2020 / volume 32 / number 2

ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA

FEATURE:
Risk Factors for Low Back Pain in Recreational Distance Runners

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ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA

In this issue

Regular features

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

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Editor's Note

Most of my time in the clinic I am happy. I work 10-hour shifts in an orthopaedic and sports clinic. I have been working at the same clinic on a per diem basis for the past 6 years and the clinic has been bought and sold by 3 different companies. For this reason and many others, the clientele has changed since I started working there. Now, I treat patients with a wide range of diagnoses and ages varying from 2-month olds to 98-year olds. I see patients with neurologic disorders including traumatic brain injury, multiple sclerosis, concussion, vestibular migraine, and stroke. I am clinically challenged to the right amount and I am able to run ideas by other therapists who have great ideas for treatment. It's a great profession, isn't it? I help patients get better on a daily basis and being in the clinic is exciting for most of these days. Many times, I leave thinking that I just got paid for something that I love! Wow, what a great profession to work in!

Besides the clientele changing, many other things have changed over the past 6 years and I am certain that these changes are being seen by clinicians across the country. When I first started working at this ortho/sports clinic, I had a high volume of patients which was extremely challenging but forced me to become more efficient. To give you an idea of what I mean by high volume, I admit that I treated 34 patients in one day. I am not sure about your clinic, but I was more familiar with seeing about 15 patients a day. I have talked with many therapists who work under extreme demands for productivity. These therapists had to get used to the idea of having 15-minute treatment sessions and 30 minutes for an evaluation. When I talk to therapists that have never been in this type of clinic, they are outraged. (Watch this video to get the idea! https://www.youtube.com/watch?v=AS4aiA17YsM)

Let's point out the benefits of this model of care, and start with the idea of a 30-minute evaluation. I think this type of time limitation helps focus our process of selecting which assessment items are going to inform the treatment. What is going to help this patient reach his or her goal? Staying with the good from this environment, when I worked those high-volume days, I had to get in the groove from the minute I walked in the door until the time I clocked out, so it was an adrenaline rush each and every day in the clinic.

The negative aspects of seeing that many patients are numerous though. I did not get to know the patients well. The co-morbidities that influenced a patient's primary condition were not addressed as much. Some of the exercise was supervised by others who did not always know why I wanted exercises to be done in a specific manner, so they did it as best they knew how. And the documentation! Documentation takes forever and often follows me home because at 7 at night without dinner, I get grumpy. Maybe this is the case for you as well. So, I would go home, eat, and then document. The Bureau of Labor and Statistics (May 2018) reports that 33% of physical therapists work in outpatient settings so I am certain that others feel this way.[1] The challenge of staying on top of notes, evaluations, discharge reports, contacting other health care providers to provide the best care for the patient is still a crazy balancing act for therapists across the country. Managers are asking for therapists to do more. For example, a therapist I know quite well tells me that at the beginning of the day in the inpatient setting, each therapist would receive a yellow sticky note with the time that they were expected to leave for that day and the number of patients that they were assigned to see in that time. Every day, the clinic manager would print out the productivity of the therapists and post it for all to see in yellow highlight. Look at the terrible therapist! The manager was responding to demands from her supervisor. More productivity AND a wider bandwidth of patients. Less money—or no money—for continuing education courses. Mandatory training has also changed. Unfortunately, I now have to watch annual modules on what to do if there is an active shooter in the workplace. A necessary task in our ever-changing world. Something has got to give…

There is hope, though. *Forbes* ranked physical therapists as having 1 of the "Ten Happiest Jobs" in the United States according to articles published in 2011 and 2013.[2] As I said in my opening paragraph, I love our profession and I really enjoy most days in the clinic. Are there things that I would like to improve? Absolutely! I try to do this by being involved in our profession. At the state level, national level, and in our great Academy. What would you improve? What can you do about it besides yelling out the window "I am as mad as hell and can't take it anymore." (See earlier video reference.) Do you have strategies to make any of this better? If so, please share your ideas so we can post them online and on social media!

According to a survey conducted in 2007 by the University of Chicago's National Opinion Research Center, more than three-quarters of physical therapists polled reported to be "very satisfied" with their occupations. Physical therapists were second only to clergy in the study and were the only health care professional in the top 5.[3] Similar reports were done by CNNMoney.com which gave physical therapists a grade of "A" in Personal Satisfaction back in 2012.[4] *Forbes* magazine listed physical therapy as one of the "top 10 jobs in high demand and the US News & World Report has continued to include physical therapists as its '100 Best Jobs' in terms of employment opportunity, salary, manageable work-life balance, and job security.[2] Apparently, we are needed as well! According to the Bureau of Labor Statistics, employment of physical therapists is expected to grow by 36% until 2024.[1] This is reported to be much faster than the average for all occupations. Interestingly, Arizona and Pennsylvania are asking APTA for an in-depth look at workforce supply of physical therapists for the upcoming House of Delegates. More to follow on this after June!

I think you'll agree, that while no job is perfect, the opportunities for physical therapists are pretty good. You play a huge role in helping assure that patient care is delivered in efficient and effective ways. Your participation in professional organizations and your voice help shape the way we work in the future.

Professionally,
John Heick, PT, PhD, DPT
Board-certified in Orthopaedics, Sports, and Neurology

(Continued on page 68)

Paris Distinguished Service Award Lecture

Transform Society Through Service

Joe Godges, DPT

Here are two statements that I think are appropriate to initiate my conversation about this Distinguished Service Award.

> ***Vision without execution is hallucination.***
> – quote attributed to Thomas Edison
>
> ***"Strategy is a commodity; execution is an art."***
> – Peter Drucker

Service is the critical element, with the typical focus to address an issue or perceived need, and most effective when a team with a common vision works toward addressing the need.

> Service
> is the critical element
> always part of a team
> attempting to address a perceived issue
>
> (there is nothing worse than industrious stupidity)

I was always part of a team in my roles at providing service to our Academy. Thus, I actually feel quite uncomfortable receiving this award because it was always a team effort that accomplished the items that Jay summarized in the introduction. It was never one person doing the service.

Hence, with loads of appreciation, I will point out a few of the many team members who served with me. I always felt like I was the fortunate one. I would also like to mention that I am so grateful for Gerard and members of his team who put in the effort to recognize me – it is quite humbling. I am also grateful for all of you attending this evening's event. It is really quite an honor.

> ***"Strategy is a commodity; execution is an art."***
> – Peter Drucker

Getting back to Peter Drucker's quote, Strategy is a commodity. I would say a common commodity - that attempts to address a perceived issue. And, I like how Dr. Drucker puts it, the art is in execution of that strategy, or of our strategic plans. But, I always keep in mind something I learned from my father-in-law – and something I have repeatedly experienced throughout my life.

> ***(There is nothing worse than industrious stupidity.)***

So, since I am old, and at this service of our Orthopaedic Academy and the APTA for 40 wonderful years, I can speak about history – history that I lived. Sometimes artful, sometimes stupid, at times wroth with hallucinations, and at times wonderfully strategic and successful.

> **1980s issues**
> following treatment orders
> treating a medical disorder or dysfunction
> vs
> profession that can make clinical decisions
> based upon subgroup classifications

In the 1980s, with regards to the management of common musculoskeletal conditions by physical therapists, the common belief was that that physical therapists were a profession that followed treatment orders from medical practitioners, and thus, carried out a prescription that was treating a perceived tissue disorder.

Nice thought, but looking back and knowing what we know now – that is, reading the key concepts and recommendations from current clinical practice guidelines, I think the vision that following of a prescription to treat a perceived tissue disorder, was, as Thomas Edison is attributed to say, a hallucination. On the other hand, there were trend-setters that promoted that clinicians in the physical therapy profession who work with patients with common musculoskeletal disorders can make clinical decisions based upon suspected subgroup classifications, and then focus the treatment to address the common impairment pattern, or clinical findings associated with that classification.

> **1980s issues**
> profession and competence defined
> by continuing education
>
> McKenzie Certification
> Paris Certification
> PNF training in Vallejo
> Rolfing Certification
> Michigan State Osteopathic Series
> Maitland focused Residencies
> Norwegian focused Residencies

Another issue of the 1980s was that clinical excellence in orthopaedic physical therapy was defined by continuing education seminars. That is, to be a skilled clinician, one had to invest time, energy, and financial assets to complete a variety of continuing education offerings. I actually spent about 12 years and did the first 5 listed.

I was even an instructor for one on the list. One which has the same name as the Service Award I am receiving this evening. Many memories, right Stanley?

> **1980s problem**
> took decades for a clinician to learn clinical
> decision making for differing subgroups
> and to
> effectively apply matched treatment

It seemed like this was a problem—a problem because it took several years to become comfortable with making clinical decisions about what we would now call differing subgroups and effectively applying the treatment that was best for that subgroup.

Think of the contrast of how our medical or dental colleagues receive clinical training. After they receive their MD, DO, or DDS, they do not go from one con-ed series to another over the course of several years to become a specialized practitioner, such as a pediatrician or endodontist. They go to a specialized, clinical residency - a residency that has progressive and guided clinical supervision that follows a standardized training curriculum of best practice in that field.

> **1990s issues/strategies**
> define Ortho PT expertise for the stakeholders
> (PTs, Medical Professionals, Payors, Public)
> and
> create efficient training programs for expertise
> (accepted residency and fellowship models)
> and
> train clinical supervisors/mentors
> of PT interns, residents, fellows

So, in the 90s, there were several strategies that seemed sensible to be on the "need to do list." Simply put, we had to define what the standard of care was, create efficient and effective programs to train that standard, and train clinical supervisors who can exponentially expand the positive influence in society by implementing that standard and train others.

I would like to point out that one thing that we did not think about was sustainability of a particular strategy. That is, if we were able to accomplish a strategic objective, we did not focus on what would we need to do to put incentives in place to sustain, nurture, or grow that strategic objective?

1990s issues
Team members in defining expertise
Tony Delitto, Julie Fritz, Steve George, Chris Powers, Linda Van Dillen, Lynn Snyder-Mackler
JOSPT & PTJ & Ortho Section/Academy & APTA

Team members in clinical residency development
Ann Ryder, Naomi Schwartzer, Renee Rommero
Katie Gillis, Joy Yakura, Richard Jackson
Alan Lee, Denis Dempsey, Nicole Christensen

There were several stars of the 1990s and early 2000s that set the stage for the accomplishments in the following years. When it came to defining our practice, there was a huge value to define what we do as physical therapists in high impact, peer-reviewed scientific journals rather than books and seminar course notes full of testimonials and beliefs of how to best treat a particular patient subgroup.

As we have learned in the last few decades, our hard-working colleagues on our practice affairs committees at the federal and state level can at least argue for paying for physical therapy evaluation and treatments that are consistent with the recommendations in medical journals. Arguing for what is in textbooks or CEU course notes does not typically provide our political action committees any traction with payors.

I would like to give a shout out to some of the leaders and their many colleagues at their respective universities when it comes to publishing the evidence for our practice. In my role as coordinator and editor of the clinical practice guidelines over the last two decades, the recommendations in the guidelines would not be powerful without the contributions of Tony and his colleagues at Pitt, Julie and her colleagues at Utah, Steve and his colleagues at Florida and now Duke, Chris and his colleagues at USC, Linda and her colleagues at Wash U, and Lynn and her colleagues at Delaware. There were also several leaders and their colleagues in the Shoulder and Elbow Society whose contributions were instrumental in defining the best practice for evaluating and treating shoulder conditions, such as Phil McClure, Paula Ludewig, and Lori Michener.

And, when it comes to clinical practice, I have a soft spot in my heart for the administrators at Kaiser Permanente in Los Angeles – Ann, Naomi, and Renee – for taking a gamble in 1990 and implementing a vision of clinical residencies following the OCS practice description that trained so many of today's clinical leaders in the United States and around the world. And, the leadership of the original clinical mentors of our residency in Los Angeles was amazing – Katie, Joy, Richard, Alan, Denis, and Nicole – your legacy truly lives on through your mentees, who, are now leading-edge mentors of others.

1990s strategic goal
Create practice privileges for clinicians practicing at an advanced level
and
Create clinical educators who can train clinician that the stakeholders can trust
(PTs, Medical Professionals, Payors, Public)
and
create science
("if it is not published in a peer-reviewed journal… it did not happen")
Steve Rose

These professors and researchers and clinical supervisors were darn effective at publishing the science and training the clinicians that our stakeholders (PTs, medical professionals, payors, public) can trust.

It was a goal of mine to help our profession create practice privileges for clinicians who are practicing at an advanced level – and thus, providing services in the optimal manner to sustain high levels of clinical excellence that is truly distinct from the novice or entry-level practitioner. I was following the economic principle that for a product or service to have sustainability in a market, there needs to be some perceived value of the service and some incentive, such as pay, promotions, or practice privileges, for those providing the service.

I have a quick survey. Please raise your hand if you have attained board certification in orthopaedics or sports physical therapy. Hands down. Put your hand up if that certification has resulted in you being paid at a higher level than your other physical therapists in your community who are not board certified - or - have the ability or get promoted to more esteemed job titles, - or - if you have practice privileges, such as being reimbursed at a higher rate for management of particular patient subgroups that require more training - or - have the privilege and responsibility to apply specific, specialized evaluation or intervention strategies. Hmmm. The small number of hands in the air is telling. In contrast, note that not every dentist has the privilege and responsibility to perform a root canal, or to straighten teeth. And, not every physician has the privilege and responsibility to manage patients with schizophrenia, or to diagnosis, remove, and manage an individual's basal cell carcinoma.

It will be interesting to observe over the next couple of decades if physical therapy board certification is a sustainable entity. I am a bit concerned. There was, and still is, a tremendous effort put it to promote and sustain board specialization in physical therapy. As you know, I was part of that huge effort. However, except for those who have attained ECS, I am not seeing the incentives to sustain the process – as it now stands. Maybe something will change in the future. I would hate to think that this was an example of industrious stupidity. Time will tell. Perhaps, we need to do something different to provide incentives to promote and sustain high levels of expert care.

Creating practice privileges for PT specialists
probably a hallucination

Creating credible clinical educators and CE sites
there are many shining stars! (so proud of them!) but the wide variation in our clinical education and thus, our practitioner's behavior and outcomes is an ongoing (and not well addressed) problem

Creating science
substantial foundational success

A parallel, related issue of the 1990s, and still an issue today, is the problem of unwarranted variation of physical therapist practitioners' clinical practice.

Think of the scenario where one of your relatives or friends or colleagues, and I am talking about a relative or acquaintance that you like, calls you or texts you and asks you for a referral for a "good" physical therapist in the city where they live. How many options can you comfortably give them, compared to the number of physical therapist practitioners in that city for which you would not feel comfortable with as a PT for your family member or colleague?

Raise your hand if you can relate to that dilemma.

I am always amazed at how much one can get paid in the medical profession for being mediocre, or even worse, for promoting disablement in individuals who come to them for health care. I am sure I am jaded, but my residents and fellows that I supervise typically have the privilege and responsibility of evalu-

ating and going into therapy with individuals who are difficult. And the definition of difficulty typically means the patient, or his/her health insurance, have paid for many visits of "health care" that was not close to following a clinical practice guideline and, unfortunately, this particular patient actually needed good health care to facilitate his/her recovery.

At the moment, I think that I, and we, still have a lot of work ahead of us to achieve the strategic goal of creating practice privileges for physical therapist specialists and with reducing unwarranted practice variation.

I also think that I have learned/we have learned, from our failures, which gives me hope and a reason to keep at it. That is, keep serving. It is an honor to receive this service award. But, holy Toledo, we really do have some unfinished business. You can count on me to stay in the business of working at this art – the art of executing the strategic plans of our Academy.

2000s Issues/Strategies

Payors want to pay for what works
(requesting clinical guideline recommendations)
and
Published evidence grows for science of PT
(USC, Pitt, Utah, UDel, UF, WashU, Baylor, ASSET, lead the way)
and
Medical model of expert driven care not working
(sick care business thrives, health of population declines)

In the 2000s, the theme of the major payors, such as the United States Department of Health and Human Services, was to "pay for what works." With the rising national debt of many governments, coinciding with the continual, rapid, rise of health care costs in most countries, the large institutional payors of medical services, including physical therapy, have cut back on reimbursement. And, one clear strategy for these institutional payers is to use available funds to pay for what works and refrain from paying for what does not work. Thus, it has become imperative for health care professions to clearly describe to payers and the public what physical therapy services are predictably valuable for particular patient subgroups. Hence, the need for clinical practice guidelines to guide the decisions of payers, policy makers, and the public when it comes to allocating their available resources for medical services.

Clinical practice guidelines are only as powerful as the evidence in the peer-reviewed literature that is available to be reviewed. The researchers and clinicians at several of the institutions across the United States and the world have really led the way and gave our profession the foundation to describe its practice and to train our clinical educators.

However, in the past decade, more and more experts, including researchers, economists, and clinicians, have recognized that professionals responsible for caring for patients with common musculoskeletal disorders are really good at sick care and not so good at health care.

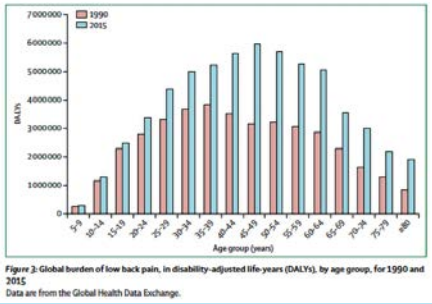
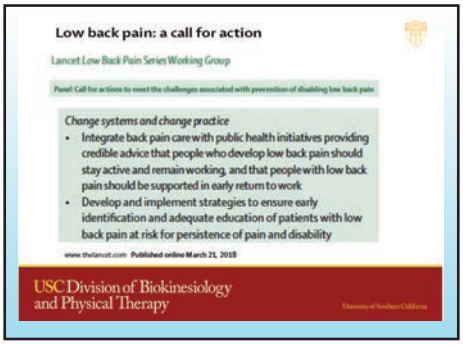


Figure 3: Global burden of low back pain, in disability-adjusted life-years (DALYs), by age group, for 1990 and 2015
Data are from the Global Health Data Exchange.

Global Burden of Disease – 2015 study
Low Back Pain is the #1 cause of disability globally

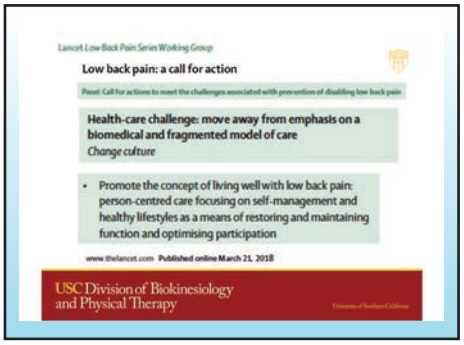
For example, data from 2015 shows that low back pain was the number one cause of global disablement – and not on the decline from the 1990s.[1,2] So, I/we can interpret this as demonstrating that in spite of all of the research and clinical care and payment for our services, we as health care professionals not performing. I think we should take some responsibility for this. I feel that we should actually be embarrassed, or, at least be willing to try something different.



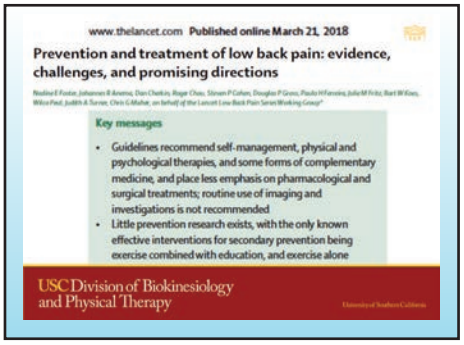
I love the theme of this publication in *The Lancet* in March 2018, entitled, Low Back Pain, A Call to Action.[3]

A publication of a working group of world-wide experts in the care of low back pain.

It calls for us to be responsible. It calls for us to "change systems and change practice."



It calls for us to "change culture" and "move away from a biomedical and fragmental model of care."



And a parallel publication by this work group in the same issue of *The Lancet* titled, Prevention and Treatment of Low Back Pain: Evidence, Challenges, and Promising Directions,[4] summarizes clinical practice guideline recommendations, that should be implemented. And these recommendations highlight some sweet spots that physical therapist should own, such as: self-management, physical and psychological therapies, exercise alone, and exercise combined with education.

Promising Directions
Physical and Psychological Therapies
Exercise
Exercise Combined with Education

The table is set for our profession. It is our time to execute. We have a beautiful vision to transform society by improving the way people move. But, remember, vision without execution can be considered a hallucination.

Prevention and Treatment of Low Back Pain: Evidence, Challenges, and Promising Directions
Author/Work Group: …Julie Fritz…

I must again call out Julie Fritz. Notice who is representing the scientific evidence in literature for physical therapy and other movement-related therapies on this esteem workgroup of experts. We are very fortunate to have colleagues, such as Julie, that are so

highly respected in the international scientific community to represent the best practice in the scientific literature for the management of common neck and back conditions.

Academy of Orthopaedic Physical Therapy, APTA

LEADERS
INNOVATORS
CHANGEMAKERS

our logo is very fitting for the present and future leaders but it also describes the recent past leaders

I feel that the reason the table was set for the next generation of physical therapists to execute and thrive was because of the leadership, innovative, and changemakers within the Academy of Orthopaedic Physical therapy.

2000s Issues/Strategies
Innovators & supporters of the AOPT/JOSPT, CPGs
Section/Academy Board of Directors
Mike Cibulka, Jay Irrgang, Steve McDavitt
and Finance Committee

CPG body region workgroup leaders
John Childs, Rob Wainer, Tim Flynn
Phil McClure, Joy MacDermid, Tony Delitto
Mike Cibulka, Doug White
Lynn Snyder-Mackler, Tom McPoil

Current CPG Editors
Christine McDonough, RobRoy Martin,
Guy Simoneau

Quick story, in 2004, I was voluntold onto a committee for the California PT Chapter that was responding to a request from the California Division of Workers' Compensation. The Division of Workers' Compensation was requesting guidance for the problem of physical therapists who, for example, after providing 70 visits of ultrasound to treat plantar fasciitis, the physical therapist is requesting more visits because the workers' problems have not resolved. Another committee member, Leslie Torburn and I went to the Orthopaedic Section Board of Directors at that time and asked: "Can the Section take the lead and create guidelines for our stakeholders for managing common musculoskeletal conditions?" And this was just on the heels of the American College of Occupational and Environmental Medicine publication of their book – their guide to practice – describing the "best practice" for managing common musculoskeletal conditions. So, we had clear evidence that either we define our profession's best practice or others will do it for us. Well, the Board at that time said, "Yes! Let's give it a shot. We can do this – and the rest is history. Jay and I went to leaders of our profession, and they uniformly said, yes, let's do it!

Again, as you see, it was such a great team of volunteer leaders addressing a need - from the workgroup leaders for each body region, the CPG Editors, the authors for each guideline, the contributors and reviewers of each guideline, to the guideline implementation teams, including the translators.

2000s Issues/Strategies
Clinical Practice Guidelines Heavy Hitters
Author Leaders
David Logerstadt, RobRoy Martin, Pete Blanchard
Chris Carcia, Keelan Enseki, Martin Kelly
Mia Erickson, Amelia Arundale, Richard Wiley

Contributors and Reviewers
Julie Fritz, Paul Beattie, Amanda Ferland
John DeWitt, Tim Flynn, Julie Whitman
Leslie Torbin, Joy MacDermid
Roy Altman, Paul Shekelle, Julie Tilson

and 100s more!
including the Chinese, Korean, Greek,
and Spanish Translators

2000s Service Outcomes

CPGs tell payors what to pay –
what is best practice for a specific subgroup of patients
and
CPGs guide clinicians in recognizing
clinical patterns and matched interventions
and
CPGs guide clinicians and other stakeholders in
functional and outcome measure options

I am pleased to say that CPGs did, and continue to, accomplish their strategic objectives of helping payors to "pay for what works," providing tools for clinicians to facilitate their pattern recognition skills and clinical decision making, and guiding clinicians and stakeholders outcome and functional measures to use to measure progress.

I want to express my
GRATITUDE
to my team members
to my strategic plan implementors
for the trust, sharing, challenges, celebrations,
& reflections

clinical specialization
clinical residency
finance committee
clinical practice guidelines
JOSPT

I want to express my
GRATITUDE
to my mentors in leadership

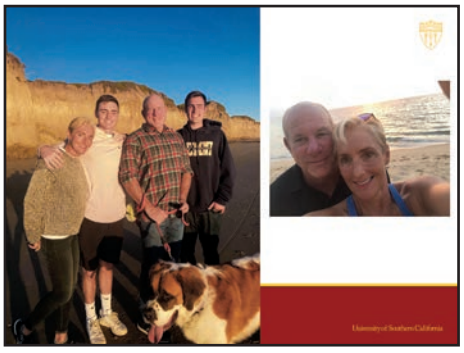
Renee Rommero
Kaiser Permanente

Edd Ashley
Loma Linda University

Jim Gordon
University of Southern California

All of those serving the Academy, including me, serve as unpaid volunteers. Thus, we are all sustained by our bosses of our "day jobs." I have been fortunate to have bosses who have been my mentors in leadership. Thanks Renee, Edd, and Jim.

and, importantly,
I am very grateful for my primary influencers
Arlette
Mark
Ryan
(and Shadow, Freddy, Osa, & Gus)



in closing

We have reasons to do our best to stay healthy and continue to be a force for good as we transform the world.

We have a huge decade in front of us.

(Continued on page 68)

2020s Challenges & Opportunities

Transform society in a positive manner

Continue to publish evidence to guide care

Continue with ongoing practice guideline revisions

Embrace guideline implementation – including International Classification of Functioning models – facilitating health, wellness, and self confidence

Create awareness that credible clinical education matters – and implement transformative models

As we move into the 2020s

Continue to go in gratitude

Continue to transform

Thank You All for the Opportunity

Lastly, I would like to end with a quote from Peter Drucker.

"The best way to predict the future is to create it."
– Peter Drucker

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EDITOR'S NOTE

(Continued from page 63)

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Risk Factors for Low Back Pain in Recreational Distance Runners

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ABSTRACT

Background and Purpose: The purpose of this study was to examine differences between runners with and without low back pain (LBP) and a control group of non-runners in demographic, physical/running, and LBP variables. Impact from running can range from 1.5 to 6 times bodyweight. As a result, the low back is commonly injured during running. **Methods:** There were 102 runners included in the study. Runners were divided into 3 groups. **Findings:** Significant differences were found in the side bridge test, Biering-Sorensen test, and body mass index. Group differences were found in run days/week, rest days/week, years run, marathons run, km/week of running, and age. **Clinical Applications:** Competitive runners may possess a strong training motive leading to development of LBP. Runners may also possess better core strength and trunk muscle endurance compared to non-runners and still develop LBP. **Conclusion:** Runners with LBP demonstrated different characteristics than runners without LBP and non-runners.

