriateness of manual therapy, and concludes with chapters organized by region of the spine. The discussion of evidence in each chapter is extensive and relevant in the current practice of manual physical therapy. Each spinal region chapter includes in-depth descriptions and pictures of examination and treatment techniques with corresponding good quality, multi-angle videos online. Case studies at the end of the chapters will be useful for students and faculty for practicing clinical reasoning. Although the book includes some soft tissue manipulation, it is not as exhaustively covered as joint manipulation. The author mentions therapeutic exercises to maintain the effects of spinal manipulative therapy, which is clinically relevant for students and experienced physical therapists. Website Content/ **Features:** The corresponding website includes over 200 high-quality video clips of examination and treatment techniques. **Assessment:** This is an accessible book for learning about the examination and treatment of the spine with an emphasis on current research. I recommend it to students interested in orthopedics as well as clinicians looking to update their references.

Monique Serpas, PT, DPT, OCS
Touro Infirmary

OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

President's Message

Lorena Pettet Payne, PT, MPA, OCS

Spread the Word! Combined Sections Meeting (CSM) is coming up. Consider getting some advanced networking and instruction from experts in occupational health by attending the preconference course, **"Diversifying and Increasing your Revenue Stream: How to Start or Expand the Occupational Health/Wellness Component of Your Practice."** This preconference course will be sponsored by the Orthopaedic Section, APTA, and the Occupational Health Special Interest Group (OHSIG) at the CSM in Anaheim, California, Tuesday, February 16, 2016, 8:00 a.m. – 5:00 p.m. Location is to be determined.

For anyone that may assist in teaching work rehabilitation and injury prevention, check out the 4th edition of Catherine Goodman's text, *Pathology - Implications for the Physical Therapist*. The OHSIG is given recognition as a resource for Physical Therapists working with work-related injuries and prevention. Part of the SIG's objectives include sharing entry-level knowledge with educators and providing advanced training for all interested colleagues.

A group of engaged therapists met in Worcester, Massachusetts, August 15-17, to pour over literature, identifying the efficacy of the Physical Therapist practicing in work-related injury prevention and management. Under the direction of Reuben Escorpizo, the group hopes to complete the Work Rehabilitation Guideline over the next year.

Join your colleagues to discuss the current activities of your special interest group in Anaheim for the preconference course (Tuesday, February 16), OHSIG Board Meeting (Wednesday, February 17 at 6 p.m.), and the OHSIG membership meeting and educational session on Thursday, February 18, 2016, from 7 a.m.-10 a.m.

Members of the Work Rehab CPG group met for a productive meeting in Worcester, MA, in August.

Does the Evidence for Thoracic Spine Manipulation Translate Into Better Outcomes In Routine Clinical Care For Patients With Occupational Neck Pain?

Brad L. Dalton, DPT, OCS, FAAOMPT
Intermountain Physical Therapy
Murray, UT

Neck pain has an annual estimated incidence of about 15%.[1] Annual worker's compensation costs in the United States for neck pain are second only to low back pain.[2] Previous research has shown that patients with mechanical neck pain who received thoracic spine manipulation and exercise exhibited significantly greater improvements in disability compared with patients who received exercise only.[3] The application of this evidence and its effects on clinical outcomes among patients with occupational neck pain has not been examined. The purpose of this study was to examine outcomes of patients treated in physical therapy with occupational neck pain who received thoracic spine thrust manipulation compared to those who received no thoracic spine thrust manipulation.

MATERIALS AND METHODS

Subjects

A retrospective review of patients with occupational neck pain receiving treatment at 8 outpatient physical therapy clinics of Intermountain Healthcare in the Salt Lake City region from January 1, 2007, to December 31, 2011, was done using the Intermountain Rehabilitation Agency Rehab Outcome Management Systems (ROMS). The ROMS is an electronic database that stores baseline and follow-up data collected from the Intermountain outpatient physical therapy clinics. All patients receiving at least two visits of outpatient physical therapy are entered into ROMS. Demographic data are input and the ROMS database is linked to the billing database, which allows the identification of patients with neck pain receiving worker's compensation, and computation of physical therapy costs for each patient. The protocol for this study was approved by the Intermountain Institutional Review Board. All patients completed the Neck Disability Index (NDI) at the beginning of each visit. The NDI is a widely used disability scale administered to patients with neck pain and consists of 10 items addressing different aspects of function each scored from 0 to 5 with a maximum score of 50 points. The score is then doubled and interpreted as a percentage of the patient's perceived disability. The higher the score, the higher the perceived disability. The NDI has been found to be a reliable and valid outcome measure for patients with neck pain.[4] Patients with neck pain of less than 4 weeks duration between 18 and 60 years of age with or without unilateral upper extremity symptoms, and a NDI score of at least 20% receiving worker's compensation and referred to physical therapy were included. Exclusion criteria were bilateral upper extremity symptoms, two or more positive neurologic signs consistent with nerve root compression and previous surgery of the cervical spine.

Methods

There were 128 patients classified as having acute occupational neck pain during the time period that were reviewed for the inclusion and exclusion criteria. Symptom duration, age, postoperative status, and baseline NDI were all determined from the ROMS database. The charts of those not excluded on one of these factors were reviewed to see if there were any other exclusion criteria present.

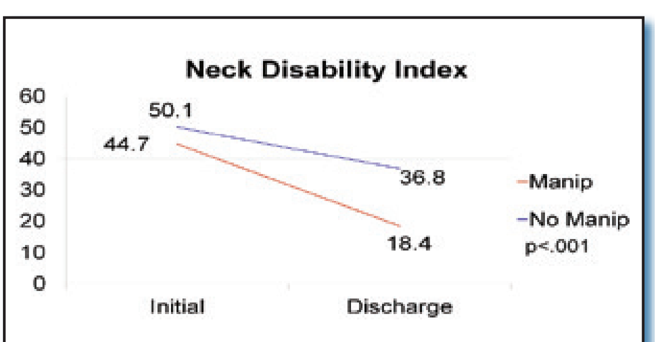
Physical therapy documentation of all of the patients in the study were examined to see if a thoracic spine manipulation technique was administered during at least one of the treatment sessions. If the treatment record showed that a high-velocity thrust procedure was done to the thoracic spine, the patients were categorized as having received manipulation. If the treatment record indicated that a mobilization was used other than a high-thrust procedure, then the patient was categorized as no manipulation. All patients in both groups received some form of exercise as part of treatment. Pain intensity and disability were recorded at each physical therapy visit. The number of visits, work status, length of stay, and costs of physical therapy were recorded. Comparisons were made between patients receiving thrust manipulation versus no manipulation.

