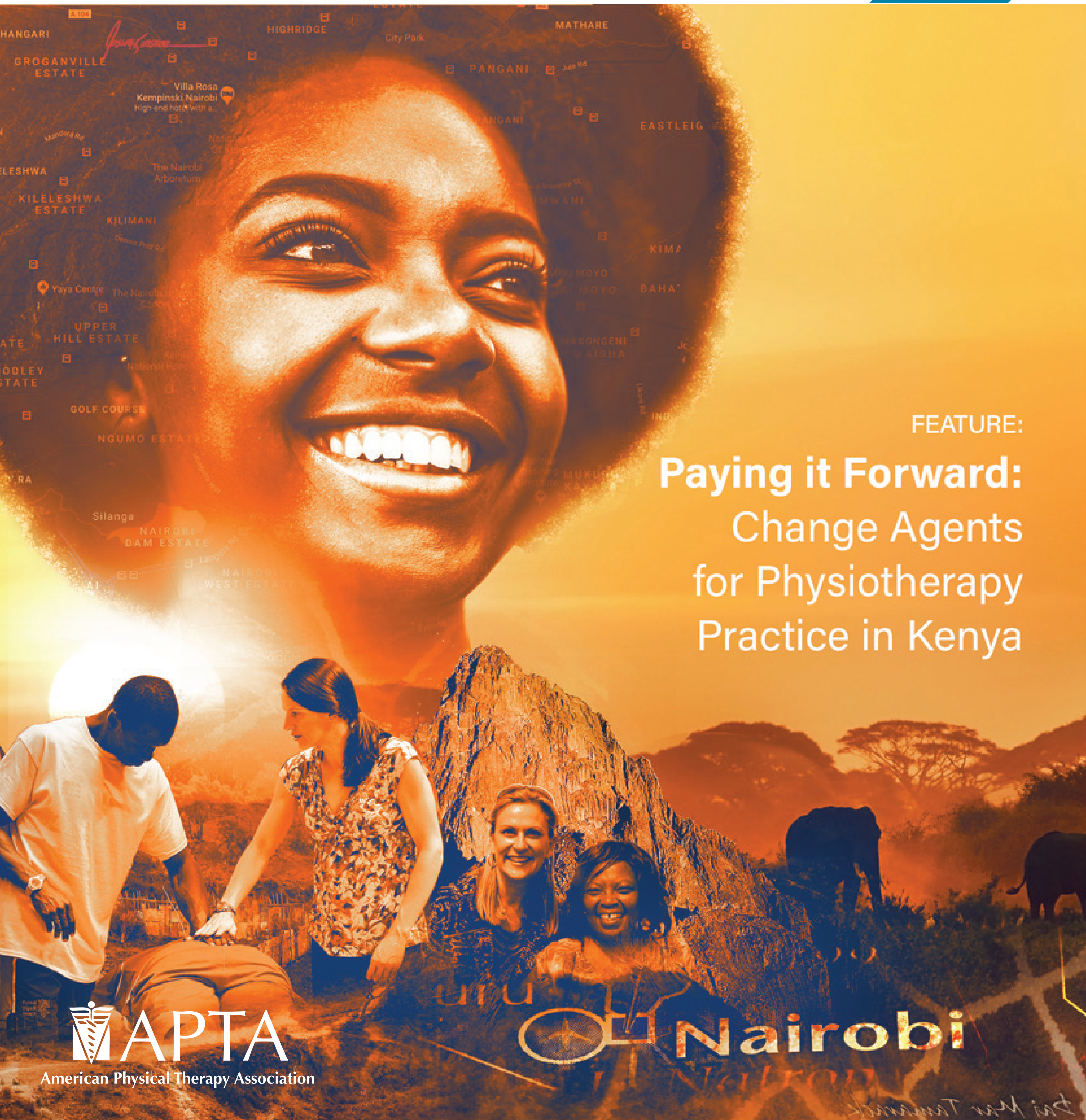
2018 / volume 30 / number 3

ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The magazine of the Orthopaedic Section, APTA



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PHYSICAL THERAPY PRACTICE
The magazine of the Orthopaedic Section, APTA

In this issue

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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

The Calling

Christopher Hughes, PT, PhD, OCS, CSCS

Our lead article this month is a first for *Orthopaedic Practice*. The article by Richard Jackson and his colleagues highlights some work that I feel is worthy of publication. Many physical therapists give unselfishly by participating in various types of local, national, and international activities. I think it comes from within. The field draws compassionate people who not only love what they do but who are also very caring in making a difference. Often it just takes a small spark. In the lead author's case, it was his first exposure years ago as a Peace Corps volunteer. As many private practice owners can attest, it takes an enormous amount of energy to run a business today. In Richard's case, I thought it was very unique the way he tied in staff development to his passion for helping Kenya establish an educational program that would not only be sustainable but also of high quality. I was intrigued by his Memorandum of Understanding agreement that he clearly admits is built on trust and has no "legal teeth." A shared vision and commitment along with clearly defined roles keeps things moving. In business, success tends to be measured by a tangible bottom line metric. The same can be true for this program. All one needs to know about the outcome is expressed in the words of one its graduates, Martin Otieno Ong'wen, Physiotherapist. He expressed, "Joining the OMT program was the best thing that ever happened to me as a Physiotherapist."