Key Words: Biering-Sorensen, side bridge test, running, low back pain

BACKGROUND AND PURPOSE

Low back pain (LBP) ranks among the most common musculoskeletal injuries in the general population. In the United States, LBP affects over 74 million people per year,[1] and results in over $5 million in medical costs per year.[2] Lifetime incidence of LBP in the general population falls between 60% and 90%.[3-7] Impact forces from running can vary from 1.5 to 6 times a runner's bodyweight, particularly at heel strike.[8-12] As high loads are transferred to the lumbar spine on a repetitive basis, it is not surprising that LBP would occur in distance runners.[13] The low back was identified as one of the most common sites for injury in runners.[14,15] Ten percent of recreational distance runners experienced LBP during their first year of running,[15,16] similar to the general population of non-runners which demonstrated a one year incidence of LBP ranging between 6% and 15%.[17-20] Lewis identified recurrence rates of LBP in athletes including runners ranging from 41% to 85%.[1,2] The recurrence rate of episodes of LBP in runners was identified as high as 85% in one year.[1] This was much higher than the recurrence rates in the general population.[21,22]

Running injuries are more common in women than men.[23-26] Females with an increased BMI demonstrated a greater prevalence of LBP in the general population of non-runners.[27,28] In contrast, female athletes including runners with lower BMI were more susceptible to LBP.[23-26] The annual incidence of running-related injury ranges from 14% to 70%.[14,15,29-32]

Sixty percent of runners reported that they had an insidious onset of LBP.[33] Twenty-three percent of distance runners were unable to run because of their LBP.[2] Prior research identified that variables such as gender, age, height, weight, BMI, and years of running experience may be risk factors for development of LBP.[16,23-28,34,35]

Researchers were consistent in their findings that incidence of LBP increased over the age of 40.[7,17,35-41] Individuals in the general population over age 40 had a 67% greater risk of developing LBP.[36] Taunton et al reported in a survey study of 844 recreational runners that runners older than age 50, especially females, were more likely to develop running injuries including LBP.[14] Authors demonstrated that females in the general population were more likely to experience LBP.[7,42] The Nord-Trondelag Health Study (HUNT study) indicated greater prevalence of LBP with increasing values of obesity/BMI for both males and females. The association between LBP and obesity/BMI was slightly greater in females than in males.[28] Buist et al[43] reported in a 2010 study of 532 novice runners that elevated body weight/BMI in males was associated with increased risk of running injuries including LBP. Wong and Lee studied[44] 61 subjects, with 41 of them having LBP, and found that active lumbar flexion was limited in subjects with LBP. Authors have shown that lack of trunk muscle endurance and core strength is correlated with LBP.[23,45-50] The Biering-Sorensen test was previously validated to demonstrate the difference in trunk muscle endurance between subjects with and without LBP (Figure 1).[47] Impaired core stability has been shown to be related to LBP and lower extremity injury in athletes.[24] The side bridge test was established as an effective way to address core muscular endurance in one study (Figure 2).[51]

Previously researchers had suggested that runners with increased training volumes were at greater risk for running-related injuries including LBP.[14,48,49,52] Koplan et al found a linear relationship between increased weekly running distance and injury.[53] A review article by Fredericson and Misra concluded that weekly running distance of greater than 64 km was associated with a high chance of running injuries including LBP.[52] The purpose of this study was to determine if a difference exists between runners with and without LBP and a control group of non-runners in relation to demographic, physical/training, and LBP variables and running. These variables were chosen because previous research showed specific variables were linked to LBP and/or LBP and running.

METHODS

Following Nova Southeastern University IRB approval, a 10 subject pilot study was performed on runners with LBP. Subjects included males and females between the ages of 18 and 55. Subjects from running groups with and without LBP were running at least 20-30 km/week for at least 1 year. Subjects for the running group were required to have had a current episode of LBP for at least 2 weeks but not longer than 6 months that had impeded their running. Potential subjects were excluded if they had a history of known spinal spondyloarthrosis or stenosis, spinal malignancy, history of fracture of the lumbar spine, history of spinal infection or spinal fusion, cauda equine syndrome, referred pain from the gastrointestinal and genitourinary tracts, and inability to flex or extend the spine to perform the testing. Subjects were also excluded if they were currently receiving physical therapy for LBP that included stabilization exercises or were currently experiencing running-related injuries other than LBP. Subjects were recruited from a local running store and health club in the Rockford, IL area. All subjects were asked to sign an informed consent form that provided information about the required activities and their

Figure 1. Demonstration of the Biering-Sorensen test.

Figure 2. Demonstration of the side bridge test.

rights. The completed and signed forms were brought back by subjects to their data collection session. A total of 102 subjects—35 runners with LBP (16 males, 19 females), 33 runners without LBP (16 males, 17 females), and 34 non-running control group subjects (12 males, 22 females)—were included in this study.

Demographic data collected via a questionnaire asked for demographic data and physical/running variables. Lumbar active ROM measurements were taken using one BASELINE® bubble inclinometer (Fabrication Enterprises Inc. White Plains, NY). Lumbar flexion active ROM measurement involved inclinometer measurements taken at the S2 and T12-L1 spinal levels in an erect position and as the subject bent forward and reached towards the floor with knees straight. Total active lumbar extension ROM was determined by taking inclinometer measurements at the T12-L1 spinal level only in an erect position and as the subject bent backward as far as possible, without stabilizing the pelvis, while looking up at the ceiling and keeping the knees straight.[54] The Biering-Sorensen test is used to measure trunk extensor muscle endurance.[51] The test involves a subject lying prone on a plinth with his or her trunk from the waist up off the plinth and the legs secured to the plinth with straps or belts.[51]

FINDINGS

All data analysis was completed using PASW (IBM® SPSS® Statistics Gradpack 22 for Windows®/Mac®) statistics package. Outcomes variables were compared among the 3 groups using a one-way analysis of variance for each variable. Post-hoc analysis was performed using Tukey's test when significance was identified (Tables 1 and 2). Outcomes data for all ordinal data was compared using a Mann Whitney U test (Table 3). Outcomes data for all categorical data was compared using a Chi square or Fisher exact test as appropriate. The significance level was set a priori at the .05 level, using a 2-tailed test for all hypotheses. A significant difference was identified among the groups for BMI. Post-hoc analysis indicated that the control group demonstrated a higher mean BMI (24.9) compared to both running groups (22.5, 23.8). The analysis of variance revealed no significant difference among the control, runners with and without LBP groups for total lumbar flexion but marginal in active extension ROM. The control group demonstrated more total active lumbar extension ROM (40.4°) than both running groups (34.1, 37.2). The analysis of variance revealed a significant difference among the groups for the Biering-Sorensen test. Post-hoc analysis indicated that runners without LBP (52.3 sec) demonstrated significant greater endurance than the controls (40.1 sec). The results of the side bridge test were significantly different among all groups for both the right and left sides. Post-hoc analyses indicated that both running groups demonstrated significantly greater core strength than the control group. Two-tailed independent t-tests were performed on both running groups. A significant difference between running groups in years run ($p = .004$), marathons run ($p = .030$), rest days ($p = .035$), and running days/week ($p = .035$) was demonstrated by t tests. No significant difference was identified between running groups in races/yr. Chi square tests or Fisher exact tests (any cell <5) for categorical data between running groups failed to find any differences. A significant difference was identified among running groups for age ($p = .05$). For ordinal variables, a Mann Whitney U test was performed. This test did not reveal any significant differences between running groups. The Mann Whitney U test did identify a marginally significant difference between running groups in km/week of running ($p = .05$).

CLINICAL APPLICATIONS

Works by Taunton and Nadler et al indicated that runners with lower BMI were more likely to encounter LBP related to running.[15,26] Runners with LBP in the current study demonstrated a lower BMI compared to runners without LBP. However, the difference was not statistically significant. The current study demonstrated a significant difference in age among running subjects with LBP compared to running subjects without LBP. This may be because the runners with LBP group possessed more runners ≥40 years old. Taunton et al[14] and Roncarati et al[55] identified this increased incidence of LBP in runners over the age of 40 and 50, respectively.

Prior research has identified that female non-running subjects are more likely to demonstrate LBP.[38,56] The current study did not identify this difference in non-running subjects and runners with and without LBP. The mean total lumbar flexion value (range) for each group, 47.4 (27-70), 47.5 (19-70), and 45.4 (20-64), was less than the cutoff value suggested by Fritz et al[34] of 53° in non-running subjects. The mean total lumbar extension value (range) for each group, 40.4 (14-60), 37.2 (15-53), and 34.1 (13-55), exceeded the cutoff value suggested by Fritz et al[34] of 26° for non-running subjects.

The current study did show significant differences between the control group and both running groups for the right-side bridge test (32.9, 48.1, 48.3 sec) and for the left side bridge test (31.7, 45.4, 49.1 sec). The results of the side bridge tests were lower than reported by Leetun et al[57] (65 sec in subjects experiencing injury and 72 sec in subjects without injury) and Waldhelm[58] (82 sec on the right side and 77 sec on the left side for healthy male subjects). It is likely that the participation of the running groups in this challenging core activity had contributed to their superior core muscle stability and trunk endurance compared to the control group of non-runners.[24] A significant difference was found among the control group and runners without LBP for the Biering-Sorensen test (40.1, 52.3 sec). A previous study examined the Biering-Sorensen test in runners vs. non-

Table 1. Runner Characteristics and Differences between Groups of the Current Study[a]

Variable	Runners with LBP (n=35)	Runners without LBP (n=33)	Control (n=34)	F[c]	P
Height (cm)	171.5±7.9 (157-188)	172.7±9.4 (155-196)	169.0±10.2 (142-188)	1.42	.248
Weight (kg)	66.4±10.0 (50-85)	71.3±11.7 (49-95)	71.3 ±12.8 (47-102)	2.07	.132
Age (y)[b]					
18-19	0	3	2		
20-24	1	3	2		
25-29	6	4	9		
30-34	6	7	8		
35-39	2	6	6		
40-44	7	4	4		
45-49	6	3	1		
50-55	7	3	2		
BMI (kg/m^2)	22.5±2.5 (18-31)	23.8±2.5 (19-29)	24.9±3.8 (19-34)	5.35	.006*
Gender (# subjects)[b]					
Male	16	16	12		
Female	19	17	22		
TLF Active ROM	47.5±10.2 (19-70)	45.4±12.1 (20-64)	47.4±12.1 (27-70)	.343	.710
TLE Active ROM	34.1±10.1 (13-55)	37.2±10.1 (15-53)	40.4±12.0 (14-60)	2.90	.060
BST (sec)	45.9±19.6 (10-90)	52.3±20.3 (23-90)	40.1±14.0 (5-65)	3.84	.025*
Side Bridge Test-Right (sec)	48.3±20.4 (15-90)	48.1±19.0 (25-90)	32.9±17.6 (6-75)	7.29	.001*
Side Bridge Test-Left (sec)	45.4±20.2 (5-90)	49.1±19.0 (17-90)	31.7±15.8 (6-75)	8.00	.001*

[a]Values are mean ±SD (range). [b]Other values are counts. *Significant difference between groups (p<.05). [c]F = F value

Abbreviations: LBP, low back pain; BMI, body mass index; TLF, total lumbar flexion; ROM, range of motion; TLE, total lumbar extension; BST, Biering-Sorenson test

runners revealed average hold times of 66 seconds for runners and 48 seconds for non-runners. These values are similar to what was found in the current study. The results of the current study indicated that a control group of non-runners had less core muscle stability and trunk muscle endurance than runners with and without LBP. It was possible that the control group was composed of less fit subjects and possibly greater BMI which contributed to lower trunk endurance.

In the current study, runners with LBP were older, had been running for more years, and were running an average of more km/week than runners without LBP. Runners with LBP were also running more frequently and taking less rest days. It is possible that total lifetime running distances among runners with LBP may have been greater than runners without LBP. Gucciardi et al[59] defined mental toughness as "a capacity to produce consistently high levels of subjective or objective performance despite everyday challenges and stressors." Runners take pride in their ability to suffer. Maximizing race performance is about "overriding the brain's power to slow down."[60] Since runners with LBP were running more marathons and more miles/week, they may have been more competitive and possessed a stronger training motive than runners without LBP. While the results of the current study are descriptive in nature, they may help those involved in the prescription of exercise to understand the mental toughness of runners with LBP. The cross-sectional nature of the current study prevents knowing the long-term effect of those runners with LBP that continue to run long distances for long periods of time. The results of this study may lead to future longitudinal studies in runners. The difference identified between the control group and runners with and without LBP in terms of core stability and trunk muscle endurance warrants further investigation. It is important to understand what demographic and training variables resulted in superior core stability and trunk muscle endurance in runners compared to a control group of non-runners.

One limitation of the study was that not all runners with and without LBP were able to be tested at the same time of day. The researcher found out after all data collection was completed that some subjects,

Table 2. Running Characteristics and Differences between Groups[a]

Variable	Runners with LBP (n=35)	Runners without LBP (n=33)	Difference Between Running Groups	T[b]	P
Days of Running/wk	4.8±1.0 (3-7)	4.2±1.2 (3-7)	.6	-2.15	.035*
Rest Days	2.2±1.0 (0-4)	2.8±1.2 (0-4)	.6	2.15	.035*
Years Run	14.8±10.7 (1-36)	8.5±6.0 (1-20)	6.3	-2.99	.004*
Races/yr	9.4±8.3 (0-40)	7.8±8.7 (0-30)	1.6	.738	.463
Marathons	7.8±12.7 (0-60)	2.6±4.0 (0-15)	5.2	-2.23	.030*

[a]Values are mean ±SD (range). [b]t=t value. *Significant difference between groups (p<.05).

Abbreviations: LBP, low back pain; NLBP, non-low back pain

Table 3. Mann Whitney U test between LBP and NLBP Running Variables[a] for the Current Study

Variable	Runners with LBP (n=35) Median (Interquartile Range)	Runners without LBP (n=33) Median (Interquartile Range)	P
Average Pace/mi (min)	8-9 (7-10)	8-9 (7-10)	.236
Best 5k Time (min)	19-21 (17-25)	23-25 (19-27)	.072
Km/wk	48.3 (32.2-64.4)	35.4 (27.9-56.3)	.050*

*Significant difference between groups, (p<.05)

Abbreviation: LBP, low back pain

although very small in number, ran prior to the testing. This may have negatively affected the external validity of this study. Lack of stabilization of the pelvis may have allowed rotational movement in the pelvis from activation of the gluteal and hamstring muscles that increased lumbar extension active ROM measurement;[61] which may have been a source of error leading to lack of significance in total lumbar active ROM measurements among groups.

CONCLUSION

While this study was purely descriptive in nature, it raises questions regarding the difference in core muscle strength of running and non-running subjects. It also questions the importance of training motive in running and the potential psychological involvement in this form of exercise. The current study could be used for further study into LBP and BMI and its relationship to sports involving running.

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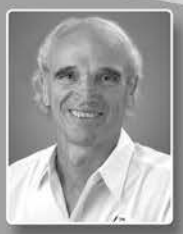

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Rehabilitation Following Anterior Cruciate Ligament and Posterolateral Corner Reconstruction with Medial and Lateral Meniscus Repairs in A High School Athlete: A Retrospective Case Report

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ABSTRACT

Background and Purpose: Complex and extensive knee injury in athletes pose a unique challenge in rehabilitation. The purpose of this case report was to describe the rehabilitation of a high school athlete who suffered a sport contact injury damaging the anterior cruciate ligament (ACL), medial and lateral menisci, and posterolateral knee compartment. **Methods:** The patient was a 17-year-old male athlete who underwent right ACL reconstruction, medial and lateral menisci repair, and posterolateral knee compartment reconstruction. Seven days postoperatively at initial evaluation he ambulated toe-touch weight bearing, using axillary crutches, with the knee immobilized by a brace locked at 0° extension. Passive knee range of motion (ROM) was 5° to 60°, with strength in available range graded 2/5 via manual muscle test (MMT). The patient was treated for 7 months for a total of 54 sessions. Physical therapy focused on passive and active ROM, therapeutic exercise (progressing from basic to sport specific), neuromuscular re-education, manual therapy, and modalities. **Findings:** At discharge passive ROM was +1-130°, active ROM 0° to 128°, and MMT of all R knee motions were 5/5. From 4 months to discharge isokinetic testing (60°/sec) of peak torque hamstrings to quadriceps ratio increased bilaterally (R LE: 43% to 61%; L LE: 57% to 72%). At discharge isokinetic knee extension peak torque-body mass ratio (180°/sec) was 66% right (R) lower extremity (LE) and 67% left (L) LE, all tibiofemoral stability tests were negative, and the patient returned to sport. **Clinical Relevance:** A 7-month progressive multi-modal rehabilitation plan was able to return a young athlete to sport following a complex and extensive knee injury. **Conclusion:** A progressive rehabilitation plan following extensive reconstructive repair of a complex knee injury was successful in returning an athlete to sport in a short 7-month timeframe.

Key Words: knee rehabilitation, complex knee injury

INTRODUCTION

Injuries to the anterior cruciate ligament (ACL) are prevalent in athletes with an estimated occurrence between 100,000 and 300,000 annually.[1,2] Approximately 50% these injuries are seen in individuals between 15 and 25 years of age participating in high velocity sporting activities.[3] Approximately 30% of ACL injuries occur as a result of external contact forces, and these type of injuries are more commonly associated with injury to secondary knee structures, such as the meniscus, articular cartilage, or the collateral ligaments.[2]

When injury to secondary knee structures occurs concurrently with the ACL, subsequent rehabilitation following surgical reconstruction can be affected. For example, significant tears to and subsequent repairs of the meniscus typically require slower progression of weight bearing (WB), range of motion (ROM), and introduction of therapeutic activity.[4] Concurrent injury to the lateral collateral ligament (LCL), a relatively uncommon occurrence, will also delay rehabilitation progression, with WB being delayed up to 4 weeks and resisted hamstring activation delayed 6 to 8 weeks following surgery.[4]

The posterolateral corner (PLC) of the knee is another secondary injury area of concern with ACL injuries.[5] It is common for injuries to the PLC to be missed as a part of the injury diagnosis, and may therefore be a contributing cause for ACL graft failure.[6-8] The PLC is comprised of the iliotibial band, biceps femoris muscle, LCL, popliteus muscle, popliteofibular ligament, lateral gastrocnemius muscle, lateral joint capsule, coronary ligament, oblique popliteal ligament, and the fabellofibular ligament.[7,9] Injuries to this area of the knee make up 16% of all ligamentous knee injuries.[10] These structures resist varus forces of the knee and rotation of the tibia.[5] Inability to restore PLC function could alter knee biomechanics and result in poor ACL outcomes, leading to early degenerative changes in the knee.[5,10,11] Posterolateral corner injuries typically occur with athletic injuries, motor vehicle accidents, and falls.[7,10]

There is a paucity of research regarding the rehabilitation of patients experiencing concurrent ACL and PLC reconstructive surgery. A systematic review by Bonanzinga et al[10] identified only 6 studies that reported patient outcomes from this procedure, and only 2 of those studies discussed, even in general terms, postsurgical rehabilitation of the patients involved. Return to sports following an isolated PLC reconstruction requires symmetrical strength, stability, and ROM when compared to the contralateral limb, which typically required 6 to 9 months to achieve. Common restrictions in combined ACL and PLC reconstruction rehabilitation protocols include bracing for the first 2 to 4 weeks postsurgery and passive ROM allowed after 1 to 4 weeks.[10-12] Typically after 6 weeks, the rehabilitation protocols follow that of a standard ACL protocol.[10,11]

Myer et al[13] have reported that return to sports following ACL reconstruction generally lacks standardized objective criteria. The decision is often based on graft stability, patient confidence, postsurgical timeline, and the medical team's subjective opinion. Although a return to sport following isolated ACL reconstruction may be possible as early as 3 to 4 months postsurgery, they indicate that athletes may not have sufficient functional stability to prevent reinjury. Functional stability deficits may include decreased muscular strength, joint position sense, postural stability, and force attenuation, and may

be evident for 6 months to 2 years following reconstructions. Standardized objective criteria of functional stability and neuromuscular control may improve successful early return to sports and long-term outcomes.[14]

Cvjetkovic et al[14] state that isokinetic testing can serve as an important objective criterion of dynamic stability of the knee joint and can therefore estimate the quality of rehabilitation outcome following ACL reconstruction. Isokinetic assessment is safe to administer and can detect hamstring to quadriceps ratio imbalances that would call for the delay in an individual's return to sport timeframe.[14] In post-pubescent adolescents and adults, normative values for knee extension peak torque-body mass ratio at 180°/s are 58% to 75% for men and 50% to 65% for women.[13] When determining an objective return to sport timeframe following ACL reconstruction, it is recommended that male athletes achieve an isokinetic (180°/s) testing criteria of 60% knee extension peak torque-body mass ratio, with female athletes achieving a similar criteria of 50%.[13]

While there exists extensive research regarding rehabilitation of isolated ACL injuries, there is considerably less research available on rehabilitation of athletes that have suffered more complex knee injuries, especially to multiple secondary knee structures such as the meniscus and the PLC.[10] The purpose of this case report therefore was to describe the rehabilitation of an athlete who suffered an ACL tear and concomitant injury to both medial and lateral menisci, as well as the PLC, and his ultimate return to sport using objective isokinetic assessment of knee extension performance.

CASE DESCRIPTION

Patient Information

The patient was a 17-year-old Caucasian male athlete who sustained a football contact injury to his right knee that resulted in a complete tear of the ACL, injuries to the medial and lateral menisci, and PLC injury that included the popliteus muscle, popliteal fibular ligament, and the LCL. Radiographs taken immediately after the injury showed no fracture or bony misalignment, but manual examination of the knee suggested a possible ACL injury. Within 24 hours the patient underwent magnetic resonance imaging of the knee that revealed a complete mid-substance tear of the ACL and pivot shift mechanism of injury with deep central sulcus sign along the lateral femoral condyle, bone contusion with microtrabecular fracture along the posterior lateral tibial plateau, complete tear of the lateral head of the gastrocnemius muscle at its musculotendinous junction, complete disruption of the lateral retinaculum of the patella, a vertically oriented peripheral tear in the posterior horn of the medial meniscus, and a similarly oriented tear to the central portion of the posterior horn of the lateral meniscus. The patient underwent arthroscopic reconstruction of the ACL 21 days after the injury that consisted of an autograft from hamstring tendon, medial and lateral meniscal repairs, and open reconstruction of the PLC using a cadaveric Achilles tendon allograft to reconstruct the LCL.

Examination

Physical therapy documentation was attained retrospectively. Seven days postoperatively, the patient presented to physical therapy ambulating using bilateral axillary crutches and restrictions of toe-touch WB, and wore a total ROM knee brace locked at 0° extension. The patient exhibited gross ROM deficits (Table 1), and strength of both hamstrings and quadriceps muscles, measured via manual muscle testing (MMT)[16] within the limited ROM, was 2/5. Edema was not assessed on the initial evaluation secondary to protective incision bandages. Pain was rated using the numeric pain scale at 1/10. Neurological review showed the patient had normal sensation of the bilateral lower extremities (LE). Secondary to the stage of healing no further tests or measures were performed at the time of the initial evaluation. Based on the patient's age, prior health status, motivation, and level of family support it was determined that the patient exhibited a good prognosis for rehabilitation.

Intervention

The patient was treated in physical therapy over a 7-month period for a total of 54 sessions using the surgeon's postoperative ACL rehabilitation protocol (Table 2). The protocol, approximately 7 months in length, was generally divided into 4 rehabilitation phases: (1) early rehabilitation (0-4 weeks), (2) controlled ambulation (4-10 weeks), (3) advanced activity (10-16 weeks), and (4) return to activity (16-30 weeks) (see Table 2).

An initial home exercise program was prescribed (to be performed twice daily) that consisted of quadriceps sets, straight leg raises, sidelying hip abduction (all 3 sets of 10 repetitions), and passive knee ROM (10 repetitions).

During the early rehabilitation phase, the patient was seen in the clinic 3 times per week for a total of 9 treatment episodes following the initial evaluation. Physical therapy interventions (Table 3) included manual therapy and modality interventions to achieve full extension ROM, gradual increase flexion ROM to 90°, increase soft tissue elasticity and extensibility, restore patellar mobility, decrease swelling and pain, improve muscle activation and recruitment, and improve gait mechanics within protocol limits of 30% WB, ambulation using bilateral axillary crutches, and total ROM brace locked in full extension. A NeuroCom® Smart Balance Master system (Natus Newborn Care, San Carlos, CA) was introduced in treatment to assist the patient in objectively progressing WB status. As the patient progressed to postoperative week 4, he began to experience increased calf pain. The patient was instructed to return to non-WB and the physician was contacted. A Doppler scan was ordered secondary to concern for deep venous thrombosis because of the patient's signs, symptoms, and length of time since surgery. The results of the Doppler scan were negative, and the patient was instructed to return to 30% WB. During postoperative week 4, the patient had progressed as scheduled per protocol having achieved normal patellar mobility, 0° to 90° tibiofemoral active ROM, and ambulation at 30% WB

Table 1. Knee Range of Motion for the Patient

Right Knee	Initial	Discharge
Active Tibiofemoral Flexion	Not Assessed	128°, symmetrical to left
Active Tibiofemoral Extension	Not Assessed	0°, symmetrical to left
Passive Tibiofemoral Flexion	60°	130°, symmetrical to left
Passive Tibiofemoral Extension	5° extension lag	+1°, symmetrical to left
Patellofemoral	Decreased	WNL, symmetrical to left

Abbreviation: WNL, within normal limits
ROM assessment made via goniometry[15]

Table 2. Postoperative Rehabilitation Stages

Early Rehabilitation Phase: 0-4 weeks Restricted ROM: 0 to 90º Partial WB 30% x 4 weeks Brace locked in 0º extension during ambulation
Controlled Ambulation Phase: 4-10 weeks Progress to full ROM
Progress WB to Full WB week 6 and discharge axillary crutches Unlock brace at week 6 Advance to Playmaker brace at week 8
Advanced Activity Phase: 10 to 16 weeks
Continue to Progress to full ROM
Normalize Gait Progress muscular strengthening/stability training
Initiate light intensity plyometric training Initiate multi-directional plane activity
Return to Activity Phase: 16 to 30 weeks
Progress muscular strengthening/stability training
Progress to Donjoy custom fit Defiance brace®
Initiate Running Program Progress to Sport-Specific Training Initiate Isokinetic Testing
Abbreviations: ROM, range of motion; WB, weight bearing

Table 3. Early Rehabilitation Treatment Protocol

Week	Interventions
0-1	Postoperative week 1 included physician instructed HEP and cryotherapy application. Physical therapy plan of care established.
1-2	Active-assistive/passive ROM, open kinetic chain hip concentric exercises, Multi-angle quadriceps/hamstring isometrics, ankle pumps, patellar mobilizations, NMES – Burst modulated AC (Russian) at maximum tolerable intensity, Game Ready Cold Compression.
2-3	Continued with previous interventions, Lower body ergometer cycle, non/partial-weight bearing wall slides, pro-long static stretching, soft tissue mobilization, NMES – Burst modulated AC (Russian) at maximum tolerable intensity, Game Ready Cold Compression.
3-4	Continued with previous interventions, heel cord stretches within WB restriction, closed kinetic chain hip/knee concentric exercises within WB restriction, soft tissue mobilization, NMES – Burst modulated AC (Russian) at maximum tolerable intensity, Game Ready Cold Compression.
Abbreviations: HEP, home exercise program; ROM, range of motion; NMES, neuromuscular electrical stimulation; AC, alternating current; WB, weight bearing	

with bilateral axillary crutches and total ROM brace locked at 0° extension without complications.