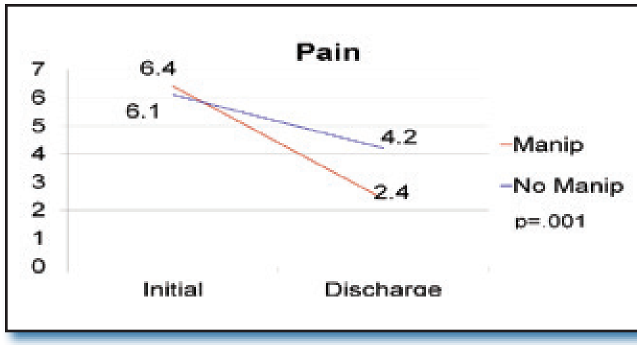
RESULTS

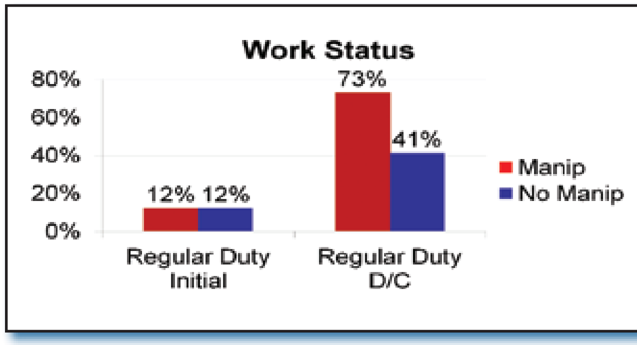
One hundred and seven patients from the original 124 met the inclusion criteria [mean age 38.3 (± 10.5), 54.2% male]. The two most common reasons for exclusion were a history of neck surgery and two or more neurological signs. Thrust manipulation to the thoracic spine was received by 73 (68.2%) patients and 34 (31.8%) patients received no manipulation. At baseline, no significant differences were found between the groups. Patients receiving thrust manipulation had on average 1.3 more visits ($p = .03$), 4.7 days longer length of stay ($p = .25$), and $272.90 more in total cost ($p = .023$), but experienced significantly greater reductions in disability ($p < .001$) and pain ($p = .001$) with treatment than patients not receiving manipulation.

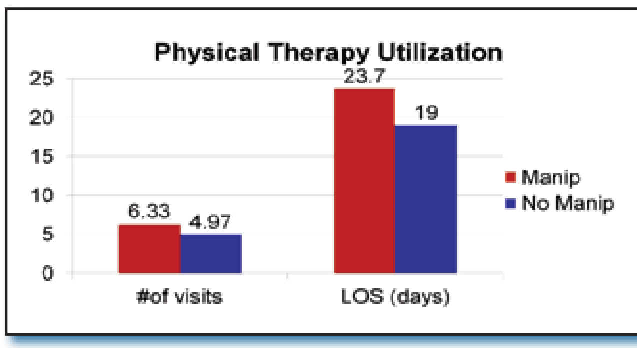
There was also a greater percentage of patients in the manipulation group (73%) that returned to work regular duty than in the group receiving no manipulation (41%).

Data analysis was done using SPSS version 15.









DISCUSSION

We performed this retrospective review of patients with occupational neck pain to examine the applicability of evidence supporting thrust manipulation for patients with acute neck pain. We also wanted to look at the clinical outcomes related to receiving manipulation versus no manipulation to determine if the evidence from randomized control trials carried over into routine clinical care of patients with occupational neck pain.

In our group of clinics, it appeared that manipulation was used in more than half of the patients which is different than what is reported in other research where many evidence-based interventions tend to be underutilized by physical therapists.[5] We did not attempt to differentiate the type of thrust technique used by the treating therapists, as this was largely determined by the individual patient's impairments and the level of comfort of the treating physical therapist that is more consistent with routine clinical care. We therefore cannot compare outcomes from receiving different types of thrust manipulations.

The research showing patients with acute, mechanical neck pain demonstrate significantly greater improvements in disability and pain when they receive a thoracic spine manipulation and exercise was supported by the results of this retrospective review among patients with occupational neck pain.[3]

The manipulation group did have more physical therapy utilization than the no manipulation group. This may have been due to more patients in the manipulation group completing the episode of care versus those in the no manipulation group who were observed to be referred on to specialists at a higher rate due to lack of progress.

We cannot exclude the influence of other factors in creating the observed differences between the groups because the design of this study was retrospective. Several factors that may have influenced outcomes could not be recorded including the patient's employer, psychological status, coping skills, and co-interventions. Also, because of the lack of a true control group, it precludes conclusions about the efficacy of manipulation among patients with occupational neck pain. However, our results suggest that further investigation among this group of patients is warranted.

CONCLUSION

The evidence supporting superior outcomes for neck pain and disability with the use of thoracic spine thrust manipulation and exercise was supported within the study limitations of our retrospective review of patients with occupational neck pain. The manipulation group did incur more costs in physical therapy, but those costs would be offset by the savings of the larger percentage of patients that were able to return to work regular duty.

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PERFORMING ARTS

SPECIAL INTEREST GROUP

President's Letter

Annette Karim, PT, DPT, OCS, FAAOMPT

Fall is upon us! It is time to submit your posters and platforms for CSM 2016. The Performing Arts SIG awards an annual student scholarship for this event. When you submit your performing arts-related poster or platform, please contact our student scholarship chair.