Following physician evaluation and physical therapy recertification, the patient was advanced to the controlled ambulation phase of the treatment protocol. During this phase, the patient was seen in the clinic 2 to 3 times per week for a total of 9 treatments. Physical therapy interventions (Table 4) included therapeutic exercises, manual therapy, and modality interventions to achieve full knee ROM, improve LE muscular strength and endurance, proprioception, balance, and neuromuscular control, restore confidence and function of movement, and progress gait to normal limits without WB restrictions, assistive device (AD) or total ROM brace. Between postoperative weeks 4 and 5, the patient was progressed to 50% WB in the total ROM brace locked at 0°extension with bilateral axillary crutches, and then progressed to 75% WB in the TROM brace locked at 0° extension and a single axillary crutch by the end of postoperative week 5. It was observed at this time that the patient ambulated with a vaulting gait pattern secondary to decreased right triceps surae extensibility.

As the patient progressed from the controlled ambulation phase and into the advanced activity phase, he was independently ambulating without AD or total ROM brace, had achieved 0° to 120° of tibiofemoral active ROM with increased strength and flexibility, had increased stability with anterior drawer testing, and was without pain. Impairments remaining included ROM, strength and flexibility deficits, impaired balance, decreased proprioception, and asymmetrical limb circumference.

During the advanced activity phase, the patient was seen in the clinic 2 times per week for a total of 15 treatments. Physical therapy interventions (Table 5) included therapeutic exercises, manual therapy, neuromuscular re-education, and modality interventions to achieve symmetrical strength, enhance muscular power and endurance, improve neuromuscular control, and progress to selected sport-specific drills. A physical therapy recertification was performed at the end of week 15 with assessment of knee circumference (Table 6). He exhibited 0° to 125° of active knee ROM and 5/5 muscular strength with MMT. Secondary to inability to detect strength deficits with MMT, the NeuroCom® system was used to assess functional strength during a lunge activity. The results demonstrated decreased force impact and time when compared to his non-involved LE indicating continued functional deficits. During his gait analysis, he was observed to have slight ankle pronation bilaterally at midstance, but otherwise gait was normal.

In the return to activity phase of treatment (Table 7), the patient was seen 2 times per week in the clinic for a total of 19 visits prior to discharge. During week 20 of the treatment protocol, a Lower Extremity Functional Scale (LEFS) was administered, with the patient scoring 71/80, rating his functional ability level at 89%. Limitations based on the

Table 4. Controlled Ambulation Treatment Protocol

Week	Interventions
4-5	Continued with previous interventions, passive and active lower extremity stretching, closed kinetic chain hip/knee/ankle concentric exercises within weight bearing restriction, Manual and instrument assisted soft tissue mobilization to lower extremity musculature.
5-6	Continued with previous interventions.
6-7	Continued with previous interventions, Stair climber, increased closed kinetic chain concentric exercises and progressed to single leg activities with full weight bearing.
7-8	Continued with previous interventions, Initiated single leg stance activity on non-compliant surfaces with/out dynamic upper extremity activity.

Table 5. Advanced Activity Treatment Protocol

Week	Interventions
8-9	Continued with previous interventions, elliptical, increased open kinetic chain and closed kinetic chain concentric exercises and progressed to single leg activities with full weigh bearing, initiated light intensity plyometric activity in gravity-eliminated positions.
9-10	Continued with previous interventions.
10-11	Continued with previous interventions. Initiated multi-directional movement training, slide board exercises, core stabilization exercises, progressed single leg stance activity to include compliant surfaces.
11-12	Continued with previous interventions.
12-13	Continued with previous interventions, progressed plyometrics to include gravity-resisted positions in sagittal and frontal planes.
13-14	Continued with previous interventions, progressed to dynamic lower extremity stretching exercises.
14-15	Continued with previous interventions, initiated Vertimax® training.
15-16	Continued with previous interventions, initiated light intensity linear running program on treadmill, and sport-specific activities without cutting/pivoting maneuvers.

LEFS included participation with usual hobbies, recreation, or sporting activities, squatting, getting out of a car, running on uneven ground, making sharp turns while running fast, and hopping. The patient exhibited 0° to 127° of active knee ROM. Isokinetic testing (speed 60°/s) was also performed during week 20, with the patient exhibiting peak torque LE hamstring to quadriceps ratio of 43% for the right LE and 57% for the left LE. Absolute peak torque deficit for the right LE was 11 foot-pounds for knee extension, and 33 foot-pounds for knee flexion. The patient exhibited knee extension peak torque-body mass ratio at a speed of 300°/s of 33% right LE, and 46% for the left LE. Continued NeuroCom®system functional strength assessments were completed during week 23 with continued force impact and time deficits. The LEFS was repeated at the start of week 27 with an increase in function to 91%. Based on the LEFS, continued limitations included running on uneven ground, making sharp turns while running fast, squatting, and participation with usual hobbies, recreation, or sporting activities. At week 28, prior to physician re-assessment, the patient completed his second isokinetic test (speed 60°/s), exhibiting a peak torque LE hamstring to quadriceps ratio increase bilaterally; 61% right LE and 72% left LE. Absolute peak torque deficit for the right LE was measured as 6 foot pounds for the knee extension and 20 foot-pounds for knee flexion. He exhibited a knee extension peak torque-body mass ratio at 180°/s of 66% right LE and 67% left LE, which was within the suggested return to sports range as reported by Myer et al.[13]

Following physician evaluation, the patient was allowed to begin cutting drills and an interval throwing program[17] (Table 8 and Table 9) with the possibility to return to sport within 3 weeks. As the patient desired to return to baseball pitching upon discharge, a throwing program was incorporated into physical therapy treatment episodes and in coordination with the high school pitching coach. Due to time restraints during treatments, only a portion of the throwing program was performed during treatment episodes to assess and monitor LE function and tolerance to activity.

Thirty weeks following surgical intervention, the patient returned to sport and was able to perform relief-pitching duties for his high school baseball team. By 3 weeks postoperative, he was pitching up to 4 innings without pain or limitations and was discharged from physical therapy care.

OUTCOMES

The patient presented to physical therapy one week following surgical intervention with significant ROM, muscular strength, and functional deficits resulting in activity limitations and participation restrictions requiring the need for skilled physical therapy. The patient exhibited excellent motivation and compliance throughout his rehabilitation process, which translated into significant ROM, muscular strength, and functional mobility increases.

As demonstrated in Table 1, the patient increased knee ROM from a limited 55° range, to a full 130°. Global strength of the knee, assessed via MMT, improved from 2/5 to 5/5. Isokinetic strength testing showed increases in peak torque hamstring to quadriceps ratio and decreases in absolute deficit in peak torque of the right LE compared to the unaffected left LE. The demonstrated knee extension peak torque-body mass ratio at 180°/s of 66% right LE and 67% left LE satisfied the return to sports criteria recommended by Myer et al.[13]

Tibiofemoral stability tests (Lachman's anterior and posterior drawer, varus and valgus stress) performed at discharge were negative. The patient self-reported 91% function based on his final LEFS administered 1 month prior to discharge. Secondary to the patient's knee function, strength, stability

Table 6. Knee Circumference Measures at Week 15

Circumference	Right LE	Left LE
5" above superior patella pole	55 cm	57 cm
2" above superior patella pole	48.5 cm	49 cm
1" above superior patella pole	47 cm	47 cm
Mid Patella	45.5 cm	45 cm
1" below inferior patella pole	44 cm	42 cm

Abbreviation: LE, lower extremity

Table 7. Return to Activity Treatment Protocol

Week	Interventions
16-17	Continued with previous interventions, progress running program intensity as tolerated.
17-27	Continued with previous interventions.
27-28	Continued with previous interventions, initiate cutting drills and throwing program.
28-31	Continued with previous interventions, dynamic running drills, sport-specific drills, return to sport.

Table 8. Return to Activity Phase Dynamic Running Program

Dynamic Phase	
50-yard run, 3 reps each of ½ and ¾ speed	100-yard run, 3 reps each of ½ and ¾ speed
Zig-Zag Run (round corners) 50 yards, 5 reps	Backward Run 25 yards then forward 25 yards 5 reps, gradual stops
Circle Run (20 ft. diameter) 3 reps to left/right	Figure 8 run (10 yards) 5 reps
Carioca (50 yard) 5 reps left/right	
Ballistic Phase	
Phase intensity: progress from walking to ½ speed to ¾ speed to full speed	
Run forward to plant and cut off of the non-involved limb, 5 reps	
Run forward to plant and cut off of the involved limb, 5 reps	
Zig-Zag drill with alternate limb plant and cut, 6 reps	
Box drill (20 yard) square, 6 reps alternate sides	
Shuttle run 50 yards with direction change every 10 yards, 5 reps	

Table 9. Return to Activity Phase Throwing Program

Warm-up	Warm–up Throwing 30-45 ft
Phase Progression	Initiate with Fast Balls Distance (ft.): 45, 60, 90, 120, 150, 180 Intensity: 50%, 75%, 100% Progress intensity at each distance prior to progressing distance
Number of Throws	25 throws followed by 5- to 10-minute rest intervals
Interval Throwing Program for Baseball Players[17]	

and isokinetic test results, he was released to return to sport participation at 7 months postoperative.

DISCUSSION

The purpose of this case report was to describe in detail the rehabilitation of a high school male athlete following ACL reconstruction with concomitant injuries to medial and lateral menisci, and the PLC of the knee. This case report demonstrates how progressive, multi-modal physical therapy interventions were employed to restore optimal lower extremity function following a complex traumatic contact sports injury and facilitate a safe return to sports participation. There is a significant amount of literature of isolated ACL tears with an expected return to sports participation generally at approximately 6 months.[1,5,10] However, the literature significantly lacks research detailing the rehabilitation of ACL reconstruction with concomitant meniscal and PLC injuries, although the same 6 to 9 month timeframe may be expected.[5,10-12] In general an agreed upon universal rehabilitation protocol for these patients does not exist.[10,13] The results of this case report indicate that a progressive, multi-modal physical therapy plan of care that uses objective return-to-sport criteria, such as isokinetic testing, allowed for the patient's return to sport within a 7-month timeframe.

A primary limitation of this case report included inconsistency in regular objective functional assessment over the course of treatment. For example, isokinetic test speeds used for testing ranged from 60-300°/s, with the only consistent speed across all sessions being 60°/s. Additionally, the LEFS was not employed until week 20 of physical therapy treatment. Greater consistency among isokinetic test speeds and earlier assessment of the LEFS would have allowed for more detailed assessment of the longitudinal functional progression of the patient.

In retrospect, addition of the Lower Extremity Functional Test (LEFT) would have provided the therapist even stronger evidence for return to sport in this patient. The LEFT assesses sport specific movement patterns with 8 agility drills consisting of forward run, backward run, side shuffle, carioca, figure 8 run, 45° cuts, and 90° cuts. Brumitt et al[18] demonstrated that an increased risk of thigh or knee injury is associated with LEFT completion times. Females who exhibited slower times were 6 times more likely to suffer knee and thigh injuries, whereas males who exhibited slower completion times had

increased risks of low back and lower extremity injury.

CLINICAL APPLICATIONS

Limited clinical evidence is available regarding rehabilitation of patients who have experienced concurrent ACL and PLC injuries and reconstruction, and no studies discuss such rehabilitation in detail. This case report described the detailed progress of a male athlete from beginning of rehabilitation to return to sport, and showed that a progressive, multi-modal plan of care that focused on objective assessment of knee performance to guide return to sport decisions allowed for successful rehabilitation outcomes.

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Clinical Reasoning and Use of a Literature Review During the Management of Patellofemoral Syndrome: A Case Report

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ABSTRACT

Background and Purpose: Evidenced-based practice is grounded upon the integration of current literature and clinical practice. Patellofemoral pain syndrome (PFPS) is a common condition with a reported incidence of 20% to 40% of all knee cases in sports medicine clinics. The purpose of this case report is to demonstrate how a literature review can enhance clinical reasoning during the management of the 17-year-old patient/client with PFPS. **Methods:** A literature search in Medline & CINAHL was conducted reviewing abstracts focusing on movement assessments to identify dysfunctional movement patterns and individuals at risk for injuries; and movement assessment assisting in development of prognosis and plan of care. **Findings:** The review of literature revealed 15 articles that were deemed appropriate. **Clinical Relevance:** PFPS is a common musculoskeletal condition facing today's clinician. The challenges for clinicians within the current health care environment stem from the fact PFPS is a multifactorial issue with no definitive diagnostic criteria, and limited clinical utility of impairment based clinical tests have provided minimal information that can assist the clinician in managing patients with this condition. Movement assessments are potential alternatives from isolated impairment-based tests that can enhance clinical reasoning by capturing regional interdependence implications. **Conclusion:** Applying evidence-based principles to specific cases can enhance clinical reasoning within clinical practice.

Key Words: anterior knee pain, movement assessment, physical therapy

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the most common overuse injuries that affects active individuals, and is most prevalent in female and youth athletics.[1-3] It accounts for 25% to 40% of all knee problems in sports medicine clinics, yet no reference standard has been developed for diagnosing PFPS.[4] Special clinical tests aimed at assessing patellar mobility and palpations have demonstrated poor diagnostic accuracy in identifying the condition.[1,5] Given that impairment based clinical tests are unable to diagnosis PFPS, the purpose of this inquiry is to assess the benefit of incorporating movement assessment procedures into the physical therapy examination for PFPS.

Movement assessment may be a beneficial evaluation approach as PFPS has been found to be a multifactorial issue with numerous identifiable risk factors and regional interdependence implications.[6] Regional interdependence states that unrelated impairments in remote anatomical locations may be associated with the patient's primary complaint.[7] In the case of PFPS, two important areas that should be examined are the hip and the ankle.

Powers demonstrated that during closed kinetic chain functional activities, in which most PFPS symptoms and complaints are felt, excessive femoral internal rotation and adduction results in dynamic knee valgus.[2,3] Below, at the ankle, limitations in dorsiflexion can result in compensatory subtalar joint pronation. Excessive pronation is coupled with tibial internal rotation, which can result in femoral internal rotation and dynamic knee valgus.[2-4] This dynamic knee valgus is a dysfunctional movement pattern that results in decreased patellofemoral joint contact area and increased joint pressure.[2,3] Evidence supports that individuals with PFPS demonstrate significant decreased hip external rotation and abduction strength, decreased gastrocnemius flexibility, and increased dynamic knee valgus during functional activities.[8-14]

Impaired proprioception has also been associated with PFPS with patients demonstrating higher trajectory tracking error and impaired active joint position reproduction error compared to healthy controls.[15,16] Most believe this impaired proprioception is a result of PFPS or associated with pain. However, Bennell et al[17] found that experimentally induced anterior knee pain, which mimicked PFPS, of moderate to high intensity did not affect joint position sense in healthy individuals. This information leads to the possibility that impaired proprioception is not caused by PFPS but impaired proprioception may actually preclude or be a risk factor for developing PFPS.

A review of literature identified two widely used movement assessments the Functional Movement Screen (FMS) and Star Excursion Balance Test (SEBT)/Y-Balance Test (YBT). Both tools are used as pre-participation screens to identify individuals at risk for injury. The FMS uses 7 tests to assess functional movement patterns incorporating the entire kinetic chain. It is designed to identify individuals who have developed compensatory movement patterns.[18,19] The FMS has been shown to identify individuals at risk for injury in professional American football players, female collegiate athletes, and Marine Corps officers.[10,21-23] The SEBT and YBT are tools used to assess dynamic postural control, balance, and functional symmetry of the lower extremities. The YBT has been shown to be able to identify individuals with increased risk for sustaining a lower extremity injury in high school basketball players and collegiate football players.[24,25]

Given that dynamic knee valgus is a dysfunctional movement pattern that involves the entire kinematic chain and that impaired proprioception may be a potential risk factor, it could be beneficial to incorporate a movement assessment when screening for or evaluating patients with PFPS. Movement assessments have been shown to be able to identify individuals at risk for injury, and have the potential to capture proprioception, motor control, body awareness, and regional interdependence of the lower extremity during functional tasks. The purpose of this literature review was to determine the benefit of incorporating a movement assessment during a physical therapy evaluation of a patient with PFPS.

PATIENT CHARACTERISTICS

A 17-year-old male presented to the outpatient physical therapy clinic via direct access following an athletic screening for bilateral knee pain. Upon initial evaluation, the patient's chief complaint was bilateral anterior knee pain, right greater then left. Patient reported playing defensive end for his high school football team and initially experiencing knee pain a few weeks prior when squatting during off-season workouts. The patient reported he eventually began to experience knee pain during running and jumping activities, but the worst pain was experienced during squatting. He reported squatting over 300 lbs multiple times a week during the off-season, with pre-season workouts and two-a-days starting in 3 weeks. The patient reported icing his knees after squatting and not stretching or warm up prior to strength training. No imaging was performed. Patient's past medical and surgical history were unremarkable.

Physical Examination

During the deep squat test, the patient was unable to reach parallel, heels rose from the floor, demonstrated bilateral valgus collapse, and increased trunk inclination. Deep squat with heels placed on a 2-inch box the patient reached parallel with decreased bilateral valgus collapse, but demonstrated right weight shift and right trunk rotation. Patient reported increased pain during both deep squats. During the YBT the patient demonstrated decreased anterior reach distance on right lower extremity and bilateral valgus collapse; Y balance was not quantified.

Significant impairment-based findings included anterior pelvic tilt, bilateral positive Thomas tests, bilateral tight gastrocnemius, bilateral talocrural joint hypomobility, decreased hip abduction, hip extension and knee extension strength, and anterior core weakness. Patellar movement during the patellar glide test was normal. Lachman's tests, McMurray test, varus and valgus stress tests were negative for ligament and meniscal damage. Patient's Lower Extremity Functional Scale (LEFS) score was 50/80. From this clinical presentation, it was determined the patient was presenting with bilateral patellofemoral pain syndrome (PFPS). Initial examination findings are listed in Table 1.

Table 1. Initial Examination Findings

ROM	Right Lower Extremity	Left Lower Extremity
Hip ROM (Flexion, ER, IR)	WNL	WNL
Knee ROM	0-125°	0-125°
Ankle Dorsiflexion (Knee straight)	0°	0°
Ankle Dorsiflexion (Knee bent)	0°	1°
Talocrural Joint Posterior Glide	Hypomobile	Hypomobile
Manual Muscle Test		
Hip Abduction	3-/5	3-/5
Hip Extension	3-/5	3-/5
Hip Flexion	5/5	5/5
Knee Extension	4-/5	4-/5
Knee Flexion	5/5	5/5
Special Tests		
Thomas Test	Positive	Positive
Conventional SLR	Positive	Positive
Patellar Glide Test	Normal Movement	Normal Movement
Lachman Test	Negative	Negative
McMurray Stress Test	Negative	Negative
Varus Stress Test	Negative	Negative
Abbreviations: ROM, range of motion; ER, external rotation; IR, internal rotation, WNL, within normal limits, SLR, straight leg raise		
Movement Assessment		
Deep Squat	- Requires 2-inch heel lift to reach parallel - Bilateral valgus collapse - Right weight shift & right trunk rotation - Positive for pain	
Y Balance (Anterior Reach)	- Left anterior reach > right anterior reach - Bilateral valgus collapse - Positive for pain bilaterally	

Interventions

Interventions emphasized manual therapy and corrective exercise to improve lower extremity range of motion, correct movement patterns, and build strength in appropriate muscle groups. Manual therapy included posterior glides to the talocrural joint to increase ankle dorsiflexion and Thomas stretch to increase hip flexor flexibility. Corrective exercises included kneeling closed chain dorsiflexion/soleus stretch, standing gastrocnemius muscle stretch, kneeling hip flexor stretch, and strengthening exercises for hip abduction and extension. Patient also performed reactive neuromuscular training (RNT) corrective squatting with bands to correct the right weight shift and bilateral valgus collapse.

METHODS

Search Strategy

A literature search in Medline and CINAHL was conducted reviewing abstracts focusing on movement assessments identify dysfunctional movement patterns and individuals at risk for injuries; and movement assessment assisting in developing prognosis and plan of care. Articles deemed appropriate then underwent an analysis of full text and the most appropriate articles were selected for use in this literature review. Search terms used to search the literature are listed in Table 2.

The International Classification of Functioning (ICF) model was applied to the case in order to assist in prioritizing the most meaningful impairments in an attempt to enhance the clinical reasoning process and presented in Figure 1.

FINDINGS

The review of literature revealed 15 articles that were deemed appropriate. Four articles provided background information on FMS, developed by Gray Cook.[18,19] The FMS composite score has been found to have moderate to good interrater (ICC of 0.74 95% CI: 0.60, 0.83) and intrarater (ICC of 0.76 95% CI: 0.63, 0.85) reliability and acceptable measurement error.[20,21] Four

Table 2. Search Terms used Medline and CINAHL Plus Databases

Key Terms	Patellofemoral Pain Syndrome	Functional Movement System	Star Excursion Balance Test	Lower Extremity Injury
Secondary Terms	• Patellofemoral Pain • PFPS • Anterior Knee Pain	• Functional Movement Screen • FMS • Movement Assessment • Deep Squat	• Star Excursion Balance • SEBT • Y Balance • YBT	• LE Injury • Non-contact lower extremity injury • LE injury risk • Injury risk

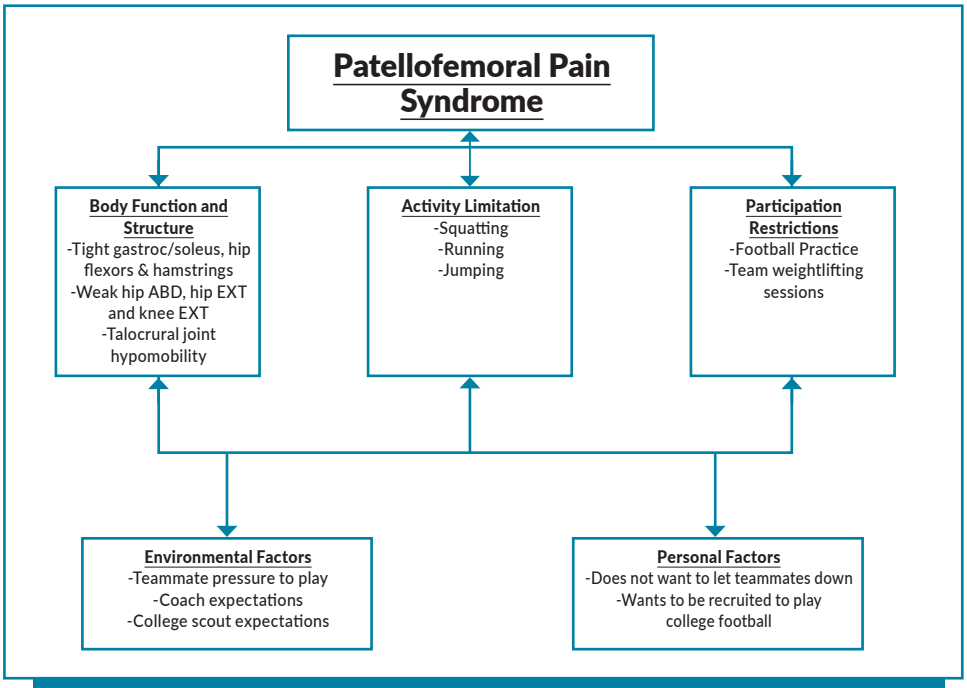

Figure 1. International Classification of Functioning (ICF) model for Patellofemoral Pain Syndrome.

articles assessed the FMS's ability to identify individuals at risk for lower extremity injury in professional American football players, female collegiate athletes, and Marine Corps officers.[22-26]

A systematic review was found that discussed the clinical utility and usefulness of the SEBT/YBT. The review found that the SEBT/YBT is a reliable and valid measure of dynamic postural control, which is sensitive enough to detect individuals at risk for lower extremity injury.[28] Two articles assessed the ability of the YBT to identify individuals at risk for lower extremity injury, in high school basketball players and collegiate football players.[27,28] The SEBT has specifically been assessed in patients with chronic ankle instability, anterior cruciate ligament reconstruction, and PFPS.[28] Aminaka et al[29] found that patients with PFPS demonstrated decreased YBT reach distances compared to healthy controls, and reach distances and pain improved with McConnell taping.

One article assessed the use of an injury prediction algorithm, which incorporated movement screening (FMS and YBT), demographic information, and injury history, to identify risk for non-contact lower extremity injuries in male and female colligate athletes. The authors found that athletes categorized as high risk were 3.4 times more likely to obtain an injury over the season.[30]

Two articles looked at the prognostic ability of the FMS. One article assessed the ability to improve the FMS composite score through an off-season intervention program. Kiesel found that individuals with a deep squat score of 1 were 5x more likely to not improve their FMS composite score following intervention.[31] Another article assessed if FMS scores were associated with longitudinal performance outcomes in elite track and field athletes. Researchers found that FMS scores and presence of asymmetries were related to magnitude in longitudinal performance changes. Specifically, athletes with a deep squat score of 3 had larger mean improvements in performance then athletes with a score of 2 or 1.[32]

One article specifically researching deep squat mechanics found that individuals with different scores on the FMS deep squat had mechanical differences when performing the test.[33] This information can assist in developing specific interventions to improve the deep squat score.

DISCUSSION

The majority of the research found in the literature review focused on movement assessments identifying healthy/injury-free individuals who were at risk for sustaining an injury during the competitive season.[22,23,25-28,30] This ability to use movement assessments, specifically the FMS and YBT, to identify individuals at risk for injury supports that altered movement patterns, motor control and proprioception are risk factors for injury. Research shows that individuals with PFPS have impaired proprioception compared to healthy controls and Bennell et al demonstrated that this impaired proprioception might not be caused by PFPS but actually be a risk factor for the development of PFPS.[15-17] The FMS and YBT have the potential to identify this impaired proprioception and dysfunctional movement patterns that could lead to PFPS. This particular patient demonstrated a dysfunctional squat pattern and pain with a participation restriction of inability to play football.

Applying this research to the specific sport of football, the FMS and YBT have been supported in the literature to identify professional and collegiate football players at risk for sustaining a lower extremity injury. Kiesel et al[23] found that professional football players with an FMS score of 14 or less had an 11-fold increased chance of suffering a time loss injury during the season.[23] Also any asymmetry identified during testing regardless of FMS total score resulted in a 2.3 increase in injury risk.[24] Butler et al[27] found that collegiate football players with an YBT composite score less than 89.6% were 3.5

times more likely to sustain a non-contact lower extremity injury. Lastly, using an injury risk algorithm, which included the FMS & YBT, Lehr et al was able to classify collegiate athletes (including football players) into low and high risk categories, and found high risk athletes were 3.4 times more likely to sustain an injury.[30] This specific patient was a high school senior defensive end with aspirations to play collegiate football. The patient was only assessed with the FMS deep squat and YBT anterior reach, so an FMS total score and YBT composite score were not obtained. However, the patient demonstrated asymmetries during the deep squat, indicating 2.3 times greater risk for injury, and asymmetrical reach difference on the YBT. Research in high school basketball players found that anterior reach difference of >4 cm indicated 2.5 times increase in injury risk.[28] The FMS and YBT have been accurate in identify injury risk in football players. The question to be considered is if dysfunctional movement patterns were a contributing factor to the patient's current condition. Our working hypothesis is movement dysfunction could be a factor contributing to his pathology.

A thorough examination that includes movement assessment specifically in this case can have prognostic benefits as well. Using the FMS scoring criteria, the current patient scored a 2 on the deep squat. This information has prognostic benefits as Kiesel et al[31] found that a player's inability to improve their FMS score above the injury threshold of 14 was correlated to Deep Squat scores. Players with a Deep Squat score of 1 were found to be 5 times more likely to fail to improve their FMS score with interventions.[31] The researchers hypothesized that the deep squat had predictive power because it incorporated the entire kinematic chain and that failure to score greater than a 1 may indicate significant movement dysfunction. Relating back to the current patient, his deep squat score of 2 would indicate a good prognosis to improve and correct his dysfunctional movement patterns and decrease his risk for further injury. The prognostic information can be take a step further as the FMS has been correlated to longitudinal performance changes in elite track and field athletes.[32] It was found that individual athletes with FMS scores <14, presence of bilateral asymmetry or deep squat score less than 3 had smaller improvements in longitudinal performance.[32] This information directly applies to the current patient as he demonstrated a bilateral asymmetry and a FMS Deep Squat score of 2. The presence of these movement deficits will potentially affect the patient's ability to improve his on-field performance, which will be critical when transitioning from high school to college football.

In addition to the prognostic benefit that it can yield to the clinician, the information gained from movement assessment can drive interventions aimed at movement correction. Kiesel et al demonstrated in a group of professional American football players that an intervention program aimed at correcting the identified movement deficit resulted in an average increase of 11% on the FMS total score.[31] This shows that identifying and prescribing interventions to address the movement deficits can improve the movement pattern and decrease the patient's risk for injury.

Using movement assessment allows the clinician to identify the dysfunctional movement pattern and then break down the movement pattern to identify the most meaningful impairments in terms of mobility and stability deficits. This specific patient demonstrated a dysfunctional squat pattern; with bilateral valgus collapse, heels coming off the floor and pain. The YBT also revealed decreased anterior reach distance on the right side compared to left, valgus collapse, and pain. Two regions that significantly contribute to the squat pattern and YBT anterior reach are the hip and ankle. Specifically at the ankle, Butler et al demonstrated that the major mechanical difference between a deep squat score of 3 and 2 is peak dorsiflexion excursion, with a score of 3 requiring greater peak dorsiflexion.[7] Also the YBT anterior reach has been correlated to closed chain ankle dorsiflexion mobility.[34] During the deep squat and YBT, in order to gain additional motion our patient compensated for his limited ankle dorsiflexion mobility with excessive subtalar joint pronation that is coupled with tibial internal rotation resulting in valgus collapse of the knee, which is consistent with the findings of Macrum and colleagues.[35] Moving up to the hip, Powers has demonstrated valgus collapse of the knee is caused by increased femoral adduction and internal rotation.[2,3] For our patient, hip manual muscle testing revealed decreased gluteus medius and maximus stability, which during squatting resulted in decreased eccentric hip control and increased femoral adduction and internal rotation causing valgus collapse of the knee, which has been shown in research by Souza and Powers.[13] Proper efficient performance of the FMS deep squat and YBT anterior reach requires sufficient ankle dorsiflexion mobility and gluteal stability.

Based on the findings of the movement assessment, isolated impairment-based testing followed to rule in or out key impairments in terms of mobility and stability. Specifically, for this patient, impairment-based mobility testing revealed ankle dorsiflexion ROM restriction, talocrural joint hypomobility, and triceps surae tightness. Impairment based stability testing revealed gluteus medius and maximus manual muscle testing grade of 3-/5. The gluteal weakness led to the assessment of hip flexor flexibility revealing bilateral positive Thomas tests. Janda's Lower Crossed Syndrome shows that muscle imbalances around the hip can alter static and dynamic function. The syndrome promotes an anterior pelvic tilt, another characteristic of the current patient, and hip flexor tightness, causing reciprocal inhibition of the gluteal musculature weakness. Based on the movement assessment findings, a plan of care was developed to address the most meaningful impairments that drive the patient's valgus collapse and movement dysfunction.

The patient's first treatment session consisted of Thomas stretch to lengthen the hip flexors followed immediately by single leg bridging to increase gluteus medius and maximus activation and strength. Treatment also included talocrural joint posterior glides and self-stretching to the gastrocnemius and soleus muscles bilaterally to increase dorsiflexion mobility. Reactive Neuromuscular Training (RNT) corrective squatting was then performed with heels elevated in an attempt to correct the patient's bilateral valgus collapse and right weight shift. With heels elevated, the patient was able to reach parallel but continued to demonstrate a right weight shift and experienced pain. When applying the RNT bands the patient squatted symmetrically with decreased valgus collapse and no reports of pain. The movement assessment allowed the clinician to appreciate the regional interdependence applications of the lower extremity, breakdown the dysfunctional pattern to reveal the underlying meaningful impairments and assisted in identifying the best interventions to improve the patient's movement pattern.

Figure 2 creates a clinical reasoning framework that helps identify both the proximal stability and distal mobility impairments as it applies to the PFPS case.

There are limitations in applying the literature directly to the current patient case. The FMS and YBT are primarily used to identify healthy individuals who are at risk for sustaining an injury. The YBT has been assessed

in populations with chronic ankle instability, anterior cruciate ligament-deficiency, and PFPS; and has been shown to be able to differentiate between the injured patients and healthy controls but has not been shown to diagnosis specific conditions.[28,29] Unlike the YBT, the FMS has not been assessed in a population of individuals with pain or current injuries, so caution must be taken when applying the FMS research to the current patient case due to the presence of pain and injury. Further research is needed in a movement assessment that discriminates painful versus non-painful fundamental movement patterns.

CONCLUSION

Patellofemoral Pain Syndrome is a common musculoskeletal condition facing today's clinician. The challenge for clinicians within the current health care environment stem from the fact PFPS is a multifactorial issue with no definitive diagnostic criteria, and limited clinical utility of impairment based clinical tests have provided minimal information that can assist the clinician in managing patients with this condition. Movement assessments are potential alternatives from isolated impairment-based tests that can enhance clinical reasoning by capturing regional interdependence implications. Movement assessments have been shown to be reliable in identifying individuals at risk for injury, but can also identify movement deficits that can be used to guide interventions in order to improve movement patterns and decrease risk for injury. Two established movement assessments tools, the FMS and YTB, can provide clinicians with valuable information regarding injury risk, prognosis and intervention selection for patients with PFPS.

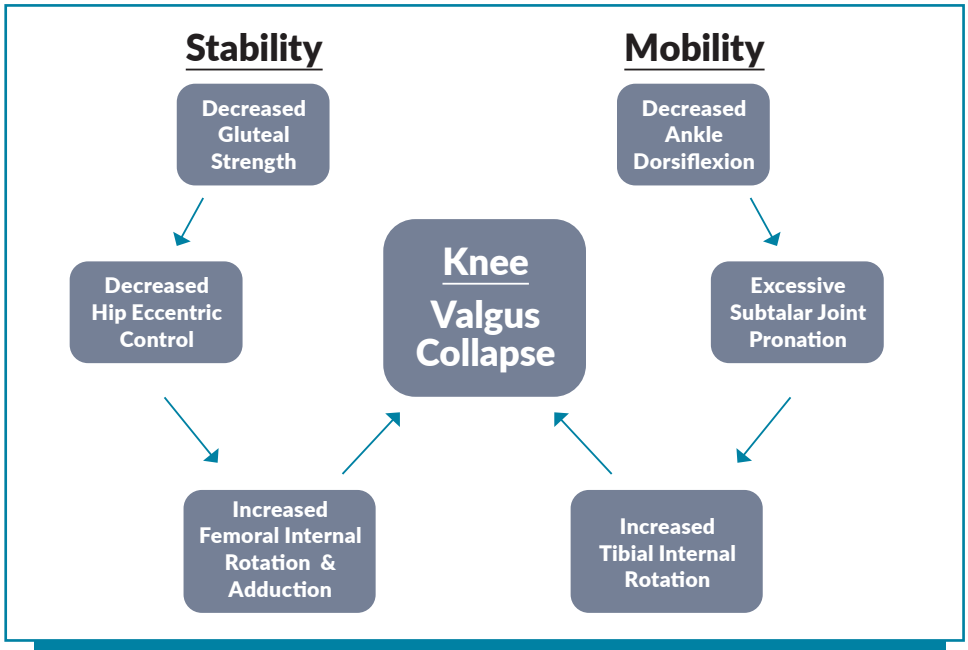

Figure 2. Regional interdependence application of Patellofemoral Pain Syndrome.

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A Proposed Modification to the Ankle Dorsiflexion Lunge Measure in Weight Bearing: Clinical Application with Reliability and Validity

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ABSTRACT

The weight-bearing lunge test (WBLT) is a common approach to measure ankle dorsiflexion motion. Because this approach requires multiple repositioning of the foot, when measured with a tape measure, a modified approach is proposed. In this approach the foot position is such that no repositioning is needed. **Purpose:** To determine the reliability and validity of a modified WBLT (mWBLT) to measure ankle weight-bearing motion. **Methods:** Healthy adult subjects were measured using the WBLT and the mWBLT. In addition, the subjects' ankle joint position was measured with a standard goniometer. Intra-class correlation coefficient, standard error of the measure, and validity correlations were tested. **Results:** The mWBLT yielded strong intra-rater reliability and test re-test reliability (ICC > 0.90) with low measurement error and sufficient correlation to the goniometer (r > 0.60), all comparable to the standard WBLT. **Conclusion:** The mWBPT provides reliable data and a valid measure of ankle motion, in weight bearing, while also being more efficient than the standard WBLT.

Key Words: dorsiflexion, functional, lower extremity

INTRODUCTION

Incorporating standardized, objective measures into clinical practice is important for all health care practitioners as a principal of evidenced-based practice and to demonstrate patient success. Ankle dorsiflexion is a key lower extremity objective measurement often altered through injury or surgical intervention that can have great impact on lower extremity functional tasks. While ankle dorsiflexion can be measured in a non-weight-bearing extremity using a goniometer, nonweight-bearing measures have had variable, even poor, inter- and intra-rater reliability, with intraclass correlation coefficient (ICC) values falling as low as 0.29 for inter-rater reliability.[1-3] Weight-bearing methods of measurement have demonstrated higher levels of reliability, with lower end ICC values of 0.90.1,[4,5] Additionally, the weight-bearing aspect of this method more directly informs the clinician of a patient's ability to perform lower extremity functional tasks.

Bennel et al[1] first described the weight-bearing lunge test (WBLT) wherein ankle dorsiflexion motion is measured based on movement of the tibia, over the fixed foot, toward a wall. It is measured with the great toe and the center of the calcaneus along a tape measure positioned along the floor. This position is monitored by the therapist throughout the duration of the lunge to ensure the calcaneus maintains contact with the ground. The patient lunges forward until the knee touches a vertical line placed on the wall. A trial is considered successful if the patient can achieve contact with the wall while maintaining proper foot alignment. The measurement recorded is the distance from the great toe and the wall measured in millimeters. The foot is then moved backwards and repositioned up to 5 times until maximum dorsiflexion is achieved. In the original version of the test, the entire series is repeated 3 times and the mean distance was recorded.

In an alteration of the original test protocol presented by Chisolm et al,[4] a single series trial was compared to the previous multiple 3 series and found to be equally reliable and valid. The authors proposed the change from a 3 series trial to a single series trial in an effort to streamline the exam and reduce the overall time of completion to make the test more appealing and user friendly for the busy clinician. However, both versions of the weight-bearing lunge test still require multiple repositions of the foot, adding time and difficulty to the test administration.

This current study looked at a modification to the traditionally proposed WBLT in which no foot reposition is necessary. The test position is similar to the original, with the great toe and midline of the calcaneus positioned along a fixed tape. However, rather than initiating the exam with the foot close to the wall and progressively repositioning and moving the foot backwards, the test is initiated with a fixed starting position of the foot 35 cm from the wall. This distance was determined based on prior testing of individuals; it was determined that 35 cm sufficiently prevented any individual from making knee contact with the wall while squatting. This foot location allowed full ankle dorsiflexion for all subjects. The total lunge distance is then recorded as the distance of the knee to wall rather than the great toe to wall. While detailed procedures for the test will be discussed in the methods section of this paper, the authors feel this simple alteration to the standard WBLT, both maintains the reliability of the test while improving the ability for the test to be administered in the clinical setting. The authors hope this will be the first step to exploring the modification of this important clinical tool.

Purpose

To estimate the test re-test reliability of the modified weight-bearing lunge test (mWBLT) for the measurement of weight-bearing ankle dorsiflexion, provide the standard error of the measure, and to establish criterion validity evidence based on goniometric measurement of ankle dorsiflexion.

METHODS

Subjects

Healthy adult subjects from the University campus participated in this study with 21 males (mean age = 28.19 yrs + 6.19, height = 1.76 m + 0.06, weight = 79.59 kg + 13.24) and 20 females (mean age = 27.25 yrs + 7.07, height = 1.61 m + 0.07, weight = 64.99 kg + 12.63),

for a total of 41 subjects. All subjects signed an informed consent document and this study was approved by the West Coast University's Institutional Review Board for the oversight of ethical treatment of human subjects.

Apparatus and Procedures

A standard long arm goniometer and cloth tape measure were used to acquire the distance and angular data for the ankle range of motion positions. The individuals acquiring the data consisted of trained Doctor of Physical Therapy graduate students, who were blinded to the measures obtained from each other.

Each subject was measured 2 times, in each of the 2 weight-bearing conditions, the standard lunge test and the modified lunge test (Figure 1), for a total of 4 trials. Ankle joint dorsiflexion angle was measured using a standard goniometer, consistent with the technique and criterion of Norkin and White.[6] During the WBLT, the distance from the foot (great toe) to the wall was measured with the cloth tape measure, as described by Bennell et al.[1] The foot location, relative to the wall, was re-positioned accordingly until the knee flexion produced full ankle dorsiflexion with minimal contact of the knee to the wall.

In the mWBLT, all measurements occurred with the foot prepositioned exactly 35 cm from the wall, as measured from the great toe to the wall. This distance assured that all individuals could complete maximum weight-bearing dorsiflexion without the wall impeding the movement of the knee into flexion. The cloth tape measure was then used to measure the distance of the anterior knee (patella) to the wall, while maintaining the tape measure horizontal to the floor.

This study used 2 different measurers for each measurement obtained. One individual was responsible for all goniometric measures, one person was responsible for all foot to wall measurements (standard weight-bearing lunge) and for all knee to wall measurements (modified weight-bearing lunge).

Data Analyses

All measurement data (ie, tape measure values, goniometric values) were tested to determine compliance with normalcy. To estimate test retest reliability, the ICC was applied based on Model 2. The standard error of the measures (SEM) was calculated using the unbiased estimate approach based on the square root of the mean square error from the repeated measures analysis of variance table. From the SEM, minimal detectable change (MDC) at 95% confidence were also calculated (MDC_{95}). Coefficient of variance (CV) were determined for both methods of the lunge test in order to draw appropriate comparisons between the WBLT and the mWBLT. The CV is typically reported as a ratio of the standard deviation with the mean of the measures (CVm); we also estimated the CV based on the ratio of the standard deviation with the range of the measures (CVr). The use of the range was included to minimize the bias created by different means with similar ranges. The means approach creates a bias that favors the modified technique. Finally, the tape measure values were correlated with the goniometric measures of ankle dorsiflexion to establish basic criterion validity evidence.

RESULTS

The average tape measure distance of the toe to the wall, in the WBLT, was 10.54 cm (sd = 3.11); the average tape measure distance of the knee to the wall, in the mWBLT, was 25.66 cm (sd = 3.01). The average goniometric ankle joint position, in either position, was 30.39° (sd = 8.14). Both measures produced correlations with the goniometer of -0.67 and -0.61, respectively for the standard and modified techniques. Table 1 provides the results of the reliability study, including the ICC (with CI95), the SEM, MDC_{95}, the CVm, and the CVr.

DISCUSSION

The average measurement distance, reliability, and standard error for the WBLT in our study compared similarly with the values obtained by Konor et al,[3] Chisholm et al,[4] and by Bennell et al.[1] Our mean toe-to-wall distance was measured at 10.54 cm, which compares with 9.5 cm for Konor et al, Chisholm et al at 8.9-9.1 cm, and Bennell et al at 13.6-13.9 cm. The test retest reliability, as measured with the ICC all exceeded 0.90 for these studies. In addition, the SEM was 0.40 – 0.60, 0.47, 0.40, and 0.63 cm respectively for Konor et al,[3] Chisholm et al,[4] Bennell et al,[1] and our study.

The mWBLT approach yielded similar reliability estimates when compared with those values obtained using the standard lunge approach, with ICCs that also exceeded 0.90 from a test retest perspective. The SEM for the mWBLT (0.70cm) was comparable to the SEM for the WBLT approach and yielded a lower CV (0.12 for the mWBLT and 0.29 for the WBLT), when expressed as a ratio of the mean. However, when expressing the standard deviation relative to the range for both techniques, the CV is similar (0.21 for both).

In order to explore validity of the mWBLT a comparison of these linear measures with ankle angular position was similar to the method by Bennell et al[1] and Hall and Docherty.[5] While our correlations (-0.67 and -0.60 for the traditional and modified techniques respectively) are lower than Bennell et al, who reported values of 0.93-0.96, our correlations are comparable to those obtained by Hall and Docherty (r = 0.74). The authors feel that this relationship is sufficient to provide early validity evidence. In addition, the current study used a larger sample (n = 42), similar to Hall and Docherty (n = 50), in comparison to Bennell et al (n = 13).

The WBLT has been shown to be strongly associated with measures of functional performance, balance, and injury risk.[7-9] For

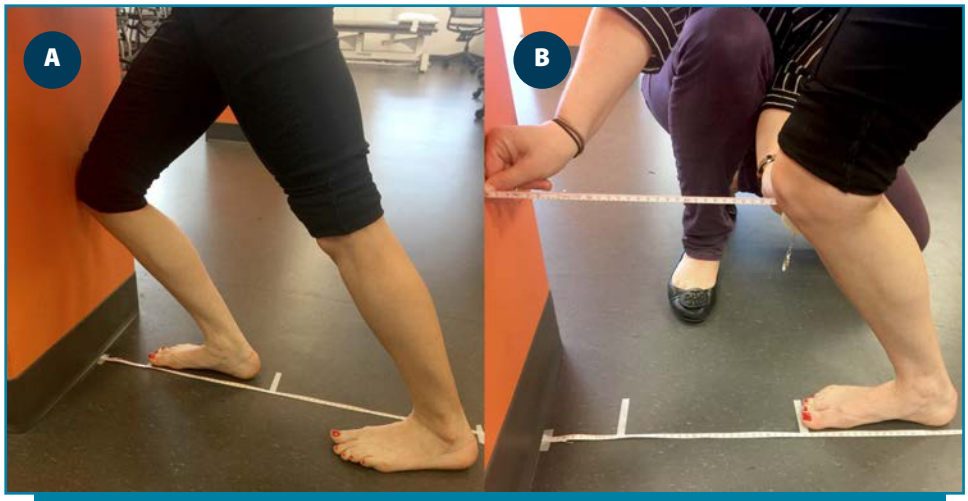

Figure 1. The standard lunge test. A, The foot is required to be adjusted based on knee contact with the wall. B, The modified technique in which the foot is positioned at a fixed 35 cm from the wall.

Table 1. Reliability Study Results

Lunge Technique	ICC (CI95)	SEM	MDC_{95}	CVm	CVr
WBLT	0.95 (0.92, 0.98)	0.63	1.75	0.29	0.21
mWBLT	0.95 (0.91, 0.97)	0.70	1.95	0.12	0.21

Abbreviations: ICC, intraclass correlation coefficients with 95% confidence intervals; SEM, standard error of the measures; MDC, 95% minimal detectable change; CVm, coefficient of variation from the mean; CVr, coefficient of variation from the range; WBLT, weight-bearing lunge test; mWBLT, modified weight-bearing lunge test

instance, a study by Hoch et al[7] found a significant correlation between landing kinematics and ankle dorsiflexion as measured in weight bearing. Further, in studies by Hoch et al[8] and Kang et al[9] ankle dorsiflexion measured in weight bearing was strongly correlated with standing balance and lunge ability in healthy and injured adults. Finally, a study by Burns et al[10] found significant differences in the range of motion measured at the ankle, in the weight-bearing position, when comparing individuals with distinct foot types. Namely, pes planus feet and normal feet demonstrated greater range compared with pes cavus feet. These strong associations provide support for the use of a WBLT to measure ankle range of motion, regardless of using the standard approach or this proposed modified approach.

The findings from this study suggest that the mWBLT, in which the foot is pre-positioned a sufficient distance from the wall to eliminate the need for repositioning, provides a reliable of data and minimal error, when compared with the traditional WBLT. The elimination of needing to reposition the foot improves the time efficiency of the mWBLT. This approach has been applied in previous studies in which a goniometer alone is the measurement tool of choice, rather than the tape measure approach, however the reliability had not been established.[7-9] The results of the current study demonstrate that reliable measures can be obtained with this mWBLT using either the tape measure or the goniometer, depending on the clinician's preference. In either case, the mWBLT is likely more time efficient requiring only one set position for measurement, compared with the traditional WBLT.

An obvious limitation to this study is the involvement of only healthy adults. This study requires replication with individuals with ankle range of motion issues and/or knee related issues. In addition, it will be helpful to provide additional validity evidence in terms of patient reported outcome measures. Further, this study used a convenience sample, which allows for bias in subject selection. Repeating this study by drawing from the clinical community will improve the external validity of this study. Finally, this study only tested the utility of linear measures (ie, tape measure distance), whereas others have included inclinometers and tiltmeters as a part of the measurement process during the lunge.[4] Future research can determine the reliability of these tools while performing the mWBLT.

CONCLUSION

Given the efficiency of the modified technique, compared with the standard lunge technique, in terms of eliminating the need for repeated repositioning of the foot, this study provides early evidence of the reliability and validity of the modified lunge technique as an alternative to the standard lunge technique for measuring linear based ankle dorsiflexion motion. Clinicians may find that the mWBLT is more time efficient, and potentially less prone to variability, compared with the traditional WBLT. The mWBLT allows the ability to complete a trial without repositioning the foot, which may provide clinicians with an approach that is less challenging for the patient, when determining ankle lunge mobility, compared with approaches that require the potential for numerous repositioning of the foot in order to achieve a single measure.

KEY POINTS

FINDINGS: The mWBLT provides comparable test retest reliability and sufficient validity evidence as a measure of ankle motion during the weight-bearing lunge motion. Beginning from a fixed distance from the wall, sufficient to allow full lunge, minimizes the need to frequently reposition the foot as required by the WBLT.

IMPLICATIONS: Clinicians may feel safe to use the mWBLT in place of the tradition WBLT when measuring ankle motion in weight bearing. The SEM for both is low, allowing for sufficient determination of change over time.

CAUTION: These data are based on healthy adult subjects. The mWBLT requires repeated testing with patients presenting with conditions affecting the knee or ankle.

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Effects of Manual Lymphatic Drainage Techniques on Conditions Affecting the Musculoskeletal System: A Systematic Review

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ABSTRACT

Background: Manual lymphatic drainage techniques (MLdT) have received interest for their efficacy in orthopedic rehabilitation and sports medicine. Strength of the body of evidence for using MLdT on conditions affecting the musculoskeletal system is not established. **Purpose:** To determine whether MLdT in addition to conventional rehabilitation interventions on conditions affecting the musculoskeletal system can decrease edema and improve ROM, patient-reported outcomes, and health care use. **Methods:** Studies published between 2007 and 2018, with similar outcome measurements, were grouped for analysis. Strength of the body of evidence was determined by using the Cochrane GRADE guidelines, and the American College of Chest Physicians guidelines. **Findings:** There is moderate support for the use of MLdT for conditions affecting the musculoskeletal system as effective interventions to reduce pain, and improve patient-reported outcomes pertaining to functional activities and quality of life (QOL). Manual lymphatic drainage techniques are moderately effective treatment methods associated with lower health care use, edema reduction, and improving ROM. **Conclusions:** Moderate evidence was observed supporting the efficacy of MLdT in combination with conventional rehabilitation interventions for the treatment of conditions affecting the musculoskeletal system. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and to determine which interventions concurrent with MLdT produce best outcomes.

INTRODUCTION

Inflammatory responses secondary to orthopedic disorders involve the lymphatic system with clinical presentations including non-infectious lymphangitis, lymphangiospasms, and lymphadenitis.[1] Subsequently, an altered cellular environment may lead to the proliferation of hyaluronan, fibrinogen, and irregular collagen that advance fibrosis and scar tissue.[2,3] Unmanaged edema promotes less favorable states of repaired tissue that is prone to subsequent injury, or is less functional than the uninjured tissue state.[2] Therapists in orthopedic practice are routinely required to select edema management interventions, which requires sound clinical reasoning.

Many modalities have been used within the rehabilitation field to address edema and pain resulting from orthopedic disorders, including but not limited to ice, elevation, compression, electrical stimulation, ultrasound, and massage.[4-10] The effectiveness of these modalities in reducing edema remains inconclusive. Additionally, their physiologic effect on the lymphatic system have not been fully explicated.[5,6,9,11] Manual lymphatic drainage techniques can decrease edema and are 1 of the 4 components of complete decongestive therapy, which is considered the "gold standard" treatment for lymphedema.[12-14] Manual lymphatic drainage techniques are gentle and rhythmic soft tissue techniques that stimulate the lymphatic structures without promoting erythema or inflammation[1,15,16] while supporting the absorption of excess fluid, protein, and waste products. The abolishment of an inflammatory reaction and associated edema is not expected from manual lymphatic draining techniques (MLdT) because this requires multifaceted treatment interventions. Although preliminary studies provide evidence to the effects of MLdT,[15-17] the mechanism for these effects are still under investigation. From a physiological perspective, the gentle pressure and stretching components of MLdT stimulate the intrinsic and extrinsic lymph pumps, which increases lymph velocity via the contraction of smooth muscles within the lymph collector vessel.[18] Manual lymphatic drainage techniques have demonstrated an effect on improving the contractility of the lymphatics as visualized by indocyanine green, near-infrared fluorescence imaging.[19]

In addition to edema reduction, MLdT are recognized for decreasing pain by stimulating a general parasympathetic response for the patient, resulting in general relaxation.[17,20,21] The absorption of nociceptive chemical stimulants, such as lactic acid, cytokines, and inflammatory mediators, from the interstitial environment as a result of MLdT may have an analgesic effect.[1,22,23] The rhythmic, intermittent, and gentle pressures of MLdT stimulate the large diameter, non-nociceptive nerve fibers and decrease pain.[24]

Manual lymphatic drainage techniques have received interest in orthopedic rehabilitation and sports medicine.[25,26] A 2009 systematic review concluded that manual lymphatic drainage techniques were effective when combined with conventional musculoskeletal therapies, in sports medicine and rehabilitation. The authors concluded that MLdT are particularly useful in reducing edema and enzyme serum levels associated with acute skeletal muscle cell damage.[26] Another review also confirmed the effectiveness of MLdT for patients with musculoskeletal edema in orthopedic injuries.[25] Although these previous reviews have provided some evidence of the benefits of MLdT pertaining to reducing musculoskeletal edema from acute orthopedic and sports-related injuries; the body of evidence on the effects of MLdT on range of motion (ROM), patient-reported outcomes pertaining to pain, functional activities and quality of life (QOL), and health care use have yet to be explored.