At CSM 2016, the PASIG will offer a preconference course, "Dynamic Neuromuscular Stabilization: Assessment & Management of Performing Artists," presented by Clare Frank, PT, DPT, OCS, FAAOMPT, and me, on Wednesday, February 17, 2016, 8:00 a.m. to 5:00 p.m.

We will have our annual CSM Business Meeting on Friday, February 19, from 7:00 a.m. to 8:00 a.m. All are welcome to join in! Our regular PASIG programming will be on the same day from 3:00 p.m. to 5:00 p.m. Jennifer Green, PT, MS, CMT, will present, "Life on Broadway: Care of the Professional Theatrical Performer." We look forward to seeing you at all of our events.

The Fellowship Task Force has a performing arts physical therapy practice analysis survey that will be distributed this fall. Thank you in advance for participating in this survey. We recognize that your time is valuable. Participation from a broad sampling of clinicians is critical to the process and very much appreciated.

Several positions on our Board will be vacant for new chairs in 2016. Please consider serving, and contact one of our Nominating Committee members. We have a lot of fun, and a little effort goes a long way, as we move forward in the areas of education, research, screening, membership, public relations, and scholarship.

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Elimination of Hip Pain After Medial Meniscal Repair in a Collegiate Dancer

Elena Akhbari, SPT, Mount Saint Mary's University
Melissa Melcher, SPT, University of Texas Health Science Center at San Antonio
Annette Karim, PT, DPT, OCS, FAAOMPT, Evergreen PT Specialists

The premise of our treatment philosophy was based on our study of the nervous system, which is interconnected and continuous with the musculoskeletal system. Neurodynamic changes are affected by chemical composition, mechanical structure, and the brain's efferent and afferent processing. Not only do sites of compression include nerve bifurcations, bony and soft tissue tunnels, and rigid surfaces, but they also involve neural tissue tension points in the spine at levels C6, T6, and L4, where the vertebral column narrows, and the movement of the spinal cord reverses with slump testing.[1,2] Thus, a positive slump test indicates adverse neural tissue tension. Neurodynamic interventions include addressing tension points at the lumbar, thoracic, and cervicothoracic spine.[1]

The patient was an 18-year-old female collegiate contemporary dancer who had participated in 4 visits of physical therapy after a June 2015 right knee meniscal repair. The patient returned after a week-long vacation. She was 8 weeks post-op, with a new complaint of right anterior hip pain, which she described as "tightness" during walking. She rated the pain as 5/10 on the Numerical Pain Rating Scale (NPRS), with a decrease to 0/10 immediately after termination of movement.[3-5] Pain at the right anterior hip occurred during ipsilateral terminal stance and the preswing stage of gait. Symptoms decreased with a half kneeling hip flexor stretch but returned after one hour. Her Lower Extremity Functional Scale (LEFS) score was 47.[6]

Pretreatment Clinical Findings:

No lower extremity edema, erythema, or rubor
Lymph nodes normal to palpation
Knee active range of motion (AROM) and passive range of motion (PROM): full
Accessory mobility normal at the tibiofemoral, patellofemoral joints
Stiff proximal tibiofibular joint
Talocrural and subtalar AROM, PROM, accessory mobility normal
Hip AROM and PROM: full
(-) Hip intraarticular provocation tests
(+) Thomas test right rectus femoris: lacking 10° bilateral
Lumbar AROM: Immediate flexion at L3-5, with no reproduction of symptoms
Minimal reversal of flexion during AROM extension
Airplane test (single leg stance with hip hinge): excessive lumbar flexion at L3-5
(+) Right femoral slump test for reproduction of symptoms[1,2] (See Figure 1)
(-) Right group hip flexion manual muscle test 4/5, no reproduction of symptoms
(-) Femoral anterior glide movement dysfunction
(+) Tinel's at the right hip flexor, with reproduction of symptoms[7,8]
(+) Tender to palpation at the right psoas
(+) Lumbar hypomobility at L3-5, limited extension passive physiological intervertebral movements, limited posterior-anterior passive accessory intervertebral movements
(+) Thoracic hypomobility at T4/T5, T5/T6
(-) Well's DVT CPR, score: -2[9,10]

Treatment:

1) Right L3/L4 lumbar gap grade V mobilization[11] (See Figure 2)
   Response: pain decreased during femoral slump test to 3/10
2) T4/T5, T5/T6 corkscrew posterior-anterior grade V mobilization (See Figure 3)
   Response: further decreased reproduction of symptoms on femoral slump test
3) Cervicothoracic seated gap grade V mobilization
   Response: no change in symptoms with femoral slump test
4) Soft tissue mobilization on right psoas
   Response: eliminated pain, 0/10 with femoral slump test
5) Therapeutic exercise: femoral slump sliders (30 repetitions)[12,13] (See Figures 4 and 5)

Posttreatment:

No movement limitations at the hip during gait
0/10 pain with femoral slump test
0/10 pain with gait
NPRS score: 0/10 [minimal clinically important difference (MCID) is 2 points][3-5]
LEFS score: 61 (difference of 14 points, MCID is 9 points)[6]

CLINICAL REASONING

Based on objective findings, it was evident that the pain was not from the hip muscles, hip joint positional faults, hip movement patterns, hip pathology, referral from the surgical knee, or vascular impairments. Ruling out contractile, joint, and vascular contributions helped us focus on the nervous system. Positive neural tissue provocation signs including restrictions at the local site with a positive reproduction of symptoms with the Tinel's test and with the femoral slump test led to evaluating the spine for neural tissue entrapments. Research shows that locations of common entrapment sites include C6, T6, and L4.[1] With assessment of the lumbar spine, the patient presented with limitations in extension at L3/L4, which prompted the manual intervention. The lumbar gap resulted in a decrease in pain, but because the femoral slump test was still (+), the thoracic spine was examined, found hypomobile, and addressed with mobilizations, which further reduced pain.

The clinical reasoning behind soft tissue mobilization at the hip is that the femoral nerve passes through the psoas major at the distal part of the lateral border between the iliacus and through the inguinal ligament, presenting potential sites of nerve compression.[14] During femoral slump testing, removal of cervical flexion eliminated the hip pain, while cervical flexion increased the same complaint of pain. If the hip pain came from contractile contributions, cervical extension would not eliminate the hip pain. Since the femoral nerve branches at the anterior thigh to the knee with motor and sensory components, and

Figure 1. Femoral slump test.

Figure 2. Lumbar gap grade V mobilization in sidelying.

Figure 3. Thoracic corkscrew posterior-anterior grade V mobilization.

the patient had knee surgery, the neural provocation tests were directed specifically at the femoral nerve.

The hallmarks of positive adverse neural tissue tension are (1) reproduction of the same symptoms, (2) difference in symptoms from side to side, and (3) change of symptoms with movement of a component distant to the painful site. Mobilizing tissues that compress or restrict the femoral nerve released the remaining tensioning of the nerve, and restored the patient to painfree gait. Root causes for her neurodynamic dysfunction include lumbar extension rotation movement dysfunction, sacroiliac joint hypermobility, and postoperative soft tissue compression of the femoral nerve at the knee. Future visits will include correction of movement impairments, stabilization of the sacroiliac joint, neurodynamic mobilization, and periodization of return to dance participation.

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Figure 4. Femoral slider part 1.

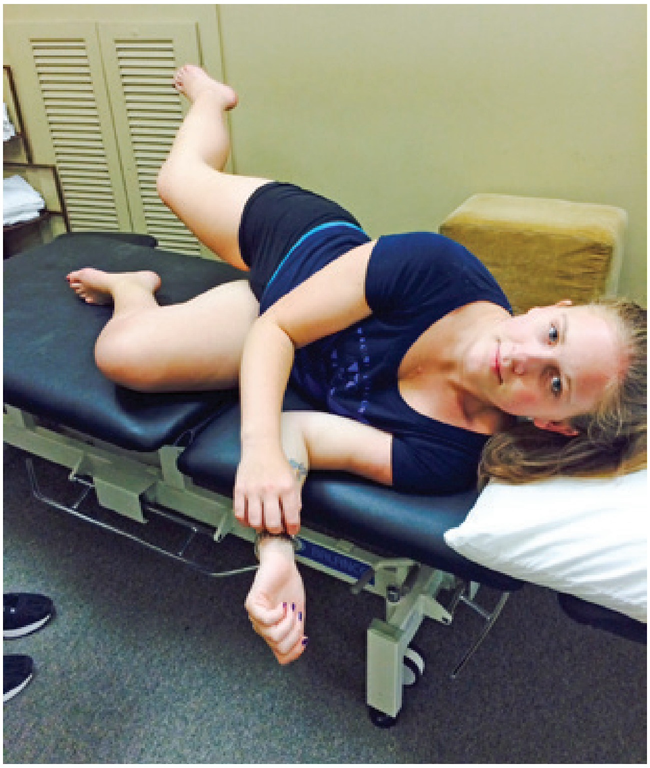

Figure 5. Femoral slider part 2.

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FOOT & ANKLE

SPECIAL INTEREST GROUP

A Case of Double Crush Syndrome in the Lower Extremity?

An interesting case of a young athlete is presented that, in order to provide appropriate treatment, demands differential diagnosis and perhaps a bit of out-of-the-box thinking. As foot and ankle specialists, we may encounter patients with concomitant, confounding, or sometimes confusing signs and symptoms that are further influenced by proximal structures or dysfunction. This case illustrates an infrequent but existing phenomenon of symptom generation, more frequently identified in the upper extremities.

Upton and McComas[1] first described a "double crush" hypothesis, stating that axons compressed at one site become especially susceptible to damage at another site. They used the double crush hypothesis to explain why patients with carpal tunnel syndrome (CTS) sometimes feel pain in the forearm, elbow, upper arm, shoulder, chest, and upper back, and further, to explain failed attempts at surgical repairs when neither surgery nor CTS diagnosis appeared faulty. Upton and McComas[1] further suggested that a high proportion (75%) of patients with one peripheral nerve lesion did in fact have a second lesion elsewhere and they implied that both lesions were contributing to the symptoms. They claim that most patients with CTS not only have compressive lesions at the wrist, but also show evidence of damage to cervical nerve roots.

Nakase and colleagues[2] used the term "peripheral entrapment" to explain how neural function could be impaired when single axons that have been compressed in one region, become especially susceptible to damage in another region. They suggested that a discrepancy between neurological manifestation and neuro-imaging sometimes occurs in cervical lesions, and double crush should be considered as a possible pathogenetic mechanism.

Some other studies have addressed this "coexisting nerve entrapment" in association with cervical spine pathologies,[3-6] while others propose the entrapment through structures associated with the thoracic outlet.[7-10]

In 1998, Golovchinsky[11] analyzed results of electromyography and nerve conduction velocity testing in 169 patients with lower back pain, mostly caused by trauma. A total of 289 peroneal, 280 posterior tibial, and 301 sural nerves were included in statistical analysis. Peripheral entrapment of nerves (tarsal tunnel syndrome and anterior tarsal tunnel syndrome) were found in 5.3% of patients, signs of acute or chronic partial muscle denervation of corresponding muscles of lower extremities in 21.8% of patients, and abnormally prolonged F-wave latency in 12.5% of patients. A higher than random coincidence of low back pain and distal EMG compromise allowed the author to conclude a cause-and-effect relationship of damage of the proximal motor nerve fibers and development of peripheral entrapment syndromes in the same nerves rather than a random coincidence of two independent pathologies, and that clinicians should consider simultaneous treatment of the lower back problem as well.

CASE STUDY

The patient was a 13-year-old female athlete who presented with primary complaints of persistent (>2 months) left posterior calf and ankle pain. She reported no specific mechanism of injury but that her pain seemed to begin when she started to attempt to run hurdles for the first time. She could not remember any specific event in which she struck her left ankle on a hurdle but rather that her pain just continued to increase *after* running hurdles. Eventually she experienced increased pain to the point that she could no longer run and was also limping because of pain while ambulating. Approximately 2 weeks after onset of posterior calf and medial foot pain, she was diagnosed with Achilles tendinitis and the foot/ankle was placed in a walking boot that she wore for 5 weeks. She reported the walking boot decreased her discomfort by 25%. The boot was discontinued in exchange for a lace-up ankle brace that she wore for another 4 weeks. During that time, she reported slowly increasing pain to previous levels (8/10).