OBJECTIVES

The primary objective of this systematic review was to examine if the addition of MLdT to conventional rehabilitation interventions in people with conditions affecting the musculoskeletal system were effective in decreasing edema, and improving ROM and patient-reported outcomes. A secondary objective was to examine outcomes specifically related to edema, pain, ROM, func-

tional outcomes, QOL, and health care use between interventions with and without MLdT.

SEARCH STRATEGY

This systematic review used the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) format.[27] An extensive literature probe was conducted from 09/07/17 through 04/07/18 using the following electronic databases: PEDro (via University of Sydney), CINAHL (via EBSCO), PubMed (via U.S. National Library of Medicine), Cochrane Library (via Wiley Online Library), Scopus (via Elsevier), Physical Therapy & Sports Medicine Collection (via GALE CENGAGE Learning), and Google Scholar. Key search terms included *lymph, lymphatic, mobilization, drainage, manual, orthopedic, musculoskeletal, edema, oedema, knee, foot, ankle, hip, back, neck, shoulder, elbow, wrist, and hand*. Filters included *[NOT] lymphedema, [NOT] cancer, human subjects, clinical trials, case reports, retracted publications, and controlled trials*. Examples of key word combinations are outlined in Appendix 1.

ELIGIBILITY CRITERIA

Screening of titles and abstracts were conducted by the principal investigator and co-investigator, using study selection-criterions, designed by the authors for guidance. Occasions in which there were discrepancies, a third reviewer also completed the screening for inclusion. Criteria for initial inclusion included those articles written in English, with a publication date range of 01/01/2007 through 05/15/2018. Due to a dearth of peer-reviewed journal articles on MLdT and conditions affecting the musculoskeletal system, the primary search included randomized trials, non-randomized controlled cohort studies, case-series, and case-control studies. The population of interest were human subjects aged 5 years or older with a confirmed condition affecting the musculoskeletal system, not limited to a specific body region. The working definition for conditions affecting the musculoskeletal system was a result of searching for inclusionary terms under this broad heading.[28-31] Inclusionary terms for conditions affecting the musculoskeletal system are listed in Appendix 1. These broadly-based definitions, enabled searching for relevant literature to expand multiple methods of MLdT, as well as, multiple conditions that are commonly seen within orthopedic rehabilitation practices.

The intervention inclusion criteria included, manual interventions from frequently reported MLdT, including Vodder technique, manual lymph drainage, Chikly technique, lymph drainage therapy, Artzberger technique, manual edema mobilization (MEM), or Leduc technique.[32-36] Techniques that stimulated the lymphatics from a light touch, rhythmic, skin tractioning method, not directly associated with a specific tenet, were also included in the study selection. Manual lumphatic draining techniques may have been used as a stand-alone treatment or concomitant with other modalities, other than those in the exclusion criteria.

Studies that were anecdotal, descriptive, expert opinions, or qualitative designs were excluded. Conditions, such as cancer, lymphedema, lympho-lipedema, and chronic venous insufficiency were excluded.

DATA EXTRACTION

Data extraction from the included studies was conducted independently by the principal investigator and the co-investigator, using a template adapted from the Cochrane Handbook for Systematic Reviews of Intervention – A.6.1 characteristics of included studies for systematic reviews.[37] Discrepancies were resolved with a third reviewer. The characteristics of interest included the authors, level of evidence, validity scale, participants, conditions affecting the musculoskeletal system, aims of the study, intervention group, control group, outcomes, key findings, and conclusions. The information on other conventional interventions were added to the characteristics template. The level of evidence was determined using the 2011 Oxford Centre for Evidence-based Medicine (OCEBM).[38] The PEDro scale, was used to determine the internal validity of the randomized controlled trial (RCT) studies.[39-41] The PEDro scale operational criteria are outlined in Appendix 2. The PEDro scores for each study were given individually by the authors, and discrepancies resolved by a third author. Upon scores finalization, studies were given a descriptive terminology quality rating, ranging from poor to excellent as previously developed by Foley et al.[42] The studies were grouped, based on similar outcomes data, for the synthesis of the body of evidence. The strength and quality of the body of evidence was determined by using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) guidelines.[43-46] Using GRADE methodology levels of evidence (Appendix 3), outcomes from the studies were assessed based on their limitations, heterogeneity, directness, and publication bias. Using operational definitions and guidelines from the American College of Chest Physicians (ACCP)[46,47] the level of evidence was further evaluated (Appendix 4).

RESULTS

The initial literature search resulted in retrieving 112 published articles. Duplicates were removed. Screening of the remaining 97 articles based on the title and abstract, resulted in the removal of 82 articles. A total of 15 articles met the inclusion criteria and were included for a full text review. A total of 5 articles[24,48-51] met eligibility criteria, and were included in the analyses (Figure 1). The kappa value for interrater agreement for manuscript selection was considered substantial[52] at 0.77.

Various tenets of MLdT were described in the literature, as well as various outcomes and their measures. All studies included in the analyses had RCT research design. Inadequate blinding of subjects, and of intervention therapists were noted in all the studies, as well as a lack of intention-to-treat analysis. Four out of 5 studies had a "good" rating of methodological quality (internal validity) according to the PEDro scale (Table 1), and categorical ratings.[42] The kappa value of 0.70 for interrater agreement for PEDro scores was considered substantial.[52] A low scoring RCT study[50] was included, as it offered information pertaining to the auxiliary intervention of compression.

Three of the included studies focused on the effects of MLdT in acute orthopedic disorders, specifically postoperative knee arthroplasty and transtibial amputation.[48,50,51] The study by Knygsand-Roenhoej and Maribo focused on subacute edema resulting from distal radius fracture.[49] The remaining study focused on the effect of MLdT in a chronic condition.[24] Homogeneous outcomes of the studies included edema, ROM, patient-reported outcomes on pain, function, and QOL, and health care use. A summary of the key findings is presented in Table 2, and a summary of qualitative assessments is shown in Table 3.

BENEFITS OF MLDT ON EDEMA

Various edema measurement methods were employed in the studies, including volumeter, bioimpedance, and circumferential measurements. Minimal clinically important difference (MCID) of edema measurements in breast cancer related lymphedema patients have been analyzed. In this population, MCID values for circumferential measurement range from 0.37 to 0.71 centimeter,

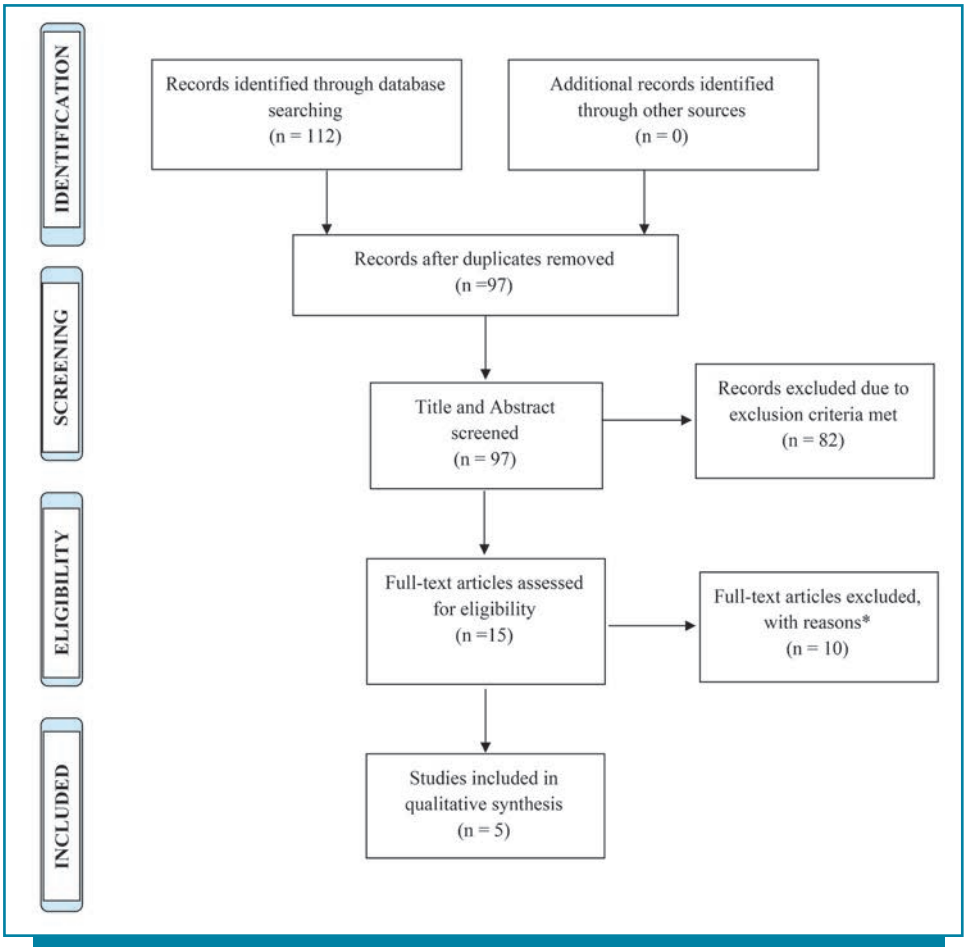

Figure 1. PRISMA flow diagram. *One study was a protocol with embedded MLdT text. One study was dismissed due to its case series design. Three studies focused on the physiological effects of MLdT not related to an orthopedic disorder. One study had English abstract but foreign manuscript. Two studies did not align with conditions affecting the musculoskeletal system definition.

and percent volume change range from 1.5% to 3.5%.[53] The MCID values have not been established for edema in conditions affecting the musculoskeletal system. Pichonnaz et al[51] and Ebert et al[48] reported a lack of significant changes in edema following MLdT. An increase in edema from the second to the seventh day during the MLdT treatment period has been reported.[51] Edema increased by 1.9% in the group receiving 30 minutes of MLdT in addition to conventional treatment, compared to 4.1% in the control group receiving 30 minutes of relaxation training in addition to conventional treatment.[51] Topuz et al found statistically significant reduction ($p < 0.05$) in circumferential measurements in patients who received complete decongestive physiotherapy (CDP).[50] In their study, multilayer short-stretch compression therapy was used in addition to MLdT.[50] In comparison with traditional edema management (TEM) techniques (ie, elevation, compression, and functional training), non-statistically significant reduction in edema following 3 ($p = 0.31$) and 6 weeks ($p = 0.31$) of MLdT was reported.[49] However, edema reduction was achieved with significantly fewer edema treatment sessions ($p = 0.03$) with MLdT (14.1 sessions) compared to TEM techniques (19.2 sessions).[49] In summary, studies providing MLdT alone or adding MLdT to a conventional treatment protocol have demonstrated effectiveness in reducing edema.

BENEFITS OF MLDT ON RANGE OF MOTION

Both MLdT and TEM improved active ROM ($p < 0.01$) for thumb opposition and fingertip to palm distance, but the difference between groups was not significant at 6 weeks ($p = 0.32$) and 9 weeks ($p = 0.23$) follow-up.[49] Studies of patients with TKA have demonstrated improvements in ROM following MLdT.[48,51] In the study by Ebert et al,[48] a significant increase in knee flexion active ROM was observed in the group receiving MLdT ($p = 0.031$) compared to controls who did not receive MLdT. Similarly, Pichonnaz et al found that knee flexion contracture was more than 2° less prevalent in the MLdT group compared to the control group at 3 months post TKA, although the difference between groups did not reach statistical significance ($p = 0.07$).[51] In summary, 3 out of 7 included studies measured ROM and all reported significant improvements in ROM with adding MLdT to the treatment.

BENEFITS OF MLDT ON PATIENT-REPORTED OUTCOMES

Pain

In the studies included for the review, pain was measured using a standard Visual

Table 1. Characteristics of the 7 Included Studies

Author	Level of Evidence (OCEBM)	Experimental Design	Internal Validity Scale (PEDro)	Rating*
Knygsand-Roenhoej K et al (2011)	2	RCT	6/10	Good
Pichonnaz C et al (2011)	2	RCT	7/10	Good
Ebert D et al (2013)	2	RCT	7/10	Good
Ekici G et al (2009)	2	RCT	7/10	Good
Topuz S et al (2012)	2	RCT	4/10	Fair

Abbreviations: OCEBM, Oxford Centre of Evidence Based Medicine; RCT, Randomized Clinical Trial; PEDro, Physiotherapy Evidence Database
**Excellent = 9-10, Good = 6-8, Fair = 4-5, Poor = below 4*[40]

Table 2. Summary of Key Findings

Author	Participants	Intervention	Conventional Interventions
Knygsand-Roenhoej et al (2011)	29 patients, 72% females with average age 64, 5-8 weeks after unilateral distal radius fracture, treated with plaster cast, internal or external fixation, and with a diagnosis of subacute edema.	n = 14; 3x/wk for 4 weeks and then 2x/wk for 2 weeks consisting of Modified MEM, HEP, low stretch bandage if needed, Isotoner glove daily.	Therapy for ROM and strengthening, HEP.
Pichonnaz et al (2016)	56 patients diagnosed status post TKA, 65% women with a mean age of 71.	n = 29; 5 thirty minutes sessions of MLD (Strossenreuther method) per working day from 2nd day to 7th day postoperatively.	Postoperative hospital-based rehabilitation protocol = ROM, strengthening, CPM, gait training, and cryotherapy.
Ebert et al (2013)	43 patients/53 knees (72% males) with a mean age of 70 years, diagnosed status post TKA.	n = 24, 30 minutes of MLD and remedial postoperative orthopedic massage techniques, on postoperative days 2, 3, and 4.	Postoperative hospital-based rehabilitation protocol = ROM, strengthening, CPM, gait training, and cryotherapy.
Ekici et al (2009)	53 women with a mean age of 38 years, diagnosed with fibromyalgia.	n = 26 females; 5x/wk for 3 weeks consisting of 45 minutes of MLD therapy.	None
Topuz et al (2012)	11 patients, mean age 67 years, diagnosed postoperative transtibial amputee.	n = 5; Received CDP and diaphragmatic breathing.	Stretching, dynamic stump exercises, isometrics, and isotonics. The CDP was instructed to conduct diaphragmatic breathing.

Author	Outcomes	Key Findings	Conclusions
Knygsand-Roenhoej et al (2011)	Measured at 1st, 3rd, 6th, 9th, and 26th week post inclusion. Edema, active ROM, pain, and ADL, number of treatment sessions.	n = 14; 3x/wk for 4 weeks and in the modified MEM group, improvement was observed in ADL after the 3 weeks measurement ($p = 0.03$). Fewer edema treatment sessions were needed ($p = 0.03$) in the modified MEM group.	Neither modified MEM treatment nor traditional edema treatment were superior to each other. Modified MEM resulted in fewer required sessions to decrease subacute edema compared to traditional methods.
Pichonnaz et al (2016)	Measured at enrollment, 2nd day, 7th day, and 3 months postoperative TKA. Truncated Cone Volumetric measures via tape, bioimpedance, VAS, Knee Society Score, Osteoarthritis Index, Gait analysis, active and passive knee ROM.	Passive knee flexion contracture at the 3 months measurement was statistically significant for being lower and less frequent in the MLD group compared to the control group. Pain level decrease on the VAS immediately after the MLD treatment was statistically significant for 80% of the MLD sessions.	MLD applied in the short-term after TKA did not reduce swelling. MLD reduced pain after the treatment session and reduced the extent of knee flexion contracture and its frequency 3 months postoperatively.
Ebert et al (2013)	Measured at enrollment, days 2, 3, 4, and 6 weeks post operatively. Active and passive knee ROM, Truncated Cone Volumetric measures via tape, VAS, and Knee Injury and Osteoarthritis Outcome Score.	Increased active knee flexion at day 4 postsurgery ($p = 0.014$, 95% CI, effect size =0.79,1.68-16.67) and at 6 weeks postoperatively ($p = 0.012$, 95% CI, effect size =0.87,2.32-16.78).	MLD applied in the short term after TKA improves active knee flexion up to 6 weeks postoperatively.
Ekici et al (2009)	Measured at baseline and at end of treatment (3 weeks). VAS, pain pressure threshold algometry, HRQoL, FIQ.	Improvements regarding pain intensity, pain pressure threshold, and HRQoL ($p < 0.05$). The MLD group improvements with the FIQ total score ($p = 0.010$). Subsets of the FIQ (morning tiredness FIQ-7 and anxiety FIQ-9) particularly demonstrated improvements ($p = 0.006$).	MLD Therapy was found to be more effective than Connective Tissue Massage according to subsets of the FIQ (morning tiredness and anxiety) and total FIQ scores.
Topuz et al (2012)	Circumferential measurements at 5 locations of the involved lower extremity, Days of hospital stay, and days to transition into permanent prosthesis.	The transition into permanent prosthesis was shorter in the CDP group ($p < 0.05$). Circumferential measurements were more obvious in the CDP group ($p < 0.05$).	CDP is effective in reducing post amputation stump edema in geriatric amputees. The reduction of edema was more obvious in the CDP group. CDP is effective in shortening the transitional period into permanent prostheses.

Abbreviations: CDP, complete decongestive physiotherapy; CPM, continuous passive motion; FIQ, Fibromyalgia Impact Questionnaire; HRQoL, health related quality of life; HEP, home exercise program; MEM, manual edema mobilization; MLD, manual lymph drainage; QOL, quality of life; ROM, range of motion; TKA, total knee arthroplasty; VAS, Visual Analog Scale

Table 3. Summary of Qualitative Assessments ◊

Outcomes	Subgroups	Author(s)	No. of Subjects	Risk of Bias
Edema	Circumferential measurements, Bioimpedance, Volumeter, Truncated Cone Volume	Ebert et al 2013; Knygsand-Roenhoej and Maribo 2011; Pichonnaz et al 2016	128	(-0)♦
Pain	Frequency, Visual Analog Scale, Numeric Scale	Ebert et al 2013; Ekici et al 2009; Knygsand-Roenhoej and Maribo 2011; Pichonnaz et al 2016	181	(-0)♦
Range of Motion	Active and/or Passive	Ebert et al 2013; Knygsand-Roenhoej and Maribo 2011; Pichonnaz et al 2016	128	(-0)♦
Quality of Life and Other Self-Reported Outcomes	Functional and Quality of Life Scales	Ebert et al 2013; Ekici et al 2009; Knygsand-Roenhoej and Maribo 2011; Pichonnaz et al 2016	181	(-0)♦
Health Care Use	Decreased supplies, treatment time, or sessions	Topuz et al 2012; Knygsand-Roenhoej and Maribo 2011	40	(-1)≡

◊ Due to limited number of events, small sample size, and studies with non-normal distribution, effect sizes were not pooled.
♦ No serious risk of bias. PEDro internal validity scale ranged 6-8, and a "good"[40] rating.
≡ Topuz et al used different compression strategies between groups, which may have influenced a type 1 error. PEDro internal validity scale is a 4/10.

Outcomes	Inconsistency	Indirectness	Publication Bias	Imprecision
Edema	(-1)♦♦	(- 0)♦♦♦	(- 0)♦♦♦♦	(- 0) ⊄
Pain	(-1)♦♦	(- 0)♦♦♦	(- 0)♦♦♦♦	(- 0)
Range of Motion	(-1)♦♦	(- 0)♦♦♦	(- 0)♦♦♦♦	(- 0)
Quality of Life and Other Self-Reported Outcomes	(-1)♦♦	(- 0)♦♦♦	(- 0)♦♦♦♦	(- 0)
Health Care Use	(-1)♦♦	(- 0)♦♦♦	(- 0)♦♦♦♦	(- 0) ⊄

◊ Due to studies with small sample sizes and studies with non-normal distribution, effect sizes were not pooled.
♦♦ Due to heterogeneity of studies and small populations resulted in inconsistent effect sizes.
♦♦♦ Conclusions of the studies directly applied to the PICO.
♦♦♦♦ Not observed and unlikely. No conflicts of interest reported.
⊄ Topuz, et al. (2012) had small number of events and moderate confidence intervals, but did not distract from the overall summary for imprecision.

Outcomes	Dose-Response Association	Residual Confounders	Large Effect	Quality of Evidence*	Quality of Evidence**
Edema	(+ 0)	(+ 0)	(+ 0) ≈	✪✪✪❍ Moderate	Moderate
Pain	(+ 0)	(+ 0)	(+ 0)	✪✪✪❍ Moderate	Moderate
Range of Motion	(+ 0)	(+ 0)	(+ 0)	✪✪✪❍ Moderate	Moderate
Quality of Life and Other Self-Reported Outcomes	(+ 0)	(+ 0)	(+ 1) ⊕	✪✪✪✪ High	Moderate
Health Care Use	(+ 0)	(+ 0)	(+ 0) ≈	✪✪❍❍ Low	Moderate

◊ Due to studies with small sample sizes and studies with non-normal distribution, effect sizes were not pooled.
≈ Topuz et al (2012) had large and/or very large effect sizes for outcomes.
⊕ Ekici et al (2009) contributed a large effect size.
*As analyzed using GRADE[41-44]
**As analyzed using American College of Chest Physicians[44-45]

Analog Scale (VAS), or a numeric pain scale. Pain scales have been analyzed for MCID with various patient populations and disorders, and therefore should be considered context-specific, and interpreted appropriately to avoid any misguidance.[54] The MCID improvements in pain, represented on a 10 cm (100 mm) Visual Analog Scale have also been noted to range widely from 8 mm to 40 mm.[54] Diagnosis may also influence the MCID; noted when comparing TKA pain levels measuring a 22.6 mm MCID;[55] whereas, in systemic sclerosis MCID was represented by 32.02 mm.[56] In this review, comparing the effect on pain levels post-distal radius fracture, during rest and activity, both MLT and TEM techniques decreased pain levels, but showed no statistically significant overall mean differences between groups (rest = 0.40, p = 0.30; activity = 0.22, p = 0.42).[49] Similarly studies in patients post-TKA did not find differences between MLdT and TEM.[48,51] Pichonnaz et al[51] noted a significant decrease in pain immediately after the application of 4 out of 5 MLdT treatment sessions, but it was not statistically significant between groups 3 months postoperative at rest (9.0 mm, p = 0.52) and during gait activities (16.7 mm, p = 0.06), and the reduction in pain did not meet or exceed the MCID for pain levels.[55] Ekici et al[24] noted significant and progressive decreases in fibromyalgia pain levels with both MLdT and massage groups, but no significant difference in pain levels between groups at the end of 5 weeks of treatment was found (p = 0.06). The improvements in pain remained stable from the first treatment till the end of the study. In summary, 4 out of 5 studies measured pain levels and all reported effectiveness in reducing pain with providing MLdT alone or adding MLdT to a conventional treatment, however, not all improvements were statistically significant in comparison to controls.

Other Self-Reported Outcomes

Various self-reported outcome measurement tools on functional activities and QOL were used across the studies. Using an investigator designed questionnaire, Knygsand-Roenhoej and Maribo[49] found statistically significant improvements in activities of daily living that were seen after 3 weeks of MEM (p = 0.03) compared to TEM techniques, but the improvements plateaued at the sixth and ninth weeks follow-up. Tying shoelaces, eating with a knife and fork, peeling potatoes, and cutting a slice of bread were among the activities included in the questionnaire.[49] The study of patients post-TKA by Ebert et al[48] reported improvements in QOL as measured by the Knee Injury and Osteoarthritis Outcome Score questionnaire, with significant time effect (p < 0.001), but without significant group or interaction effects. In comparison, another study of patients post-TKA observed that MLdT had no significant effect on self-reported knee function as measured by Knee Society Score questionnaire (p = 0.90), and the Western Ontario and McMaster Universities Osteoarthritis Index (p = 0.50).[51] Patients with fibromyalgia treated with MLdT demonstrated significant improvements in the total score of Fibromyalgia Impact Questionnaire (p = 0.01), and scores in areas of feeling more rested in the morning (p = 0.006), and less anxiety (p = 0.060), compared to those treated with connective tissue massage.[24] In summary, 4 out of 5 included studies reported on self-reported outcomes, in which 2 reported effectiveness in improving either functional activities or QOL, when providing MLdT alone or adding MLT to a conventional treatment. Not all improvements were statistically significant in comparison to controls.

Benefits of MLdT on Health Care Use

Two studies addressed the efficacy of MLdT from a framework of health care use. Health care use can be associated with appropriate or inappropriate treatment, frequent or infrequent visits, and of high or low cost. In comparison with TEM, significantly fewer sessions for edema treatment were required with MEM (p = 0.03), in order to decrease subacute arm/hand edema.[49] In geriatric patients post transtibial amputation, the application of complete decongestive therapy, consisting of MLdT and reusable, multilayer short-stretch compression bandages, resulted in a significantly shorter transition period to a permanent prostheses (p < 0.05); compared to single use, multi-application compression bandages.[50] In summary, a decrease in medication costs for migraine patients, a decrease in total number of visits for individuals with hand/arm edema, and a decrease in the cost of supplies for individuals using permanent prostheses have been reported. Therefore, MLdT may lower health care use in selected patient conditions.

DISCUSSION

Summary of Evidence

Moderate evidence supports the use of MLdT for decreasing edema in acute, subacute, and chronic healing phases of conditions affecting the musculoskeletal system. While studies pertaining to acute edema evidenced a lack of volume reduction with MLdT, one study[51] reported less increase in edema compared to the control group. Reduction in girth[50] suggested that acute edema may benefit from MLdT, when the addition of auxiliary multilayer short-stretch compression bandaging and exercises is incorporated. Compression was one key treatment that appeared to influence the outcomes of one study;[49] all subjects in the control group used compression by means of Coban® and Isotoner® gloves, whereas, the MEM intervention group used a "low-stretch bandage system if needed."[49]

Moderate evidence suggests the use of MLdT for improving ROM after TKA. This evidence seems to be antithetical with the lack of significant edema reduction noted in two studies.[48,51] One author[51] suggested that their improved ROM observations may be attributed to the slight decrease in edema, mechanical effects of MLdT during popliteal maneuvers, prevention of fibrosis through protein reabsorption, or simply through relaxation.

Moderate evidence promotes the use of MLdT for decreasing pain and improving outcomes pertaining to functional activities and QOL. While MLdT do not present with superiority in decreasing pain levels compared to other forms of manual therapy techniques, there seems to be preliminary evidence that these techniques may afford a quicker and more stable analgesic effect.[51] Similar to the effects on pain level outcomes, MLdT are not superior in improving self-reported functional or QOL outcomes compared to other treatment measures.

Moderate evidence supports the use of MLdT for improving health care use. Patient advocacy requires rehabilitation therapists to be responsible with the delivery of evidence-based practice. In these preliminary studies, MLdT promoted the use of less medication and supplies, and fewer treatment sessions.[49,50]

Limitations and Strengths

While the available body of literature pertaining to orthopedics and MLdT continues to build, there are limited high quality evidence studies encompassing the broad spectrum of conditions affecting the musculoskeletal system, which poses the inevitable random error of significant heterogeneity of included studies. The diversity of study populations, outcome measures, and study designs may lead the intended audience to question the applicability of the summary of the evidence provided. In addition, the

low number of participants included in the studies render results that are not necessarily generalizable. However, the notable heterogeneity embodies the orthopedic practice of rehabilitation specialists, which establishes this systematic review true and applicable to orthopedic practice diversity. Another limitation that arises from a dearth of literature, is the uncertainty of gathering all related studies. Finally, there may have been studies with non-significant or inconclusive data, which have not been published, that would have influenced the overall results.

CONCLUSIONS

There was moderate support for using MLdT for conditions affecting the musculoskeletal system as effective interventions to reduce pain, and improve function and/or QOL. This review also affirms that MLdT are effective treatment methods associated with lower health care use. Pertaining to ROM improvement and edema reduction, the results of this study suggest that MLdT with auxiliary therapies may be effective, and certainly not ineffective or harmful. However, due to moderate methodological quality of the included studies, the evidence-based practice of MLdT should only proceed with clinical expertise and the patient values in perspective. While the studies represented in this review demonstrated heterogeneity, their differences are an appropriate generalizable outcome for orthopedic therapy practices. Since the first similar systematic review by Vairo et al[26] there has been an increase number of randomized clinical trials pertaining to MLdT. However, the need for further RCTs and cohort studies are warranted, to understand the attributes, benefits, and limitations of MLdT. Standardized measurements are imperative to these future studies, and researchers are advised to consider homogenous methodology with previous studies. In addition, research on MCID for edema pertaining to conditions affecting the musculoskeletal system would make significant clinical and comparative lymphedema research contributions. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and provide evidence as to which auxiliary interventions concurrent with MLdT produce best outcomes.

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Appendix 1. Inclusionary Terms and Examples of Key Word Combinations

Inclusionary Terms
Conditions affecting the musculoskeletal system may consist of many conditions including, but not limited to, fractures, tendinitis, tendinosis, bursitis, sprains, strains, tears, degenerative conditions, post orthopedic surgical conditions, arthritis, bursitis, elbow pain and conditions, fibromyalgia, foot pain and conditions, fractures, hip pain and conditions, low back pain and conditions, hand pain and conditions, knee pain and conditions, neck pain and conditions, osteoporosis, shoulder pain and conditions, and soft tissue injuries.[28-31]

Key Search Terms and Strategy			
System	**Disorder**	**Treatment**	**Localization**
Lymph	Edema	Lymph Drainage	Knee
Lymphatic	Oedema	Manual Lymph Drainage	Foot
Orthopedic		Manual Edema Mobilization	Ankle
Musculoskeletal			Hip
			Back
			Neck
			Shoulder
			Elbow
			Wrist
			Hand

PubMed Search Strategy Examples:
1. lymphatic AND drainage AND hand NOT lymphedema
2. lymphatic AND drainage AND knee NOT lymphedema
3. manual lymph drainage AND ankle NOT lymphedema
4. manual lymph drainage NOT lymphedema NOT cancer
5. lymphatic drainage AND orthopedic NOT cancer NOT lymphedema

Google Scholar Search Strategy Examples:
1. "manual lymph drainage" knee edema -lymphedema
2. "manual edema mobilization" hand edema -lymphedema
3. "manual lymph drainage" -cancer -lymphedema
4. "lymph drainage" "orthopedic" -cancer -lymphedema

Appendix 2. Operational Criteria of the PEDro Scale

1. Eligibility criteria were specified;
2. Random allocation of subjects into groups (in a crossover study, subjects were randomly allocated an order in which treatments were received);
3. Allocation was concealed;
4. Groups were similar at baseline regarding the most important prognostic indicators;
5. There was blinding of all subjects;
6. There was blinding of all therapists who administered the therapy;
7. There was blinding of all assessors who measured at least one key outcome;
8. Measures of at least one key outcome were obtained from > 85% of the subjects initial allocated to groups;
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or if not the case, then data for at least one key outcome was analyzed by "intention to treat";
10. The between-group statistical comparisons are reported for at least one key outcome; and
11. The study provides both point measures and measures of variability for at least one key outcome.

Appendix 3. Operational Definitions of GRADE's Four Levels of Evidence

1. High Level of Quality (✪✪✪✪): Authors are very confident that the true effect lied close to that of the estimate of the effect.
2. Moderate Level of Quality (✪✪✪❍): Authors are moderately confident in the effect: The true effect is likely to be close to the estimate of the effect but there is a possibility that it is substantially different.
3. Low Level of Quality (✪✪❍❍): Authors confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.
4. Very Low Level of Quality (✪❍❍❍): Authors have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of the effect.

Five categories which may downgrade the quality of evidence:
1. Risk of Bias: -1 if serious, -2 if very serious
2. Inconsistency: -1 if serious, -2 if very serious
3. Indirectness: -1 if serious, -2 if very serious
4. Imprecision: -1 if serious, -2 if very serious
5. Publication Bias: -1 if likely, -2 if very likely

Three categories which may upgrade the quality of evidence:
1. Large Effect: +1 if large, +2 if very large
2. Dose Response: +1 if evidence of a gradient
3. All plausible residual confounding: +1 would reduce a demonstrated effect, or would suggest spurious effect if no effect was observed

Appendix 4. Operational Definitions of ACCP

1. High Level of Quality: Reports from RCTs without significant limitations or overriding evidence from observational studies.
2. Moderate Level of Quality: Reports from RCTs with consequential limitations (inconsistent results, methodological flows, indirect, or imprecise) or from observational studies with exceptionally strong evidence.
3. Low Level of Quality: Reports from observational studies or case series.

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Congratulations to our CSM Award Winners

The Awards Ceremony was held on February 14, 2020, in Denver, CO.

PARIS DISTINGUISHED SERVICE AWARD

The Paris Distinguished Service Award is the highest honor awarded by the Academy of Orthopaedic Physical Therapy and is given to acknowledge and honor an Academy member whose contributions to the Academy are of exceptional and enduring value. This year Dr. Joe Godges received the Paris Distinguished Service Award. Dr Godges accepted the award and provided his lecture, Transform Society Through Service, at CSM. His lecture is printed on pages 64-68.

Joe Godges, DPT, is an Adjunct Associate Professor of Clinical Physical Therapy, University of Southern California

- 1980-2020: Member, Academy of Orthopedic Physical Therapy, APTA
- 1981: Graduated from the US Army-Baylor University Program in PT
- 1989: Initial Recognition as Board Certified Clinical Specialist in Orthopaedic PT (recertified in 1999, 2009, and 2019)
- 1993-1994: Developer Ortho PT Practice Analysis & Description of Advanced Clinical Practice
- 1994-1998: Member, Orthopaedic Specialty Council, ABPTS
- 1996-1999: Examination Committee, American Academy of Orthopaedic Manual PTs
- 1998–2001: Committee on Clinical Residency & Fellowship Program Credentialing, APTA
- 2005-2007: Task Force on Practice Guidelines for Workers' Compensation, California PT Association
- 1997-2008: Finance Committee and Treasurer, Orthopaedic Section, APTA
- 2001-2011: Specialized Academy of Content Experts (item writer for OCS exam), ABPTS
- 2010-2016: National Outcomes Database Workgroup, Orthopaedic Section & APTA
- 2008-2017: Treasurer, Journal of Orthopaedic and Sports Physical Therapy
- 2006-2017: ICF-based Clinical Practice Guidelines Coordinator & Editor
- 2018-2020: Average Joe – focusing on CPG implementation

ROSE EXCELLENCE IN RESEARCH AWARD

This year's recipient of the Rose Excellence in Research Award is Dr Jason Falvey for making a significant contribution to the literature dealing with the science, theory, or practice of orthopaedic physical therapy.

Jason R. Falvey, PT, DPT, PhD, is a PhD trained clinician-scientist who studies post-acute and long-term care for older adults. He has been a physical therapist for 10 years, working mostly in the home health care setting, and also holds a board certification in geriatric physical therapy. Jason completed his PhD at the University of Colorado, Anschutz Medical Campus with Dr. Jennifer Stevens-Lapsley and is currently a post-doctoral fellow in the Yale School of Medicine, Division of Geriatrics.

He has authored or co-authored 22 peer-reviewed publications in top ranking rehabilitation, geriatric, and orthopedic journals, and has been an invited speaker at multiple national conferences. His primary research focus is evaluating the utilization and impact of post-acute rehabilitation on functional recovery, community reintegration, and symptom burden for older adults recovering from disabling hospitalizations or major surgery. Jason's research additionally extends to assessment of how social and environmental factors influence successful aging in place for vulnerable older adult populations in home and community settings.

JAMES A. GOULD EXCELLENCE IN TEACHING ORTHOPAEDIC PHYSICAL THERAPY AWARD

Dr. Morey Kolber is this year's James A. Gould Excellence in Teaching Orthopaedic Physical Therapy Award. He is being recognized for supporting excellence in instructing orthopaedic therapy principles and techniques.

Morey J. Kolber, PT, PhD, OCS, holds a faculty appointment as a Professor in the Department of Physical Therapy at Nova Southeastern University where he serves as a teacher and course leader for the musculoskeletal curriculum and lectures on additional topics that include diagnostic imaging, regenerative medicine, and exercise physiology. Dr. Kolber is a board-certified specialist in orthopaedic physical therapy and currently serves on the American Board of Physical Therapy Specialties Committee of Content Experts. He currently serves as the Senior Associate Editor-in-Chief for *Strength and Conditioning Journal* and as a Senior Associate Editor for *Physiotherapy Theory and Practice*. In 2017, he was the recognized as the Distinguished Professor of the Year for the Nova Southeastern University College of Healthcare Sciences and in 2018 he was the recipient of the Florida Physical Therapy Associations Excellence in Academic Teaching Award. Dr. Kolber has published well-over 150 refereed publications and presentations and is a co-editor for the textbook titled, *Orthopedic Management of the Hip and Pelvis*.

OUTSTANDING PT STUDENT AWARD

This year's Outstanding PT Student Award winner is Lauren Gough. Lauren has been identified as a student physical therapist with exceptional scholastic ability and potential for contribution to orthopaedic physical therapy.

Lauren Gough, SPT, is a third year Doctorate of Physical Therapy student at Thomas Jefferson University. Lauren is the Clinic Manager and Administrator of Hands of Hope Jefferson Pro Bono clinics, Vice President of the American Academy of Orthopaedic Manual Physical Therapy sSIG, works as a Graduate Assistant for the physical therapy department, and is involved in PT Society. In addition to this, Lauren coaches and personal trains athletes for Perfect Touch Soccer. Lauren played Division I women's soccer and obtained a B.S. in Kinesiology and Health Sciences with a concentration in Health Science, and a minor in Psychology from The College of William and Mary. Being raised in a military family and being an elite athlete, led Lauren to her dream profession of becoming a physical therapist. Two goals of hers are to gain her Orthopaedic Clinical Specialist certification, and to become a Certified Strength and Conditioning Specialist to provide her future patients with the best possible care in a positive environment. Lauren wants to empower patients and athletes to reach their goals and become the best version of themselves.

OUTSTANDING PTA STUDENT AWARD

Blake Eldridge is this year's Outstanding PTA Student awardee. Blake has been identified as a student physical therapist assistant with exceptional scholastic ability and potential for contribution to orthopaedic physical therapy.

Blake Eldridge, SPTA, of Somerset Community College serves as co-chairperson of the special events and philanthropy committee for his class and is a member of the program's diversity initiatives team.

He was appointed to the PTA Program's Advisory Board by the college president and served on the college's Student Appeals Board. He is an active member of the Kentucky Physical Therapy Association (KPTA) and was named to the 2019 KPTA All-Academic Team. He was also named Kentucky's New Century Scholar, presented to the top community college student of all majors, in 2019. Eldridge has been active in a number of charitable and community service activities, including volunteering for causes including the Special Olympics and March of Dimes. He has also coordinated and participated in activities to support the funding of research for the Foundation for Physical Therapy through the Marquette Challenge, with Somerset Community College named the "Outstanding PTA Program" nationally in 2019. He is expected to graduate from the Physical Therapist Assistant Program in May 2020, with plans to work in an outpatient orthopaedic clinic in central Kentucky.

OUTSTANDING RESEARCH POSTER AWARD

Dana Dailey, PT, PhD, received the Outstanding Research Poster Award for the following research project: A Randomized Controlled Trail of TENS for Movement-Evoked Pain in Women with Fibromyalgia

JOURNAL OF ORTHOPAEDIC & SPORTS PHYSICAL THERAPY® AWARDS

The following annual awards, presented by the *Journal of Orthopaedic & Sports Physical Therapy®*, recognize the most outstanding manuscripts published in *JOSPT®* within the last calendar year. The George J. Davies – James A. Gould Excellence in Clinical Inquiry Award recognizes the best article published in *JOSPT®* during a calendar year among the categories of clinical research reports (ie, that carry a "Level of Evidence" at the end of the abstract), clinical commentaries, case reports, and resident's case problems. The *JOSPT®* Excellence in Research Award recognizes the best article published in *JOSPT®* during a calendar year within the category of non-clinical research reports or brief reports (ie, that do not carry a "Level of Evidence" at the end of the abstract), and Clinical Commentaries on research topics.

2019 George J. Davies – James A. Gould Excellence in Clinical Inquiry Award was awarded to Michael Streifer, DPT; Allison M. Brown, PT, PhD; Tara Porfido, PT, DPT; Ellen Zambo Anderson, PT, PhD; Jennifer F. Buckman, PhD; Carrie Esopenko, PhD for The Potential Role of the Cervical Spine in Sports-Related Concussion: Clinical Perspectives and Considerations for Risk Reduction. J *Orthop Sports Phys Ther*. 2019;49(3):202-208. doi:10.2519/jospt.2019.8582.

(Continued on page 104)

2019 *JOSPT*® Guy G. Simoneau Excellence in Research Award was awarded to Ian A. Young, PT, DSc, OCS, SCS; Federico Pozzi, PT, PhD; James Dunning, DPT, PhD, FAAOMPT; Richard Linkonis, PT, DPT, OCS; Lori A. Michener, PT, PhD, ATC for Immediate and Short-term Effects of Thoracic Spine Manipulation in Patients With Cervical Radiculopathy: A Randomized Controlled Trial. *J Orthop Sports Phys Ther*. 2019;49(5):299-309. doi:10.2519/jospt.2019.8150.

Outgoing Officers and Committee Chairs

We would like to thank our Outgoing Officers, Committee Chairs, and SIG Presidents for their years of service to the Academy of Orthopaedic Physical Therapy:

Christopher Hughes, PT, PhD, OCS, CSCS

Kathy Cieslak, PT, DScPT, MSEd, OCS

Brian Eckenrode, PT, DPT, OCS

- Independent Study Course Editor, Christopher Hughes, PT, PhD, OCS, CSCS
- Practice Chair, Kathy Cieslak, PT, DScPT, MSEd, OCS
- Awards Chair, Lori Michener, PT, PhD, SCS, ATC, FAPTA
- Nominations Chair, Brian Eckenrode, PT, DPT, OCS
- Performing Arts SIG President, Annette Karim, PT, DPT, OCS, FAAOMPT
- Pain SIG President, Carolyn McManus, MSPT, MA

Congratulations to our Newly Certified and Re-Certified Orthopaedic Certified Specialists

At CSM in Denver, Colorado 1,528 physical therapists were awarded their OCS and 453 were re-certified. For a complete listing of the 2019 certified clinical specialists, please visit http://www.abpts.org/uploadedFiles/ABPTS-org/About_ABPTS/Statistics/CertifiedSpecialistsbyArea.pdf

As of June 2019, a total of 15,896 orthopaedic physical therapists have been awarded their OCS!

Financial Report

Kimberly Wellborn, PT, MBA
Treasurer, AOPT

For members that could not attend the Academy of Orthopedic Physical Therapy Member meeting, the financial status of the Academy is being shared here.

The audited results for fiscal year 2018 show income of $2,367,476 and expenses of $1,918,710 (Figure 1). In 2018 the BOD approved taking funds out of the Academy Reserve to pay off the line of credit for the new HVAC unit at the Academy office. This, in addition to the investment loss at the end of 2018, resulted in an investment loss of 10% compared to the prior year (Figure 2). Although there were investment losses in 2018, the AOPT increased investments in 2019 by an average of 20% over prior year (Figure 3). As the Board and members define and prioritize strategies based on our new strategic plan, the Academy is financially positioned to use resources that will promote and support the strategic plan over the next year.

The strong financial state of the Academy continues to support initiatives in research, practice, education, and advocacy.

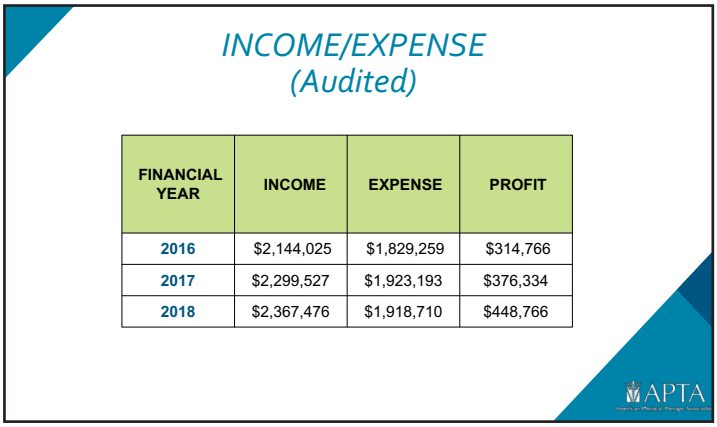

Figure 1.

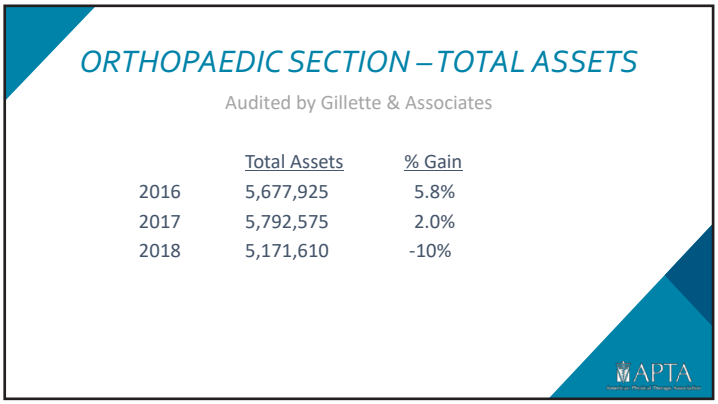

Figure 2.

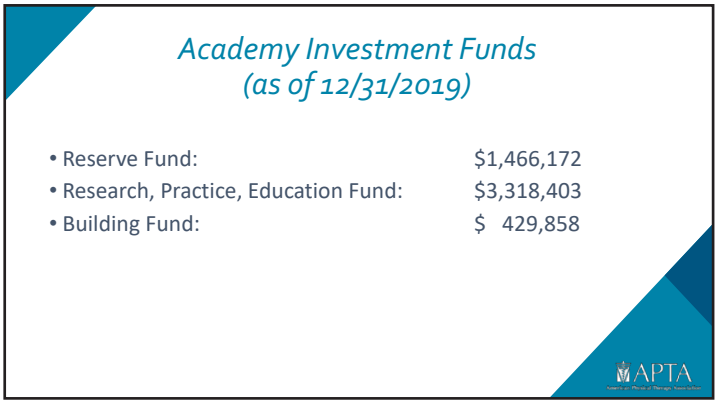

Figure 3.

President's Message

Rick Wickstrom, PT, DPT, CPE

The Combined Sections Meeting in Denver provided many opportunities to learn from and network with physical therapy professionals in our Occupational Health SIG, Academy of Orthopaedic Physical Therapy, and other Sections:

- Our Work Rehab CPG Subcommittee led by Lorena Payne and Dee Daley met on Wednesday afternoon to discuss their findings after a new literature search that included a quality review of 291 articles. Our writers are now updating to their assigned CPG sections to communicate practice based on this latest evidence.
- The All-SIG Networking Event sponsored by the Academy of Orthopaedic Therapy on Wednesday was a blast and likely to continue as an annual tradition.
- AOPT SIG Leaders participated in a great leadership training led by Bill Dickinson to consider our value proposition to our SIG members.
- I was thankful that all SIG leaders were included in Thursday afternoon's session led by Janet Bezner with other AOPT Board and Committee leaders to help prioritize goals for the new AOPT strategic plan.
- Thursday evening was capped off with an OHSIG dinner and strategic plan discussion to kick off an update to the Current Concepts on the role of the Physical Therapist in Occupational Health. This current concepts subcommittee will be led by Cory Blickenstaff and Peter McMenamin. We also discussed models for achieving advanced competency certification to recognize expertise in OHSIG members who specialize in occupational health.
- During our Friday morning networking session, we handed out OHSIG branded luggage scales, safety vests, and hard hat stickers. I expressed our appreciation to outgoing OHSIG leaders for their service: Brian Murphy (VP/Education Chair), Trish Perry (Nominating Chair), and Fran Kisner (Research Chair). We then introduced our incoming leaders: Steve Allison, Vice President/Education Chair; Marc Campo, Research Chair; and Jeff Paddock, Nominating Committee member.
- Steve Allison and David Hoyle presented, Best Practices in Functional Capacity Evaluation: Raising the Bar. It was an outstanding presentation on Friday morning.

CSM was an amazing event for networking and education. I literally did not catch my breath until after my research platform on Saturday morning about a new Active Movement Screen for Workplace Wellness. The APTA vision of optimizing the movement system and the passion reflected by many leaders and students at CSM reminded me of my experience with Dr. Shirley Sahrmann nearly 4 decades ago when I attended an APTA National Student Conclave as a PT student from Ohio State University. I look forward to joining the APTA Centennial Celebration to be held at CSM 2021 in Orlando, Florida. My goal is to get a selfie with Dr. Sahrmann and celebrate our profession with the next generation of leaders as we share another roller coaster event!

Hello Academy of Orthopaedic Physical Therapy and Foot and Ankle SIG members, and Happy Spring!

The FASIG continues to be energized by some great initiatives in 2020. These are well aligned with the newly developed AOPT strategic plan that started in 2019 and continues into 2020. We will highlight a few here in this newsletter but would also encourage anyone who would like to get more FASIG news to make sure to sign up as a FASIG member (easy and free to join at www.orthopt.org) and also please join our Facebook page: www.facebook.com/groups/FASIG/

As always, the Combined Sections Meeting (CSM) in Denver this past February was a great meeting for the over 18K in attendance. The AOPT SIGs started off the conference with a SIG social event on Wednesday evening. This may become an annual tradition so keep an eye out for the event next year. The rest of the conference included great foot and ankle content across the full range of programming including platform presentations, educational sessions, posters, and of course great vendors in the exhibit hall.

Next up – the American Orthopaedic Foot and Ankle Society (AOFAS) annual meeting will be held September 9-12 at the San Antonio Convention Center in Texas. The FASIG has formally partnered with AOFAS to help provide foot and ankle educational programming across the full range of nonoperative, operative, and postoperative rehabilitation education. Watch for more programming and speaker information as this event comes together: www.aofas.org/annual-meeting

The FASIG is also doing webinars. A thank you to Drs. Tyler Cuddeford, Jason Brumitt, and Joseph Micca for presenting on "Nonoperative Management of Sport Injuries" on March 18th. Future webinars are being developed so watch for future information.

Finally, the FASIG is working on the development of a foot and ankle fellowship specialty area of practice. This is an exciting opportunity that will help to inform the future of advanced foot and ankle care. On December 5, 2019, we submitted our formal Declaration of Intent letter to the American Board of Physical Therapy Residency and Fellowship Education (ABPTRFE) for review. We have heard positive feedback on our submission and at the time of this newsletter are awaiting the formal approval to submit our practice analysis survey that will inform the development of the specialty practice. Please stay tuned for updates on this initiative as the FASIG and the AOPT are eager to move this process ahead. This work would not be possible without the strong leadership and dedication of the entire Fellowship Task Force. Please join the FASIG in thanking the entire group for their efforts and expertise:

Practice Analysis Coordinators:
Kris Porter
Marcey Keefer-Hutchinson

Project Consultant:
Edward Muligan

Task Force Members:
Dave Sinacore
Stephen Paulseth
Michael Cibulka
Nancy Shipe
Robert Klingman
Josh Bailey
Eric Folmar
Robert Siglar
Megan Peach
Steve Pettineo
Steve Reischl
Tarang Kumar Jain

President's Message

Laurel Daniels Abbruzzese, PT, EdD

At the recent Combined Sections Meeting 2020 in Denver, Colorado, I promised to fulfill my duties and obligations as the new Performing Arts Special Interest Group President. I have big shoes to fill! Annette Karim, our immediate past PASIG President is moving on to serve on the AOPT Nominating Committee. We are all so grateful for her service; and I am thrilled and honored to take on this new challenge.

CSM is always a great opportunity to reconnect with colleagues, provoke new thoughts on practice, and interact with current researchers and leaders in physical therapy. This year was particularly invigorating, because I met so many new people eager to become more engaged and advance the role of the PASIG within AOPT and the performing arts community. I want to express my particular thanks to all of the individuals that contributed to the CSM programming. We had 12 posters, 2 platform presentations, and 3 educational sessions featuring performing arts content. Our Vice President/Education Chair, Rosie Canizares will continue to recruit presenters and secure high quality educational programming for upcoming meetings. She is working on a collaboration with the Imaging SIG for a preconference course at CSM 2021 in Orlando. Stay tuned for more information!

I also want to express my gratitude for the leadership of Marissa Schaffer, the outgoing Outreach Committee Chair. The purpose of this committee is to further the PASIG's mission and vision by providing the performing arts community with easily accessible, valuable, and evidence-based resources to aid in safe and effective wellness practices. This committee has been creating high quality resources through an inclusive process that galvanized the energy and talents of our members. Some of the resources that PASIG members should soon be able to find on our website include a document for performing arts unions and governing bodies on the role of the performing arts physical therapist. I want to ensure that all of the committee's great work gets disseminated and hope that all of those committee members that did research or developed resources will stay engaged and continue to advance the PASIG into our next "act". Brook Winder has completed her term as Nominating Committee Chair, and will assume the role of Outreach Committee Chair.

Most of the PASIG leadership team is continuing on in their current role but we do have a few changes. Mark Romanick is the new Research Chair. Marisa Hentis is the new Nominating Committee Chair and Pam Mikkelsen is the newly elected Nominating Committee member. Welcome Mark and Pam! The PASIG is in great shape with our strong leadership team.

My former role as Fellowship Task Force Chair will evolve into a new role titled, a "Fellowship Advisory Board Chair". I began my PASIG volunteer experience as a member of the Fellowship Task Force. We began with revalidating the 2004 Description of Specialty Practice for performing arts, under the leadership of Mariah Nierman. The PASIG conducted a practice analysis which informed the Description of Fellowship Practice (DFP). There are now 4 new Performing Arts Fellowship Programs:

- The Ohio State University
- Johns Hopkins Medicine
- Columbia University Irving Medical Center /West Side Dance PT
- Harkness Center for Dance Injuries at NYU Langone

The hope is that the PASIG can create a community of fellows for professional activities like journal clubs and case study presentations. The PASIG can help identify content experts and develop resources for fellowship education. We also want to support those interested in developing a Performing Arts Fellowship. The DFP is free and posted online at abptfre.org.