No other medical problems or significant medical history was discovered. Imaging of the foot and ankle included both radiograph and MRI that were negative for pathology of the foot and ankle. She was provided a lift in her shoe by a doctor of podiatric medicine (DPM) to decrease strain on the Achilles and was prescribed Voltaren cream. She reported no change in pain with the lift or the cream.

She presented to physical therapy 11 weeks after initial injury for evaluation. Evaluation revealed a 13-year-old female ambulating with a significantly antalgic gait. Active range of motion and passive range of motion of the ankle and foot were significantly limited in all directions secondary to pain. Strength testing was not valid secondary to pain levels, although she found force production difficult with plantar flexion. She presented with hypersensitivity and allodynia throughout the left Achilles tendon and calcaneus. Myofascial trigger points were noted in the flexor digitorum brevis and medial head of the gastrocnemius. She had a positive straight leg raise (SLR) and slump test on the left. She had positive signs of adverse neural tension in the left leg. Lumbar examination revealed improved SLR following repeated prone extension with overpressure. She was referred back to orthopaedics by the treating physical therapist for assessment of the lumbar spine. Radiographs were negative for pathology of the lumbar spine. An MRI revealed a moderate bulging disc at L5-S1. She was placed on Medrol dose pack and referred back to physical therapy services. Administration of a Medrol dose pack reduced her discomfort; however, following conclusion of the dose pack, her pain level increased again and no sustained relief of discomfort could be achieved with physical therapy. She was again referred back to the DPM at which point she was placed in a cast. The foot/ankle cast decreased her pain from 8/10 to 2/10. She returned to therapy showing decreased signs of neural tension through the lower extremity.

SUMMARY

The reliance on immobilization of the distal entrapment site, in light of a completely normal MRI examination, suggests that this patient had a form of double crush. The MRI of the lumbar spine established a proximal site of axonal compression, while the foot symptoms (mimicking tarsal tunnel syndrome) suggested a local entrapment of the tibial or plantar nerves. Nerve conduction studies, not performed in this case, might confirm axonal disruption. Yet, the clinician who appreciates the co-existing sites of compression may appropriately adapt the plan of care.

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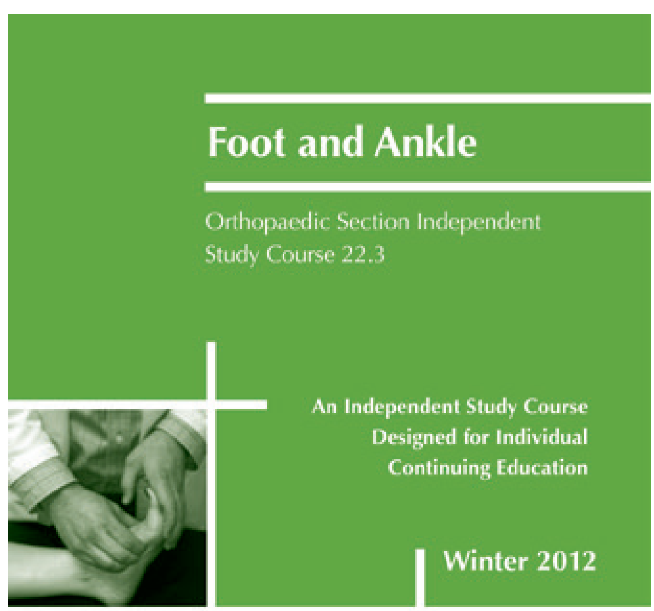

IMAGING

SPECIAL INTEREST GROUP

Imaging Education Manual

As a new academic year gets underway, the Imaging Special Interest Group reminds faculty of a new resource, the new *Imaging Educational Manual for Doctor of Physical Therapy Professional Degree Programs (Imaging Education Manual)* to provide a rich set of resource information that will assist faculty in on-going curriculum assessment and development in this content area. The Imaging Education Manual and additional resources can be accessed online at www.orthopt.org. Faculty responsible for teaching imaging content will likely find the evidence review and curriculum resource information useful in course development and other aspects of instruction. Information in the manual will also be useful to faculty members who may be called upon to provide testimony or opinion when regulatory or legislative imaging issues arise in your state. In addition, academic coordinators of clinical education may wish to share materials in the manual with clinical instructors to facilitate further student development of relevant skills during clinical internships.

As physical therapist practice evolves, including patient direct access, the ability to refer patients directly for diagnostic imaging could enhance efficiency and effectiveness of care delivery. Doing so is contingent upon doctors of physical therapy having the requisite knowledge and skills of appropriate patient referral for imaging. Published research describing physical therapist use of ultrasound imaging (USI) in patient management has been growing since the 1990s. The practicality of incorporating USI at the point-of-care has been greatly enhanced with improvement in ultrasound technology resulting in smaller machines, higher and improved resolution, and much lower equipment costs.

ARDMS Maintains the Registered Musculoskeletal Sonography Credential for Physical Therapists

The Registered Musculoskeletal Sonography (RMSK) credential was first offered in 2012 by the American Registry for Diagnostic Medical Sonography (ARDMS). Physical therapists have qualified to sit for the examination from the outset. In January 2015, the ARDMS announced it was creating a new credential, the Registered Musculoskeletal Sonographer (RMSKS). Physical therapists were no longer qualified to sit for the physician RMSK and were only eligible for the RMSKS credential. The Imaging Special Interest Group through the Orthopaedic Section and in coordination with APTA responded and asked the ARDMS to revisit their decision. Recently the ARDMS acknowledged the scope of practice of physical therapists better aligns with the physician RMSK credential and physical therapists will retain the RMSK and continue to qualify to sit for the RMSK. Additional information can be found at www.ardms.org/get-certified/RMSK/Pages/musculoskeletal-sonography.aspx.

Call for Imaging Submission

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

- 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: Background section, Diagnosis section which 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 which help inform clinical practice.

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

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Ultrasound Evaluation of Severe Osgood-Schlatter

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Georgetown University Athletics Sports Medicine Department Georgetown University Hospital Washington, DC

Osgood-Schlatter (OS) is a common injury among preadolescents engaging in athletic activities.[1] Due to repetitive stress of the quadriceps and traction forces can lead to apophysitis of the tibial tuberosity or avulsion of the tuberosity.[1] Osgood-Schlatter is most often diagnosed with clinical exam and patient presentation; however, musculoskeletal ultrasound imaging has been shown useful in the diagnosis and management.[1] The patient was a 13-year-old male who developed acute right anterior knee pain and swelling at the age of 7 after attempting to lift an adult from the ground. At the time of injury, he was seen by his primary care pediatrician (PCP) and diagnosed with a knee ligament sprain. He was advised to rest from activities for one month. After which time his pain improved, but persisted with running activities.

In 2010, four years after his initial injury, he began experiencing increased anterior knee and infrapatellar swelling with minimally strenuous recreational activity. He returned to his PCP and was referred to physical therapy. His symptoms did not improve with physical therapy, and his doctor advised he discontinue all recreational activities for two years.

In 2013, the patient presented to our outpatient rehabilitation department after reinjuring his knee while running. He was seen by a different pediatrician, diagnosed with OS, and again referred to physical therapy. On examination, he complained of right knee instability, anterior knee pain, and infrapatellar swelling after running. Significant quadriceps atrophy and weakness and poor hip and lumbopelvic motor control with functional activities were noted. He was unable to participate in recreational activities, had minimal tenderness on palpation of the tibial tuberosity, with no localized swelling. His knee was otherwise stable.

Musculoskeletal ultrasound examination was performed on initial evaluation because prior images were not available at the time of the patient's visit. The examination revealed a bony ossicle in the inferior portion of the patellar tendon (Figure 1)[1] just proximal to the tibial tuberosity. Additionally, cortical fragmentation of the tibial tuberosity at the insertion of the patellar tendon (Figure 2)[2] was noted, consistent with OS. Dynamic ultrasound examination into knee flexion demonstrated compression of the bony ossicle into the anterior tibial cortex, reproducing the patient's anterior knee pain at the point of contact. Sonographic images of a normal patellar tendon at the insertion onto the tibial tuberosity (Figure 3)[3] demonstrates the hyperechoic, fibrillar patellar tendon inserting onto the tibial tuberosity. Based on the sonographic findings, the patient was referred for an orthopaedic consult and for plain radiograph imaging. On plain lateral radiograph, a bony ossicle and malunion fracture of the secondary ossification center were seen (Figure 4),[4] consistent with the findings on ultrasound. Open reduction

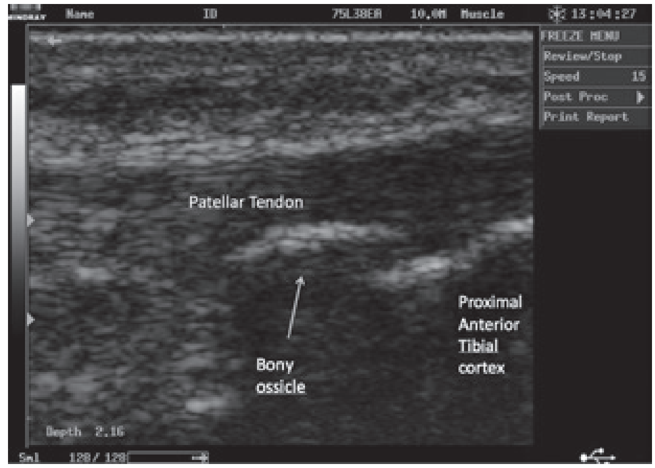

Figure 1. Long axis sonogram of the right knee in approximately 30° knee flexion. Note the bony ossicle embedded in the patellar tendon (arrow), and its proximity to the proximal anterior tibial cortex.

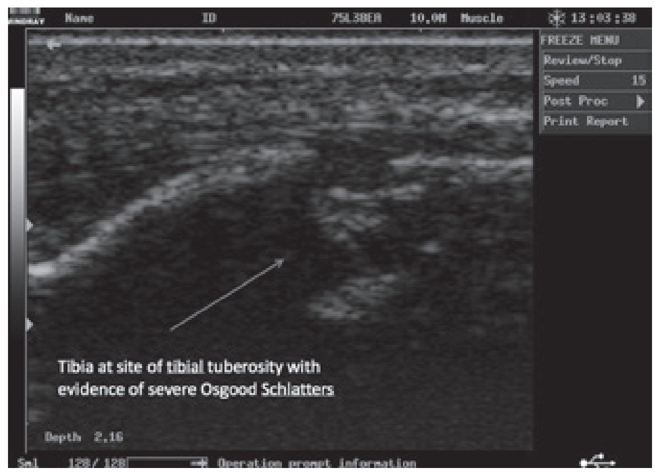

Figure 2. Long axis sonogram of the right knee. Note significant cortical irregularity of the tibial tuberosity at the patellar tendon insertion consistent with Osgood-Schlatter.