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

We are guided by our focus on **identity**, **quality**, and **collaboration**. As of February 2020, we have 676 PASIG members and 218 on the members-only Facebook group. We had $4,898.40 in encumbered funds, and $3,750.00 in 2020 non-rolling funds. We will continue to sponsor the International Association of Dance Medicine and Science (IADMS) from our 2020 non-rolling funds. We will continue to generate 11 citation blasts a year, contribute content to *OPTP,* and secure performing arts programming at CSM. Each year we also support a student scholarship. The 2020 Student Scholarship recipient was Hai-Jung (Steffi) Shih, PT, PhD(c), for her project, *Dancers with Flexor Hallucis Longus Tendinopathy Maintain Performance Despite Altered Lower Extremity Dynamics*. An interview between Anna Saunders, our Scholarship Chair, and Steffi is included on the next page. In addition to these initiatives, we will participate in on-going strategic planning in order to align with goals and propose innovation over the year.

PASIG Leadership: Marissa Hentis, Janice Ying, Pam Mikkelsen, Rosie Canizares, Mandy Blackmon, Annette Karim, Mark Romanick, Laurel Abbruzzese, Duane Scotti, Jessica Waters. Not pictured: Tara Jo Manal, Brooke Winder, Anna Saunders, Andrea Lasner, Dawn Muci, Marissa Schaeffer, Sarah Edery-Altas

Last but not least, I want to give a big "Shout out!" to Jessica Waters for choreographing the first annual CSM flash mob dance. We distributed the videos via Facebook and were excited to see so many join in on the fun at both the SIG "Meet and Greet" and the Orthopedic Academy's membership party. It was a great way to celebrate our shared interest in the performing arts, raise awareness of our SIG, and make fun memories. If you have an interest in the performing arts community, and want to join our SIG, membership is free to AOPT members. It is ok if you have two left feet or cannot keep a beat. All we need is your passion and active engagement.

An Interview Between Anna Saunders, DPT, and PASIG Research Award Recipient, Hai-Jung (Steffi) Shih, PT, BS

Research Title: Dancers With Flexor Hallucis Longus Tendinopathy Maintain Performance Despite Altered Lower Extremity Dynamics

Hai-Jung Shih, PT, BS; K. Michael Rowley, PhD; Kornelia Kulig, PT, PhD, FAPTA
Division Biokinesiology and Physical Therapy, University of Southern California

Give a brief summary of your research and why you chose this topic, including a brief explanation of the purpose of this research.

The research I presented this year at CSM is part of a 2-year study funded by PASIG. From previous studies, we know that the saut de chat (a dance specific split leap) places the highest demands on the toes, especially during takeoff. Therefore, we looked at how dancers with flexor hallucis longus (FHL) tendinopathy perform saut de chat differently, and how we could potentially use a clinical feasible measurement to inform us about biomechanical alterations in a saut de chat takeoff without having to go through extensive laboratory experiment. We chose this topic because we know that FHL tendinopathy is a huge problem in dance and there were not sufficient non-surgical studies out there that clinicians can draw upon. We needed studies that use dance-specific tasks, and answer questions such as identifying the injury mechanism and how we can treat and prevent it.

With the help of 8 dancers with FHL tendinopathy without concurrent pathology elsewhere and 11 uninjured dancers, we were able to identify several different biomechanical factors related to FHL tendinopathy. Dancers with FHL tendinopathy stayed on the ground longer before taking off, and had lower vertical ground reaction force during ground contact (they did not push the ground as hard). Dancers with FHL tendinopathy also had lower joint torsional stiffness (their joints were more compliant in a way that they go through more range of motion under the same loading) in the metatarsophalangeal, ankle, and knee joints. Despite these changes in lower extremity dynamics, they were able to maintain jump height performance the same as the uninjured dancers.

We also found that a clinical feasible measurement, the lower limb contact posture, was able to differentiate between uninjured dancers and those with FHL tendinopathy. Dancers with FHL tendinopathy stretched their leg further in front of their bodies at initial contact. The lower limb contact posture was also associated with the biomechanical factors mentioned above (joint torsional stiffness and ground reaction force). The angle and the horizontal distance from the center for pressure (approximately toe position) to the center of mass (approximately pelvis position), taken at initial contact, can be measured using video analysis in the clinic or the field. More researchers should look into the feasibility and validity of using this measure as a movement screening for dancers at risk of FHL tendinopathy.

Did you review previous research and literature on this topic? Can you discuss how the reviewed academic literature resonates with your practice experience?

The majority of the research on FHL tendinopathy or posterior ankle pain in dancers were focused on surgical interventions. I did not see a lot of dancers when I was practicing, but when I worked with an artistic gymnastic team there were certainly FHL injuries and it was challenging not having enough literature to inform my practice.

What related or similar topics are covered in previous research?

As mentioned above, most of them were on surgical interventions and there were also some epidemiological studies on the prevalence. A previous study from our lab looked at the FHL tendon's morphology on the ultrasound along with some clinical measures such as toe strength and endurance, but only in healthy dancers and non-dancers (Rowley et al). Rowley et al helped us build a fundamental understanding of FHL and how dancers use their toes, which led us to pursue the current study in dancers presenting with FHL tendinopathy. There were other dance-related studies, many from our lab, that look at other lower extremity injuries such as patellar tendinopathy (Fietzeret al), and characterizing common dance movements (Jarvis and Kulig), and studies about dancer's lower extremity landing strategies (Orishimo, et al) that we were able to draw on.

Summarize the key findings of previous research; what are the important relationships between earlier studies?

Flexor hallucis longus tendinopathy is a rare condition. Even in ballet dancers, it was reported to have a 1.5% prevalence, although this is already the population with the highest prevalence. This number may be underestimated due to underreporting in dancers. A lot of the older studies were case studies or case series on surgical intervention (usually a tendon sheath release, and sometimes accompanied by an osteoplasty to reshape and repair the adjacent bone). Some studies described the functional importance of FHL in different tasks such as the push-off in gait, or providing stabilization on a demi-pointe position. However, these do not directly

address the mechanism of the development of FHL tendinopathy and therefore cannot inform us how best to prevent and manage it non-surgically.

The previous study from our lab on the FHL tendon in healthy dancers and non-dancers showed that dancers were able to balance longer on a single-leg demi-pointe position, but have worse endurance for repetitive heel raises when the toes were not supported than non-dancers (Rowley et al). These findings indicate a potential over-reliance on the FHL muscle in dancers, which could be a predisposing factor for developing FHL tendinopathy. We therefore conducted a 2-year study on FHL tendinopathy funded by the PASIG to investigate the potential mechanism of FHL tendinopathy. One of the strengths of this research is that we carefully screened our dancers for obvious signs of FHL tendinopathy without concurrent pathologies like Achilles tendinopathy. We used ultrasound imaging, EMG, and motion capture to look at common dance movements such as releves, sautes, and saut de chats.

How might practitioners experience the focal phenomenon of our research in their practice?

I am not entirely clear about what you mean by focal phenomenon, but I will try my best to answer. I think clinicians can use our findings to complement their clinical thinking and use interventions specific to the patient. Currently, there seems to be evidence of altered biomechanics and movement strategies in dancers with FHL tendinopathy. If the specific findings line up with what clinicians see in the clinic, what could we do to retrain those movements? If there are certain intervention strategies that worked in the clinic, we would want to take that and try it on a larger cohort to see if the effect still holds. This is where clinical research and intervention-base studies can come in and bridge the gap between mechanism and treatment.

What direction is needed for future research work in this area? Point the way forward for further research.

Dance-specific injury or movement research is still extremely limited. Any dance-related research would be very helpful, but in terms of FHL tendinopathy, I think the need for future work is identifying intervention strategies. Some of the ideas include specific cueing, movement retraining, foot and calf muscle strengthening, an off-loading (rest) period followed by eccentric re-loading of the tendon, etc. Other than identifying intervention strategies, there is still a lot to learn from this condition, such as the effect of different pointe shoe designs and so on. These are great opportunities to push the envelope of research about this unique condition and advance our physical therapy care for performing artists.

Best regards,
Hai-Jung (Steffi) Shih, BS, PT
PhD Candidate
Division of Biokinesiology and Physical Therapy
University of Southern California

The Development of Ballet Exercises With Proprioceptive Neuromuscular Facilitation Techniques for Patients With Parkinson's Disease: An Abbreviated Case Report

Christina Del Carmen, PT, DPT

Parkinson's disease (PD) is one of the most prevalent neurologic diseases in the world and it is estimated that 20 out of 100,000 persons in the United States will be diagnosed with PD per year.[1] Due to the progressive and neurodegenerative nature of PD, patients have a higher risk of falling, which can jeopardize their functional independence and quality of life. The high prevalence of fall risk with PD is associated with bradykinesia, shuffling of gait, rigidity, muscle weakness, balance deficits, and decreased proprioception. Current research has shown that because PD patients have an increased fall risk, they are at a 3 times higher risk of hip fracture than those without PD.[2]

The most common interventions to address motor symptoms caused by PD are drug therapy and physical therapy. Research has shown that the most effective rehabilitative programs to address postural instability include dynamic balance practice and continual adjustment to environmental demands.[2] Traditional exercise programs have addressed these requirements; however, there is developing evidence that has shown dance was effective in addressing balance and gait impairments while also fostering continued participation to exercise and promoting enjoyment. There has been substantial literature supporting the use of dance as an intervention to improve balance and gait in individuals with PD.[3] Researchers have shown that patients with PD were 29% less active in comparison to the average elderly adult.[3] Thus, as fall risk increases as PD progresses, it is imperative for this population to have a strong adherence to exercise as developing research has shown that physical activity has a neuroprotective and neuroplastic effect on the brain and has the ability to slow the degenerative process of the disease.[4]

Proprioceptive neuromuscular facilitation (PNF) is an intervention that is widely used to improve neuromuscular dysfunction with an emphasis on the trunk and uses nervous system reflexes to relax a muscle. It is used to "enhance movement re-education and expand on existing techniques already utilized for muscle strengthening and stabilization".[1(p1535)] Researchers have shown that PNF techniques improve the swing phase of gait and dynamic balance in individuals with PD; however, the body of evidence on PNF needs further development on the efficacy of this method in the PD population.

Furthermore, there has been no research to date on the use of both ballet exercises and PNF techniques to improve dynamic balance and gait in the PD population. Thus, the purpose of this case study was to evaluate balance and gait impairments in an elderly female with PD and to determine if ballet exercises and PNF techniques were more effective at improving dynamic balance and increasing the duration of the swing phase of gait in comparison to a standard intervention of aerobic exercise, treadmill training, and balance training. Fall risk is of high concern for the PD population so the outcome measures used in the study assessed dynamic balance and single-leg stance in gait.

The patient was a sedentary 78-year-old female who was diagnosed with PD in 2012 and volunteered to be a part of this case study. Her primary complaints were a loss of balance and decreased aerobic endurance. In addition, the patient was likely a Modified Hoehn and Yahr Stage of 2.5 because she demonstrated "mild bilateral disease with recovery on Pull Test".[5] This stage indicates that PD affected the patient on both left and right sides of her body, in which she demonstrated stooped posture, forward head, decreased arm swing bilaterally, and decreased axial rotation in her trunk in gait. The Pull Test is the gold standard to assess postural instability in the PD population and the patient demonstrated a normal response to the Pull Test as she was able to recover with one step. While the patient reported no gait-related falls, she did report reduced balance since her diagnosis; therefore, balance was tested for this patient. Overall, the patient was fully independent for her age as she did not need an assistive device or physical assistance while ambulating in the clinic, so she was tested as such. Moreover, due to the student physical therapist's expertise in ballet, the patient's interest in dance, previous long-term history of adherence to a Zumba exercise program, and her ability to ambulate independently, ballet was an appropriate intervention for this patient.

Based on the objective measures obtained from the examination, the patient's impairments included decreased range of motion, decreased muscle strength, and balance, and gait impairments. Despite these impairments, the patient was functionally independent at her baseline measurement; and thus, it was appropriate to use dance and PNF as interventions to improve gait and balance measures. The plan of care was as follows: the first 3 weeks the patient learned ballet exercises within the format of a standard ballet class and the last 3 weeks of treatment PNF techniques were added into the treatment in combination with the ballet class.

During the first half of the study, the patient attended a 45- to 60-minute ballet class 2 times per week for 3 weeks. Following a 4-week washout period due to sickness, the sessions were 45- to 60-minutes 2 times per week for 3 weeks except for the last week. Due to a conflict with availability, the patient was only able to attend one session during the last week of testing. Each session began with a 5-minute warm up that consisted of walking at a brisk pace or dynamic stretches, such as lunges, high kicks, high knees, and buttock kicks. Like a typical ballet class, after warming up, the patient proceeded to do ballet exercises at the ballet barre for approximately half of the class. During a standard ballet class, exercises begin at the ballet barre to serve as a warm-up for exercises or combinations in "center". Exercises in center are done without the barre and occur in the center of the room or moving across the studio space. These exercises require more control and are usually a combination of steps done at the barre.

During the second half of the study, after the warm-up, a D1 PNF pattern to the lower extremities was used to improve single-limb balance during the swing phase in gait. A D1 pattern begins with a lower extremity with the hip extended or straight, internally rotated, and abducted, the knee extended, and ankle plantar flexed (Figure 1). For the remaining sessions, the patient completed 3 sets of 15 repetitions per lower extremity of the D1 pattern in standing while facing the barre with both upper extremities placed on the barre to apply the exercise to a more functional position. By the second week, a yellow, low-resistance band was incorporated into the second and third sets to apply a resistance against the desired movements so the patient would have to increase her efforts to do the movement correctly (Figure 2). The addition of an ipsilateral arm movement in a "high fifth" ballet position was added to increase complexity of the exercise and improve muscle activation and coordination during gait (Figure 3).

Figure 1. PNF D1 pattern start and end positions. PNF indicates proprioceptive neuromuscular facilitation.

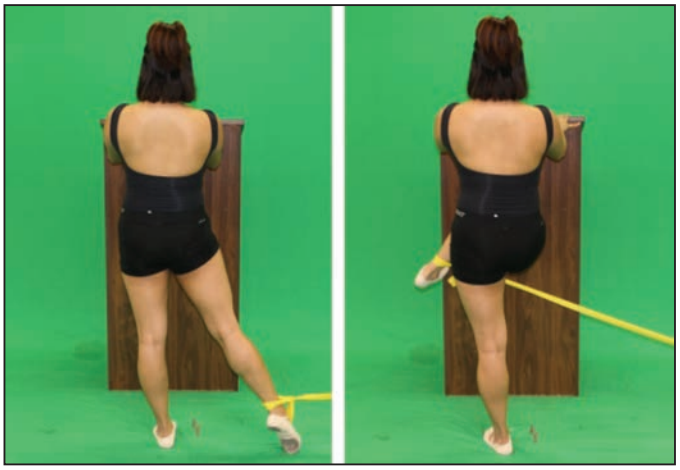

Figure 2. PNF position with resistance band positioning in starting and end positions. PNF indicates proprioceptive neuromuscular facilitation.

The patient was able to retain the ballet vocabulary and demonstrate steps from previous sessions throughout the study. As the sessions progressed, she improved in balance, muscle coordination, motor control, and confidence as the movements became more familiar to her. The patient improved in dynamic balance in accordance to her scores on the Functional Gait Assessment (FGA) and Functional Reach Test (FRT). In regards to the FRT, the patient demonstrated minimal detectable change in the right arm, but not in the left arm (Table 1). For the FGA, the minimal clinically important difference for the FGA in the PD population is 4 points and the patient showed a clinically significant change of 4 points at the final assessment of the FGA. For the Sharpened Romberg Test, however, scores decreased at the mid-assessment and the follow-up. The Sharpened Romberg Test is conducted with the hips in neutral. Thus, the results were most likely variable since the patient was trained in hip external rotation for ballet. Additionally, a video analysis of the patient's gait was recorded during mid-assessment and the final assessment; however, a limitation to the study was that gait was not recorded during the initial assessment. Moreover, the patient's time in single-limb stance increased from 36 msec at

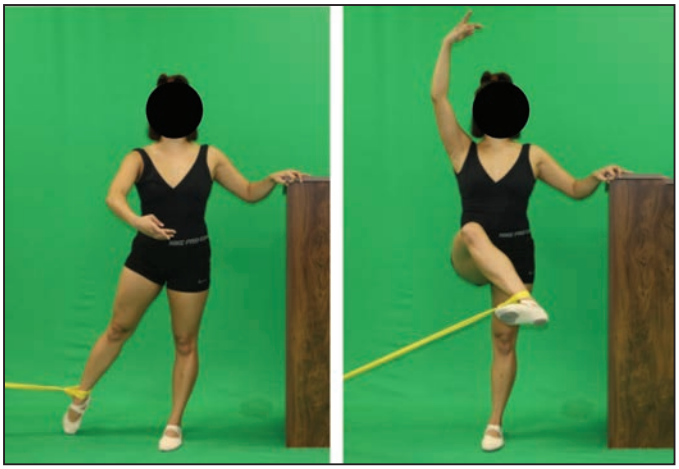

Figure 3. PNF position with the coordination of the ipsilateral upper extremity. PNF indicates proprioceptive neuromuscular facilitation.

the reassessment to 40 msec in the follow-up assessment (Figure 4 and 5). Additionally, in comparing the patient's posture at initial contact from the mid-assessment to the follow-up assessment, she increased from 21° of hip flexion to 22° and decreased in trunk flexion from 8° to 6°.

Limitations in the case report include that this case report was not generalizable to all patients with PD as it was only one patient. The patient had significant improvements; however, she would have benefitted from involvement in most exercise rehabilitation programs since she was a non-exerciser. In addition, the patient was limited in her ability to execute more complex, single-leg stance movements due to her decreased ability to maintain static and dynamic balance on one lower extremity without upper extremity support. Thus, using ballet exercises as an intervention to address gait and balance may be limited to patients with PD that are mildly to moderately impaired by the disease process given the nature and difficulty of ballet.

This case study suggests that using ballet and PNF techniques may be useful for patients who are interested in ballet and need variation and desire to be cognitively challenged. According to Fox et al,[6] there are 5 key principles of exercise that stimulate neuroplasticity in PD, which in summary are physical activities that are intensive, complex, and rewarding and are executed often, and introduced early on in the disease. Due to the multi-faceted and dynamic nature of ballet, in which it challenges an individual physically and cognitively, and the fact that PNF has the ability to re-educate and improve motor dysfunction, the use of ballet exercises and PNF may stimulate increased neuroplasticity in comparison to traditional physical therapy interventions. However, more research should be conducted to support this theory. Additionally, physical therapists who are unfamiliar with ballet can be taught simple ballet exercises that can be performed as rhythmic movements to music in the clinic. This may assist individuals with freezing or difficulty with initiating movements to begin moving with greater ease due to the change of environment and external cues.

Future research should establish standardized protocols, dosage, and periodization for ballet as an intervention to address gait and balance in PD patients. Other factors to consider are standardizing complexity of the exercises and verbal and external cueing. In addition, more research is needed on using PNF in combination with

Table 1. Outcome Measures for Pre- and Post-treatment

Outcome Measure	Initial Assessment	Post-treatment	Comparative/Normative Value
Functional Gait Assessment	20/30	24/30	≤ 22 effectively predicts falls & ≤ 20 predictive of unexplained falls in the next 6 months for older adults.
Functional Reach Test	R: 11 in, L: 11 in	R: 14 in, L: 13 in	Cut off scores for PD patients are <12.50 in (31.75 cm), which indicate fall risk.
Romberg Test	Negative; 30 sec eyes open, 30 sec eyes closed	Negative; 30 sec eyes open, 30 sec eyes closed	No normative data, but 184 volunteers performed the Romberg test & they maintained their balance for 30 sec, eyes open & closed.
Sharpened Romberg Test	Positive; Eyes open for R anterior: 17 sec & 20 sec L anterior: 18 sec w/ modified tandem stance & loss of balance, 29 sec & 65 sec. Eyes closed: Did not attempt for safety	Positive; Eyes open for R anterior: 17 sec & 20 sec L anterior: 18 sec w/ modified tandem stance & loss of balance, 29 sec & Eyes closed: R anterior 8.15 sec & 22.26 sec with modified tandem stance 10.35 sec & 13.95 sec	For ages 70-79, the cut off scores for right anterior tandem stance with eyes open is 30 sec. & for eyes closed 16 sec.
Single Leg Stance	L: 3.95 sec & 2.94 sec R: 2.16 sec & 3.50 sec	Not reassessed due to lack of relatability to function	The cut off score was <10 sec for PD patients with a history of one or more falls.
Berg Balance	52/56	Not reassessed due to ceiling effect	Scores between 41 and 56 indicate low fall risk.

Abbreviations: PD, Parkinson's disease, sec, seconds; cm, centimeters

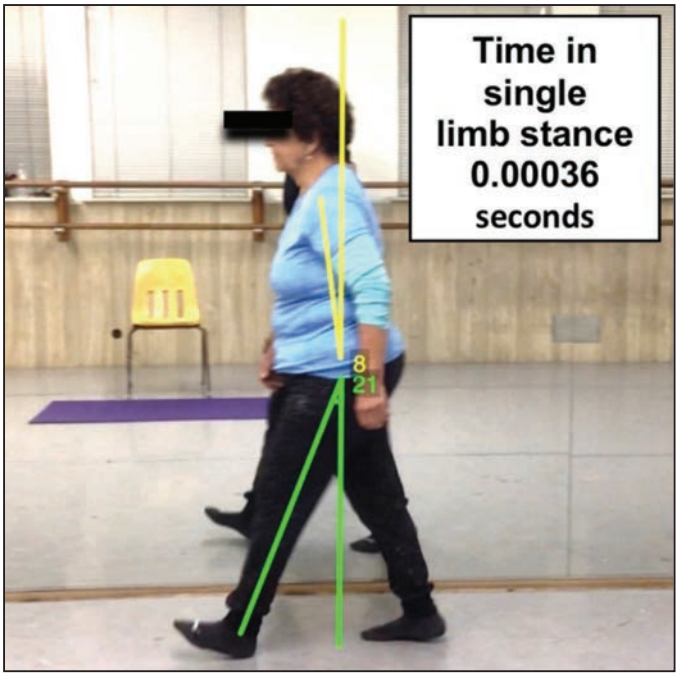

Figure 4. Mid-assessment screen shot of gait using the Hudl Technique™ application. Time in the swing phase of gait was 36 msec.

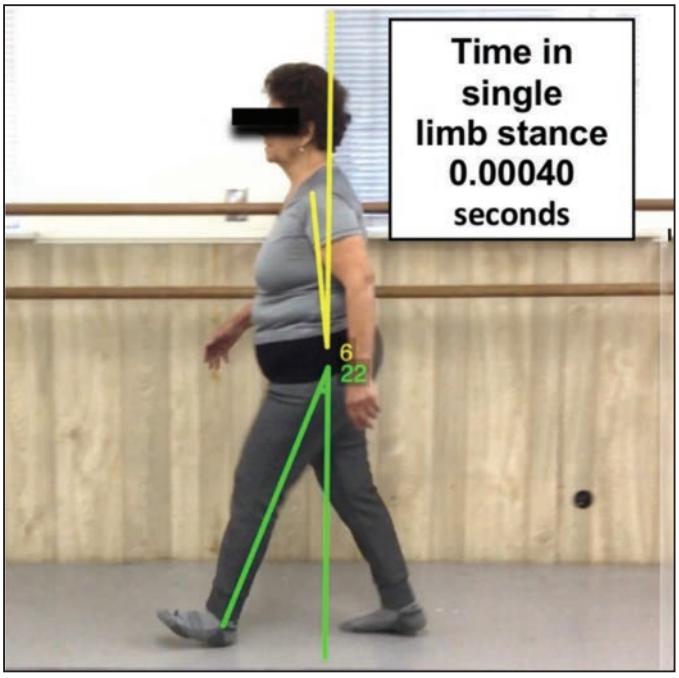

Figure 5. Follow-up screen shot of gait using the Hudl Technique™ application. Time in swing phase of gait was 40 msec.

ballet. Studies examining the effects of training the arabesque position in ballet and terminal stance may also be of value in increasing the stride length of PD patients.

In summary, since the literature supported the use of dance as an intervention for PD patients and the case study supported the use of both ballet and PNF, the use of both treatments may be useful for individuals with PD to address balance and gait impairments.

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President's Message

Nancy Durban, PT, MS, DPT

CSM Overview

The APTA CSM conference hosted over 18,000 attendees. Our Pain SIG business meeting was well attended. Thank you to all who attended so early Thursday February 13, 2020. Our meeting was led by Pain SIG Vice President Education Chair, Mark Shepherd, PT, DPT, OCS, FAAOMPT.

On behalf of the Pain SIG and the Academy of Orthopaedic Physical Therapy (AOPT), we would like to give a very special heartfelt "Thank You" to our outgoing leaders: President, Carolyn McManus, MPT, MA; Nominating Committee Chair, Colleen Louw, MPT, MEd, CSMT, TPS; and Social Media Chair, Tosha Parman, DPT, OCS. The Pain SIG is what it is today thanks to your hard work, dedication, and passion. Thank you for all you have done and for your continued support. Carolyn provided us with her final farewell message. To view her message please see the link on the Pain SIG webpage. We would like to welcome our new leaders who were sworn into their office for the 2020-2023 term, Nominating Committee member, Max Jordan, PT, DPT, PhD, and President, Nancy Robnett Durban, PT, MS, DPT.

Membership Meeting and Pain SIG Year in Review 2019-2020:

Our membership has grown to 678 members. The Monthly Research (Dana Daily, PT, PhD) and Clinical Pearls (Bill Rubine, MPT) emails were reviewed.

2019-2020 Articles for the PSIG Section in the quarterly *OPTP* publication have included:

- Yoga: An Ancient Practice as a New Approach for Chronic Pain by Janet Carscadden, DPT, OCS
- Pediatric Amplified Musculoskeletal Pain Syndrome by Nancy Robnett Durban, PT, MS, DPT
- Motivate to Rehabilitate: The Use of Motivational Interviewing in Physical Therapy Practice by Katie McBee, DPT, OCS

Pain SIG Activities:

- Derrick Sueki, PT, PhD, DPT, GCPT, presented an update on the Pain Specialization and Residency/Fellowship. Derrek shared that the process began 3 years ago with the recognition of the need for a specialization process. Two years ago, letters of intent were submitted to the ABPTS to inform them of the intent to pursue pain specialization. A grant for funding was secured from the AOPT to help offset the costs of the petition process. A year ago, Jeannie Bryan Coe, PT, DPT, PhD, was secured as our consultant to help guide us through the specialization process. Four months ago, a group of clinicians, researchers, and educators came together to create the first draft of the Description of Specialty Practice. The sample survey will be distributed in the near future. Also, parallel to the creation of a pathway for pain specialization, we have begun to create a pathway for accreditation of pain residency/fellowship that is being headed by Katie McBee, DPT, OCS. Below is the tentative timeline for the Pain Specialization initiative.
- Other Pain SIG initiatives include an initiative to create a DPT manual and resource packet to help guide DPT education standards on pain directed by Mark Shepherd, PT, DPT, OCS, FAAOMPT, with his committee members, is directing an initiative to create a DPT manual and resource packet to help guide DPT education standards on pain.

Task	Timeframe
Creation and distribution of a pilot survey	(3 months)
Analysis of pilot survey	(2 months)
Creation and distribution of final survey	(3 months)
Analysis of final survey	(2 months)
Prepare Phase 1 Submission establishing Demand and Need based of final survey	(3 months)
Phase 2 Submission of Application to ABPTS including Description of Specialty Practice	(6 months)
Approval of Petition by ABPTS	(3 months)
Creation of Specialization Test	(12 months)
Awarding first Pain Specialization	(tentative 2023)

- Craig Wassinger, PT, PhD, and Derrick Sueki, PT, DPT, OCS, are leading the way developing Clinical Practice Guideline for Education as an Intervention for Individuals with Musculoskeletal Pain. Derrick Sueki, along with Pain SIG members, David Morrisette, PT, ATC, PhD, Joel Bialosky, PT, PhD, and Joseph Godges, PT, DPT, MA, presented on the Clinical Practice Guideline Friday, February 14, 2020.
- Our Pain SIG sponsored education session titled, Assessing and Classifying the Challenging Patient with Maladaptive Pain Behaviors with presenters Yannick Tousignant-Laflamme, PT, PhD; Chad Cook, PT, MBA, PhD, FAPTA; and Timothy H. Wideman, BSc (PT), PhD, was Thursday, February 13, 2020, immediately following our Pain SIG membership meeting. It was so well attended, that overflow accommodations were provided so all who wanted to attend the presentation could do so. The presentation included an in-depth overview of what Maladaptive Pain Behaviors are, psychometric objective measures and clinical approaches for treatment of patients with maladaptive pain behaviors.

In closing, the Pain SIG would like to thank the AOPT office personnel and President, Joseph M Donnelly, PT, DHSc, for their support and guidance. I personally would like to thank the outgoing leadership officers and the current officers for their passion and dedication to the mission of the Pain SIG. I would like to encourage you to complete your APTA Member Profile and check the box to activate your profile on Find A PT site. Please contact me or any other Pain SIG leader to volunteer to help our initiatives, submit ideas for Pain Pearls, or Research/Education Topics.

Going forward, this is an exciting time to be a member of the Pain SIG. There are grassroots efforts being developed and directed by our SIG members in Education, Specialization, Residency/Fellowship, and Research. We are positioned strategically to collaborate with the APTA and other Pain Organizations. We are revising our strategic plan. Our time is now to find our "#." What do you think ours should be…#thepainspecialists…#thepainexperts? The future is bright and moving forward for the Pain SIG.

Combined Sections Meeting—Denver

The Imaging SIG Educational Session entitled, "Building an Imaging Alliance for Future Practice: One Voice, One Vision" was presented by James Elliott, Aaron Keil, Daniel Watson, Scott Rezac, and two physicians: Frank Crnkovich, MD (Radiologist) and Mark Slabaugh, MD (Orthopaedic Surgeon). The session focused on a vision toward future practice with collegial relationships and the potential role for physical therapists.

Beyond the Imaging SIG's programming, there were 8 other sessions over the course of the 3 days at CSM featuring imaging content. Clearly, imaging is of growing interest in the profession.

CSM Scholarship

While at CSM, the Imaging SIG awarded the third annual winner of the Imaging SIG Scholarship for an accepted presentation. Ruth Maher and Cara Morrison were recognized for their work, "The Piriformis: Effect of Hip Position on Function and Hip Rotator Strength." More applications than ever were received by the Imaging SIG's Scholarship Workgroup, headed by Lena Volland.

Keep this scholarship in mind for yourself, a colleague, or a mentee in the future.

Watch for more information about the scholarship application becoming available again in 2020 for CSM 2021 in Orlando. Information about the scholarship is available on the Imaging SIG's web page on the AOPT website.

APTA, AIUM, and Inteleos Alliance

APTA, the American Institute for Ultrasound in Medicine, and Intelos have announced a formal 3-way alliance to facilitate the education of physical therapists in musculoskeletal ultrasound and their eventual credentialing with the Registered in Musculoskeletal Sonography (RMSK). Much more will be known about this in the near future as details of this cooperative effort become established and publicized.

AIUM Webinars

Webinars with AIUM are continuing through 2020.

By the time this issue appears, one additional webinar will have occurred and another is planned in the near future: "Decoding Wrist and Hand Tendon Pathology with Ultrasound Imaging" by Mohini Rawat, DPT, MS, ECS, OCS, RMSK, on Tuesday, March 3, 2020, at 1:00 PM-2:00 PM ET and "Musculoskeletal Ultrasound Detection and Longitudinal Follow-up of Muscle Contusions, Tears and Early Detection of Myositis Ossificans Traumatica (Heterotopic Ossification)" by Bruno Steiner, PT, DPT, LMT, RMSK on Tuesday, June 2, 1:00 – 2:00 pm ET.

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

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

Strategic Plan Activities

With the revision of the AOPT Strategic Plan, all the SIGs under the purview of AOPT will also be revising their strategic plans. Once the AOPT Strategic Plan is finalized, a specific methodology with all the SIGs will subsequently follow. We need your input into this process. The Imaging SIG leadership will be reaching out to members for their input in developing a new strategic plan in revision of the one established in 2016. Details are still emerging, but a small number of web meetings is likely to be one component of the new plan formulation. More information will be coming.

Changes in Imaging SIG Leadership

Jim Elliott, who has a long history of service with the Imaging SIG, has stepped down from the office of Vice President and will not complete the final year of his term. Jim moved to Australia a few years ago and has multiple roles to manage at the University of Sydney. All of the SIG members are certainly indebted to Jim for the breadth and depth of his service to the SIG and the profession. To fulfill the final year of that term, Marie Corkery has been appointed. She will, in effect, fill that role of SIG Education Chair until after CSM 2021 in Orlando.

Mohini Rawat has assumed the Nominating Committee Chair subsequent to CSM in Denver. Megan Poll's term as Committee Chair has ended in the rotating sequence of that committee's structure. The new at-large committee member from the election in November 2019 is Lynn McKinnis, who joins Kimiko Yamada as the other committee member.

The November elections this year will be for Vice President and Nominating Committee, both with 3-year terms. If you are interested in one of those positions, you can let that be known to any of the Nominating Committee members; and they will also be seeking others who may be interested beginning in late summer and early autumn. The slate of candidates will be announced in October.

The Imaging SIG is appreciative of Megan and Jim for their generous service to the Imaging SIG for many years of effort.

Input on AOPT Clinical Practice Guidelines

In future AOPT Clinical Practice Guidelines, the Imaging SIG will offer content recommendations and reviews of the draft guidelines with specific reference to imaging relative to patient management decisions. While discussed at CSM in Denver, details of the process and the interaction between the AOPT CPG Editors and the Imaging SIG is still being determined.

The Emergence of Ultrasound as an Important Tool in Physical Therapist Practice in the United States

Ultrasound (US) as an imaging modality in care of patients with musculoskeletal (MSK) conditions is growing in its use within the United States. Widely used in several European countries for many years, the value of US imaging is becoming more appreciated across physical therapist practice domestically. This expanded growth in physical therapist practice is expected to continue, perhaps at an accelerated rate in the near future. Toward

this, the American Physical Therapy Association (APTA), the American Institute for Ultrasound in Medicine (AIUM), and Inteleos (the largest organization for practitioner credentialing with US) have announced a formal 3-way alliance toward educating physical therapists in US and facilitating their qualification for the Registered for Musculoskeletal Sonography (RMSK) credential. This is a remarkable development with these external entities of outstanding professional stature recognizing physical therapists as expert users of US, worthy of the efforts of their associations. The common goal of these organizations is ultimately to have many more physical therapists as expert users of US in care of patients with MSK disorders.

In early 2019, Jackie Whittaker and colleagues published an excellent manuscript descriptive of physical therapists' use of ultrasound: Whittaker JL, Ellis R, Hodges PW, et al. Imaging with Ultrasound in Physical Therapy: What is the PT's Scope of Practice? A Competency-based Educational Model and Training Recommendations in the *British Journal of Sports Medicine* 2019;53:1447-1453. They described 4 domains of use within physical therapist practice for US: Research, Rehabilitative, Interventional, and Diagnostic. For the Research category of US, they specifically cite using US for measurements, exploration of muscle and soft tissue structure and function, and developing and evaluating screening tools and interventions. Interventional US is that in which imaging is used to guide percutaneous procedures such as dry needling. Rehabilitative US is more familiar to many in the United States with expanded use in recent years for evaluating muscle and soft tissue structure and function, including biofeedback to enhance muscle performance. Less familiar and growing rapidly is Diagnostic US. In this domain, US is used to augment the clinical examination to reveal particular structures of interest and perhaps even visualize dynamic testing in the clinical examination.

In an effort to aide others in understanding the utility of diagnostic US, 4 physical therapists, all with the RMSK credential, were asked about their experiences with US imaging as examples of the value of US in clinical practice as well as their experiences in earning the RMSK. In some of these examples, practitioner use of US bridges across more than one domain of use.

Daniel Staats, DPT, OCS, MTC, Cert. SMT, Cert DN, RMSK, of Staats Physical Therapy in Brick Township, New Jersey offers this in reference to use of US and earning his RMSK: "Ever since obtaining the RMSK certification, I feel my evaluations are more thorough and complete. The RMSK credential offers the opportunity to have confidence in eliminating uncertainty when conducting evaluations involving the health of soft tissue. When faced with the question of determining either a tendon tear vs. tendinosis vs. bursitis, I am able to decipher with greater confidence due to the aid of the US. With having this information available to me, I feel as though I am able to prescribe treatment interventions to my patients with greater specificity. By knowing the stage of healing the tissue is in, I can then advance patient protocols with greater confidence of effectiveness. As a clinical case example, a patient may present with impingement signs and pain with external rotation. The US images, however, demonstrate a homogeneous, hyperechoic supraspinatus tendon of normal thickness (<6mm). Therefore, I would be more inclined to advance this patient with less hesitation. On the flip side, a patient may present with 4+/5 strength throughout, good active range of motion, and no pain with special testing. The US images, however, demonstrate a full thickness tear of the supraspinatus. In this scenario, I would be more careful with advancing this patient's protocol due to the findings provided by US imaging. US can provide the clinician with an accurate vital assessment of the integrity of the soft tissue fibers."

Staats continues "Objective measurements are an essential component to the practice of physical therapy. US imaging has the ability to provide numerous objective measurements that aid in classifying dysfunction and assist in measuring progress. Through the measurements of tendon girth, nerve girth, joint spacing, bursa size, along with many others, we are able to more confidently identify nerve dysfunction, tendon dysfunction, and even joint pathology. US imaging also has the ability to demonstrate real objective progress."

"In 2018, I was evaluating a female, age 47, with calcific tendinosis of the supraspinatus using US imaging. I found a large calcific deposit measuring 14mm2. The patient presented with typical impingement-like symptoms. I forwarded the evaluation with the images to her referring orthopedist. The Orthopedist suggested arthroscopic debridement to remove the deposit. The patient sought to avoid surgery and elected to first try conservative care through physical therapy. After two months of physical therapy, the patient's function was successfully restored and pain was a 0/10. At discharge, US imaging was performed and to my pleasant surprise the calcific deposit had actually shrunk by 50% to 7mm. I could see the confidence in my patient when she saw the before and after images. This is one of many examples how US imaging influences my practice as a PT."

Nancy Talbott, PT, PhD, Professor at the University of Cincinnati provides her perspective in use of US as a faculty member at an educational program. "As a full-time faculty member, the addition of credentialing in musculoskeletal US has been of significant benefit to me in the research area. The potential to directly visualize structures in real time using a safe, relatively inexpensive and simple research technique led me to US imaging. Over time we have investigated scapular muscle activation patterns in individuals with and without shoulder impairments, have published reliability methodologies for measuring dynamic muscle changes and intraarticular movements of the shoulder, and have researched translational movements of the fingers and shoulder during manual therapy. We have compared special tests, looked at the effects of positioning on muscle activation and have reported on the use of US biofeedback on scapular muscle thickness. We continue to investigate the reliability and validity of examination techniques and to determine effects of common manual techniques."

"While I initially used US almost exclusively for research, we now integrate additional US learning activities into DPT classes. Historically, the US examination emphasizing joint pathology has been part of the curriculum but over time the use of US in the classroom has been expanded. US is demonstrated during anatomy lectures, when palpations of bony landmarks are mastered and as examination techniques such as shoulder special tests are performed. It is also presented as a potential form of biofeedback for use with patients who are challenged with abnormal activation patterns. We have found that one of the most effective uses of US as a teaching tool has occurred during labs in which students are learning to assess joint play and to perform various grades of mobilization. Visualization of the movement while changing positioning and force provides very effective feedback for students and seems to serve as a connection between what they are feeling and what they are doing."

"As a full-time faculty member, qualifying for the credentialing exam did take time. There were no sonographers in my location that specialized in US imaging although a few physicians were beginning to utilize US to guide injections. I found AIUM to be an excellent resource. Attending their conferences, listening to information at their community meetings and accessing their resources was an ideal starting point. Hands-on imaging courses are more difficult to find than some other types of continuing education and attending those that are available is always a priority for me. Completing all of the scans needed for the certification may also have taken me more time than is traditional as there is no faculty practice at my institution. By approaching an orthopedic clinic interested in US imaging, I was able to complete the scans needed."

Greg Fritz, PT, DPT, RMSK, a very early adopter of US in PT practice and owner of clinics near the Seattle area, has a specialized interest in US: "Prior to the RMSK credential being available, I had already purchased every textbook and video that contained MSK point of care US education and had attended the leading MSK US venues of training. I was also provided a hand-me-down US unit to "play" with. So, long before there was even a way of demonstrating competency in MSK US, I was looking for a way to identify how well I compared with the standard of practice in imaging. In 2012, when the RMSK was first offered, I could easily document several hundred exams that I had performed and documented the findings in my clinical notes. At that time, we had to also document 30 hours of continuing education in MSK training."

"Because I am partial to the way I obtained my certification, I strongly prefer the candidate to have been motivated by personal passion in learning. Having said that, I recommend borrowing a scanner from an imaging colleague or buying a used unit through an on-line merchant and bringing home a bottle of gel along with an excellent anatomy application on a personal tablet or standby anatomy text from school and "goop up" your family and friends for some sloppy good time of learning. I still remember the shock I had when I imaged a growth plate on my son's fibula and freaked out for a short bit wondering how this kid could jump and run with his glaring fracture! Practice and more practice are what separate the passionate from the 'want-to-do-that-too' mind-set clinicians."

On how earning his RMSK impacted my clinical practice, Greg says "I must first clarify that I practiced with MSK US as an adjunct to my clinical practice for many years prior to the evolution of the RMSK certification. So, I do not think it fair to specifically state that the RMSK impacted my practice at all. However, I cannot deny that in my small-town medical community, where radiologists and orthopedic surgeons were expressing, amongst themselves, frustration of my using this tool, I am certain that with the RMSK certification came a notable reduction in the grounds for their bewilderment."

"If I were to single out what the use of imaging US has improved in my clinical practice, I would have to say that its primary effect has been on my professional confidence and credibility. Showing a frustrated, hurting athlete the healing partial-tear of his rotator cuff, works wonders in obtaining continued participation and compliance with activity restrictions. Confidently putting an acute ankle sprain right back on the court because you have just cleared all the structures that you just witnessed being strained under full bodyweight, is unprecedented."

"As a private practice owner, I would be remiss to not platform the marketing value that MSK US has provided me. There is a clear advantage to having the only clinic in the community that has ability to watch a joint move, verify fracture healing, assure that the hardware is NOT 'out of place' or the repair did not 'pull apart,' or to reassure the patient that they are getting longer, successful pubococcygeus contractions."

On how using MSK US made a difference in his clinical practice, Greg specifically cites a few examples in patient care:

"Knowing that the shoulder weakness and blade pain was NOT from a rotator cuff lesion helped me focus my treatment on the cervical spine and the patient avoided the cost of a shoulder MRI.

"I helped triage an emergency MSK assessment sent from the local occupational medicine clinic of a worker who slipped on the ice and was having quad cramping with knee extension. Radiographs deemed a fracture unlikely. MSKUS found full-thickness vastus tendon group tear with retraction (oddly, the rectus femoris fibers were spared).

"I confidently returned to full weight-bearing a patient with a tibial fracture by serial monitoring of the fracture zone callus responses.

"We supported continued compliance with conservative joint loading in a patient with a bone marrow concentrate stem cell injection with serial imaging of the articular cartilage dimension and seeing it improve and grow. The difference may have been only .2 mm but it made the patient feel their $5000 was worth it.

"I sent a patient being seen for cardiac rehabilitation to the neurosurgeon after the patient asked, "What is this bump on my wrist?" In the past I may have said "Whack it with a book," but this was a neuroma and I saw the superficial radial nerve was profoundly enlarged.

"I watched a patient working on spinal deep core training grow the external oblique to transversus abdominis ratio (RUSI ratio) from 50% to 80%! We use this as a milestone to advance to another phase of rehabilitation."

Mohini Rawat, DPT, MS, CMP, RMSK, ECS, OCS, a New York-based clinician and teacher of US imaging to PTs, recommends to those interested "There are live hands-on courses available in MSK US training. I would recommend not restricting the search to courses for PT only but attend courses which are open to anyone interested in learning MSK US. Some of these courses are taught by MDs and most of the audience are MDs but they are open to anyone interested, including PTs."

She also says "Earning the RMSK brings recognition and demonstrates your competence to peers, patients and also to insurance carriers. Like any other professional credential, it proves that you are a dedicated professional, committed to adhere with the practice standards. It also has meaning to patients to know that there is a body regulating the practice standards."

As for how US use has affected her clinical practice, Mohini states "US has been a game changer for me and how I practice my specialty. I am a clinician as well as an educator. I work in a unique setting where I am mostly involved in diagnostic aspect of the practice using my board certifications, ECS, OCS and RMSK. Adding US testing to my electrophysiological examination and other orthopedic cases has provided me with in-depth understanding of pathophysiology as well as the structural perspective of the problem. It has significantly impacted the management and clinical decision-making."

Mohini further says "I teach musculoskeletal US in continuing education courses and also serve as fellowship director in muscu-

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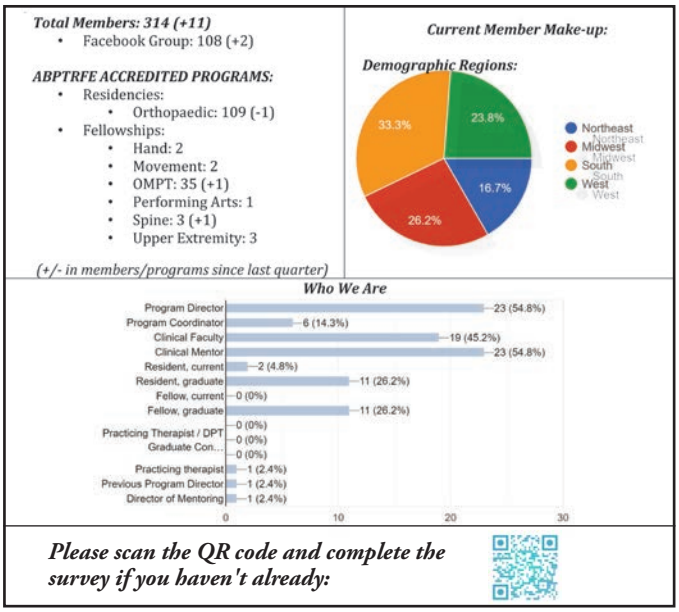
ORF-SIG Dashboard:



President's Message

ORF-SIG Members,

It was a pleasure being able to connect with several of you in Denver at the Annual Combined Sections Meeting. For those of you who were able to attend, we greatly appreciate you carving out time to meet, mingle, and brainstorm on how we can continue to create excellence in Residency and Fellowship Education. For those unable to attend, I will try to create a recap of all the great events!

Our week got started on Wednesday with our Preconference Course: Beyond the Basics: Design and Implementation of Best Practice in Residency and Fellowship Education. Thank you to our Vice President, Kathleen Geist who again put together a great crew of instructors including Tara Jo Manal, Aimee Klein, Kirk Bentzen, and Eric Robertson. For a second year in a row, this class was maxed out going over 60 attendees! We look forward to providing similar programming in Orlando next year while also creating another great line up of speakers directed to established programs.

Later Wednesday evening, we held the inaugural AOPT Special Interest Group Meet and Greet. This event provided a great opportunity to meet and mingle with our members while also helping to grow our membership. We look forward to this event again next year.

Thursday kicked off the first day of actual programming. Over the past 5 years, we have seen a nice slow and steady growth in programming dedicated to residency and fellowship education. We still see most of the programming based around development and identifying value. The key questions that continue to be discussed is how residency and fellowship is valued by all stake holders and in what way. We are currently looking at avenues to better understand and educate health administrators to reduce the barrier of access to programs while still promoting residency and fellowship as the preferred next step following graduation.

On Thursday, the ORF-SIG was again involved with the AOPT strategic planning where we set our new initiatives and defined our values. Over the next year the ORF-SIG will reshape our current strategic plan to be in alignment with the new AOPT Mission, Vision, and Goals.

To end the day, the ORF-SIG in collaboration with the American Academy of Orthopaedic Physical Therapy (AAOMPT) brought back the Residency and Fellowship Career Fair. We had a great attendance of 58 programs! We look forward to hosting this again in 2021 while still working to grow this event.

Friday was filled with meetings and collaboration among our various partnerships including the Academy of Education Residency and Faculty Special Interest Group, AAOMPT's Program Director, and Academic and Clinical Faculty SIG. These meetings all lead up to our ORF-SIG Leadership meeting where we set the plan for 2020. I look forward to the continued progress in creating excellence.

To close out the conference on Friday, we held our annual business meeting. Here we had the opportunity to give back to some of the key change makers in our group. Thank you for the various work within the committees and subcommittees. I cannot give these folks enough thanks for all their hard work and support.

- **Practice/Mentorship Committee**
  - Darren Calley
  - Megan Frazee
  - Vanessa Mirabito
  - Sarah Worth
- **Research Committee**
  - Kathleen Geist
  - Mary Kate McDonnell
- **Membership**
  - Robert Schroedter
  - Matt Stark
- **Communication**
  - Kathleen Geist
  - Kris Porter
  - Kirk Bentzen
- **Liaisons**
  - APTE RF-SIG: Christina Gomez
  - AAOMPT: Robert Schroedter
- **ACAPT Subcommittee**
  - Carrie Schwoerer
  - Kirk Bentzen
- **ABPTRFE Policy and Procedures Subcommittee**
  - Brooke McIntosh
  - Kathleen Geist
  - Kris Porter
  - Tom Denninger
  - Kirk Bentzen
- **Curriculum Subcommittee**
  - Molly Malloy
  - Dave Morrisette
  - Linda Dundon
- **RF-PTCAS/Applicant Sharing Subcommittee**
  - Steve Kareha
  - Kirk Bentzen

The ORF-SIG continues to be very active in creating a Community of Excellence in Physical Therapy Residency and Fellowship Education. Please be sure to get involved with one of our Committees or Subcommittees!

Matt Haberl,
President, ORF-SIG

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IMAGING SIG

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loskeletal US. I have several success stories that my students and mentees share with me on every day basis. Many of my students or mentees now hold RMSK credentials and it has brought recognition to them from insurance carriers and their referral sources. In the February 2020 issue of JOSPT, one of my fellowship graduates has published a case report in Musculoskeletal Imaging Section. That case is a great testimony of power of musculoskeletal US in clinical practice." Please refer to Buchanan V, Rawat M. Schwannoma of the Posterior Tibial Nerve. Journal of Orthopaedic and Sports Physical Therapy. 2020 50:2, 111.

There are still other applications, such as that used by Bruno Steiner, PT, DPT, MT, RMSK, who has used US to image the joints and surrounding structures of those with hemophilia. Steiner, who works with the Washington Center for Bleeding Disorders, has offered one webinar with AIUM previously entitled "Monitoring Joint Health, Damage and Disease Activity using MSKUS: The MSKUS Experience in Hemophilic Arthropathy Management." Another webinar is planned entitled, "Musculoskeletal Ultrasound Detection and Longitudinal Follow-up of Muscle Contusions, Tears and Early Detection of Myositis Ossificans Traumatica (Heterotopic Ossification)" on Tuesday, June 2, 1:00 – 2:00 pm ET. Information for this webinar is available at https://aium.org/cme/cme.aspx and search under "CME Center."

Thus, the application and utility of US in PT practice has only begun to be established domestically. Those who use US in clinical care and research are enthusiastic supporters of the added dimensions it brings to their clinical care, research, and educational endeavors. With the combined efforts of APTA, AIUM, and Inteleos, rich opportunities lie ahead for PTs using US imaging.

Letter From the President

Jenna Encheff, PT, PhD, CMPT, CERP

Denver CSM Update

Hello Members! I am sitting here typing this only two days post CSM, and I am hoping that many new or soon to be new members are reading this as well! With that being said, we had a great turnout for our membership meeting which was held at 7 a.m. on Saturday, February 15th. Approximately 30 people showed up bright and early to hear about the accomplishments and initiatives of the APTSIG. To summarize, 2019 saw many positive steps forward in the promotion and support of animal physical therapy, most namely: completion of the practice analysis and clinical practice standards documents; unanimous approval by the AOPT Board of Directors for our name change to the Animal Physical Therapy Special Interest Group; and publication of a Frequently Asked Questions document on the APTSIG website. Initiatives for the upcoming 1-3 years include, but are not limited to: revising and adapting the APTSIG strategic plan to align with the new overall strategic plan of the AOPT; posting of a reference guide for all 50 states' physical therapist practice acts regarding animal physical therapy on the APTSIG website; introducing electronic resources such as links to articles, example protocols for treatment, and educational videos on the resource page of the APTSIG website; increasing outreach and marketing for animal physical therapy; and increasing offerings of the Introduction to Animal Physical Therapy continuing education course. We are asking you for YOUR input as to what you feel are important issues to address for the APTSIG, so be on the lookout for an e-blast asking for your input if you have not already received it!

The AOPT and the APTSIG formally recognized the election of Francisco Maia to the office of Vice President, which he will hold from 2020-2023. Former Vice President, Stevan Allen was recognized for his 6 years of service to the APTSIG and was presented with a plaque for his years of service. Thank you, Stevan for the time you have committed to the APTSIG!

Newly elected Nominating Committee members, Nicole Windsor, PT, DPT, FAAOMPT, CERP, and Marilyn Miller, PT, PhD, GCS, FSM, were unable to attend CSM, but were recognized and will be serving 3-year, and 1-year terms, respectively.

Jenny Moe, PT, MS, DPT, CCRT, APT, and Jill Kuhl, PT, DPT, MSPT, CCRT, OCS, presented an engaging and educational course to a packed house following the membership meeting. Their presentation, Dysfunction of the Lumbo-Pelvic-Hip Complex in Human vs. Canine Clients, included discussion of comparative anatomy, gait analysis, and many case examples comparing human pathology to canine. The informative presentation was extremely well-received, and we thank Jenny and Jill for their time and expertise!!

Finally, thank you to all our members who have helped us reach our goals outlined in our strategic plan. To those members and our new members, we look forward to continuing to work towards our initiatives as well as identifying new goals to work towards over the next 3 years.

Stevan Allen was presented with a plaque recognizing his 6 years of service as Vice President of the APTSIG from President, Jenna Encheff

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