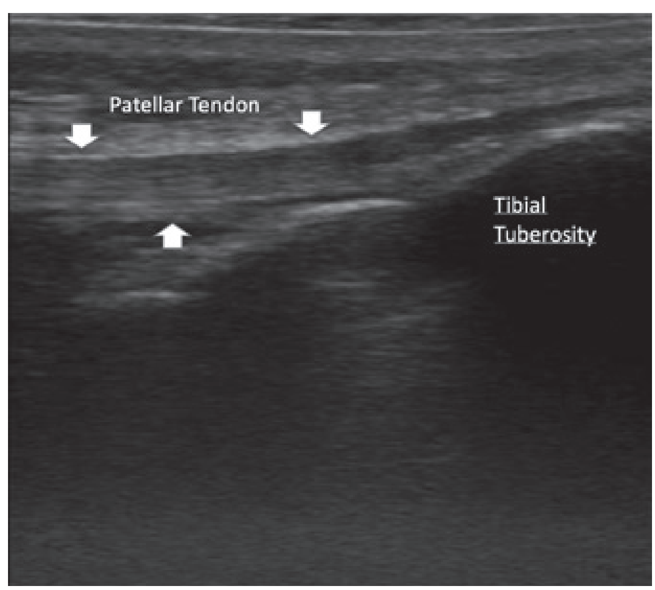

Figure 3. Longitudinal image of normal patellar tendon (white arrows) and its insertion onto the tibial tuberosity.

internal fixation of the proximal tibial region with take down of the malunion and a local bone graft (from Gerdy's tubercle) was performed. The bone graft was secured with two 4.5 mm screws and a washer in the tibial tubercle region creating the desired compression across the prior growth plate (Figure 5).[5] Intraoperatively, it was decided not to excise the intra-tendinous bony ossicle for risk of tendon compromise.

The patient was lost to physical therapy follow-up postoperatively. This case demonstrates the importance of a thorough clinical examination and appropriate use of imaging within the scope of physical therapy for optimal patient outcomes.

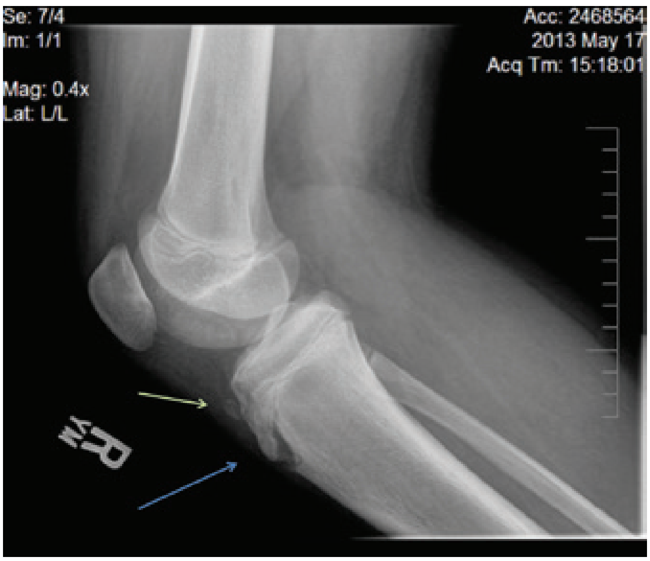

Figure 4. Plain lateral radiograph of the right knee demonstrating bony ossicle (green arrow) and nonunion fracture across secondary ossification center (blue arrow).

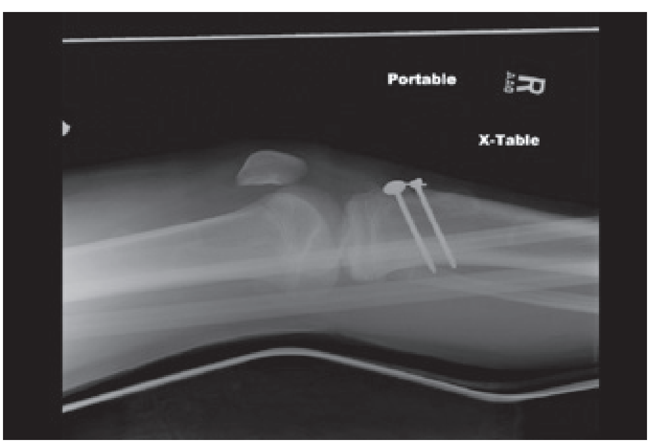

Figure 5. Postoperative radiograph films demonstrating open reduction internal fixation with 2 screws at the tibial tuberosity region.

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ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

President's Message

Kirk Peck, PT, PhD, CSCS, CCRT

Get Ready For "Big Time" Excitement During the 2016 APTA Combined Sections Meeting

A double win for the ARSIG is scheduled for February 2016 at CSM in Anaheim, California. The SIG is hosting two exceptional educational opportunities. First, a preconference course will be offered at CSM entitled, *"Evaluation and Application of Select Manual Therapy Techniques for Canine Cervical Spine Dysfunction."* This one-day course will be presented by Ria and David Acciani, two physical therapists with extensive experience practicing in New Jersey at the Advanced Canine Rehabilitation Center. This is a "must attend" opportunity to engage in live dog lab demonstrations to fine-tune or advance hands-on skills with canine manual therapy. Please do not hesitate to add this course to your personal continuing education agenda for 2016.

Second, the ARSIG CSM programming session will be one of the most amazing educational opportunities you simply cannot afford to miss. The topic for SIG programming in Anaheim is entitled, *"Olympic Equestrian Showjumping: A Physical Therapy Approach To Assessment, Conditioning, and Rehabilitation of Horse and Rider."* The speakers are Sharon Classen who is a physical therapist and elite competitive show jumper, and Danny Foster, the 1991 Pan American Games Gold Medalist and Hall of Fame Inductee. This unique presentation will incorporate two speakers who will focus on common injuries and rehabilitation related to equine and equestrian athletes. Those interested in either human or animal rehab will not be disappointed with this outstanding learning opportunity.

Step Up and Become a Scholar

I usually end with this section on a call for article submissions, but not in this edition of *OPTP*. This topic has become all too important, and yet, I would say one of the most neglected aspects of animal rehab today. Yes, I realize the fun of animal rehab is exactly doing just that…applying your knowledge of physical therapy to animals and experiencing the gratification of success. However, if the practice of animal rehab is to truly evolve as it should, then practitioners of the art need to support the profession by advancing the knowledge base, including sharing new ideas and innovations with others in the field.

The motto I frequently use to explain the value of scholarship in animal rehab is, *"To promote, educate, and advance the practice of animal rehabilitation."* Please take note of the word "advance." How can any single profession advance its level of care without the scholarship of discovery? It simply cannot be done. Therefore, I end with a request for all SIG members to please consider sharing some of your hard-earned wisdom with others in the field of animal rehab by submitting an article for potential publication in *OPTP*.

My request extends to a variety of scholarship ideas including clinical pearls, critiques of recently published articles, unique case studies, excerpts of primary research, or even personal interest stories related to animal rehab. Feel free to even share stories with an international flare if appropriate. Maybe you have experience working with animals outside the United States others might find of interest. If any of these options appeal to you, then please contact the President or Vice President of the ARSIG to submit an article for review.

Practice Analysis Update

The Practice Analysis Task Force has continued to progress with creating a comprehensive survey to assess competencies for animal rehab. The goal is to finalize the survey during the fall of 2015 and distribute to all SIG members. In addition, work is still being done to complete a White Paper and a full analysis of certification and educational programs in existence for animal rehab. The Task Force will be looking forward to receiving your input once the survey is released.

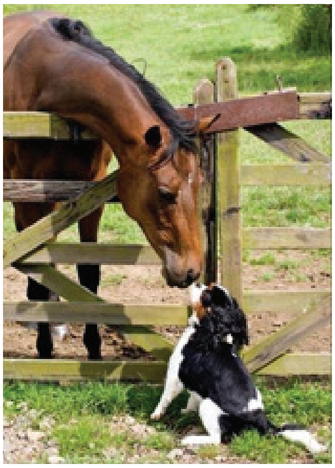
California Veterinary Medical Board

The California Veterinary Medical Board (VMB) has scheduled a public hearing on September 10th for the proposed regulatory language to mandate "direct supervision" over PTs. In the last edition of the *OPTP*, I expressed concerns about what potentially might occur if the Vet Board succeeds in mandating direct supervision over PTs and PTAs. I re-emphasize, the profession of PT deserves a lot more than to be viewed as simple technicians. Unfortunately, the public hearing will be over by the time this article goes to print. Therefore, I can only hope that regardless of the final decision moving forward, the Vet Board acts with a conscious effort to improve collaborative relations with the profession of physical therapy.

Future Communications

If there is a topic of interest or something you personally believe should be brought to the attention of ARSIG members, please let me know. I am more than happy to entertain new ideas or thoughts on what members might enjoy reading as part of the *OPTP* publication.

The Beauty of Olfactory Communication!



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Perspectives on the Use of Mechanical Vibration in Equine Rehab

Kirk Peck, PT, PhD, CSCS, CCRT

HIGH FREQUENCY MECHANICAL VIBRATION

Whole body vibration is a therapeutic intervention used in equine rehab to increase blood and lymphatic circulation, induce muscle relaxation, and promote bone strength.[1] The concept uses a large vibration plate to accommodate the entire body weight of a horse. More recently hand held devices have been developed to localize vibration over specific body tissues.[2]

Rapid release therapy (RRT) is a mechanical unit that vibrates at a frequency of 60 Hz. The device is composed of several application surfaces depending on the type and location of tissues being treated (Figure 1). The purpose of RRT is to mechanically agitate soft tissues to induce a massaging effect, promote relaxation, reduce pain, and to treat sensitive areas of muscle and myofascial tissue. On a personal note, I have used the RRT on elite show jumping equine clients and have observed immediate effects of muscle relaxation and decreased tissue response to pain provocation tests (Figure 2).

Recently, researchers from Taiwan investigated the use of high frequency mechanical vibration, interferential current, ultrasound, and low level laser on the effects of microcirculation in the Achilles tendon.[3] Outcomes of the study were enlightening. In short, the authors found statistical significance of increased blood flow to the Achilles tendon only upon use of ultrasound and a 30 Hz hand-held mechanical vibration device.[3] Although not formally assessed in the study, the authors noted that mechanical vibration may have increased microcirculation even more than ultrasound. Further studies were recommended.

The purpose of highlighting a recently published study that used mechanical vibration as one option to promote microcirculation was not intended to serve as an in-depth critique of methods, results, conclusions, or limitations, but rather to highlight two important points. First, the use of mechanical vibration is not commonly used in the practice of physical therapy, and certainly not prevalent in peer-reviewed literature. However, it is a common intervention used in equine rehabilitation, especially in the athletic population, and is now supported to a limited degree by scientific evidence. Second, outcomes of the study by Chang et al[3] should at the very least increase awareness of mechanical vibration as a potential intervention to be considered for the goal of increasing blood flow to tendon tissues with minimal vascularity.

Figure 1. Hand held mechanical vibration device (RRT).

Figure 2. Mechanical vibration applied to the lumbosacral region of a horse.

CLINICAL COMMENTARY ON THE EVIDENCE-BASED PRACTICE AND MECHANICAL VIBRATION

Without question, scholarly exploration and dissemination of evidence has significantly advanced the science of physical therapy in recent years. Researchers have not only validated but also challenged many assertions and beliefs regarding the practice of rehabilitation. In 2014, the American Physical Therapy Association published a document entitled, "Five Things Physical Therapists and Patients Should Question."[4] This document was created as part of a national campaign called "Choosing Wisely" initiated by the American Board of Internal Medicine Foundation.[5]

Five areas of physical therapy practice were identified by experts in the profession as being questionable by way of clinical practice based on scientific evidence. One of the items listed on the document is, *"Don't employ passive physical agents except when necessary to facilitate participation in an active treatment program."*[4] This statement implies that the use of passive physical agents alone, without active engagement by the patient, is not supported by current evidence. Therefore, even suggesting that a relatively new physical agent such as high level mechanical vibration might be of interest to physical therapists may seem a bit out of context given the current de-emphasis placed on the use of modalities in patient care.

It is true that discussing one physical agent as a potential source of patient care can be dangerous. Therefore, I share words of caution to anyone who may reason that using mechanical vibration alone constitutes "good" practice of physical therapy. In fact I propose just the opposite, and agree whole heartedly with the evidence summarized by the APTA Choosing Wisely campaign indicating that physical agents are simply adjunct to a more holistic plan of care that better defines the practice of physical therapy. The positive outcomes reported by Chang et al[3] of using mechanical vibration to induce physiological change are encouraging but warrant further studies to validate this therapeutic agent in animal rehabilitation.

ACKNOWLEDGEMENT

Photos courtesy of Kirk Peck and Sharon Classen 2015.

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