There are many parts to this story that epitomize perseverance, creativity, and just a genuine need to make it work. Add in a few events of destiny, politics, and teamwork and it makes for quite a good bit of reading. The intriguing part of the whole project or idea to me was how it all progressed with just an interest to ultimately what it currently has become. The whole process replicates what we do with our patients every day. We are given a challenge to get someone better, we show a sincere desire, mobilize our skills, create a treatment plan, advocate patient compliance, and then execute toward success. What a great skill set physical therapists have. These types of "crossover" skills are what make us well-suited for service and also for being recruited as leaders in many other areas that can often be unrelated to the field of physical therapy.

So, instead of the lead article being a "how to treat" article I wanted to highlight a "how to make a difference" article. As mentioned, I applaud the many physical therapists who dedicate enormous amounts of time to serve others outside of their day jobs. Their efforts are nothing short of heroic. Ironically, the majority who give of their time and talents will tell you they get more out of it than they feel they put into it. In a normal day of chaos, challenges, and obstacles, service work sometimes can be the defining difference in understanding why we do what we do even when our own working days grind on us. With service the commitment comes through, the need never ends, and the fulfillment only gets bigger. I would like to take this opportunity to "tip my hat" to all of you who go the extra mile in the service for others, not only with extended mission trips but even efforts on a smaller but nonetheless important scale by providing care to those who are often not even on the health care radar.

For those who have not found a cause, I encourage you to put your ear to the ground and listen. That cause may be right in front of you. Who knows what will happen once you answer it! The Jacksons planted a seed and look what happened!

Call for Candidates

2019 Election

Three positions are available for service within the Orthopaedic Section beginning February 2019. If you wish to nominate yourself or someone you know, please visit www.orthopt.org, then fill out the nomination form, and submit it to the Orthopaedic Section office: tfred@orthopt.org. Deadline for nominations is September 1, 2018. Elections will be conducted during the month of November.

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POSTOPERATIVE MANAGEMENT OF ORTHOPAEDIC SURGERIES

Independent Study Course 27.1

Learning Objectives

1. Describe anatomy of the hip joint and how structure can relate to pathological conditions.
2. Describe indications for surgical intervention and select surgical procedures of the hip.
3. Describe postoperative rehabilitation intervention techniques following hip surgery.
4. Know the common structures and pathomechanics involved in knee injury.
5. Describe the physical therapy guidelines, phases, and goals for a patient who has undergone knee surgery.
6. Understand the etiology of a calcaneal fracture, Lisfranc fracture/dislocation, and an Achilles tendon rupture.
7. Identify the advantages and disadvantages of surgical fixation versus closed treatment for calcaneal fractures.
8. Develop appropriate treatment plans for patients who have sustained a calcaneal fracture, Lisfranc fracture/dislocation, or an Achilles tendon rupture.
9. Synthesize the current evidence comparing conservative care versus early surgery in different subgroups of patients with cervical and lumbar spine pain.
10. Identify the clinical findings that identify patients who are most likely to benefit from cervical or lumbar surgical intervention.
11. Screen and appropriately manage postoperative complications for presented pathologies.
12. Develop an evidence-based rehabilitation program for patients who have undergone different cervical and lumbar surgeries.
13. Integrate biomechanics and pathomechanics of the shoulder to evaluation and treatment.
14. Implement evidence-based nonoperative treatment strategies for shoulder pathology.
15. Describe evidence-based rehabilitation guidelines following shoulder surgery.
16. Understand the anatomy and biomechanics of the elbow complex and how it relates to surgical interventions, tissue healing, and treatment.
17. Understand postoperative guidelines and treatment progression for the elbow complex.
18. Apply appropriate patient-reported outcome measures for select surgical procedures of the hip, knee, ankle/foot, spine, shoulder, and elbow.

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Description

This 6-monograph course covers postoperative management for injuries and pathology of the hip, knee, ankle/foot, cervical/lumbar spine, shoulder, and elbow. Each monograph addresses the anatomy and biomechanics of the structure, a review of select or common injuries, and nonsurgical and surgical management. Emphasis is placed on rehabilitation guidelines, precautions and contraindications to care, and also expected outcomes.

Topics and Authors

Hip—Keelan Enseki, PT, MS, OCS, SCS, ATC, CSCS; Dave Kohlrieser, PT, DPT, OCS, SCS, CSCS; Craig Mauro, MD; Michaela Kopka, MD, FRCSC; Tom Ellis, MD
Knee—Michael J. Axe, MD; Lynn Synder-Mackler, PT, ScD, FAPTA; Anna Shovestul Grieder, PT, DPT, OCS; Jeff Miller, PT, DPT, OCS, SCS; Melissa Dreger, PT, DPT; Michael Palmer, PT, DPT, OCS; Tara Jo Manal, PT, DPT, OCS, SCS, FAPTA
Ankle and Foot—Stephanie Albin, DPT, OCS, FAAOMPT; Mark Cornwall, PT, PhD, FAPTA; Drew H. VanBoerum, MD
Cervical and Lumbar Spine—Paul Reuteman, PT, DPT, MHS, OCS, ATC
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ORTHOPAEDIC SECTION
LEADERS. INNOVATORS. CHANGEMAKERS.

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Making A Difference: The Kenya Program

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Daniel Kangutu, PT, MSc, HDOMT[3]
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THE BEGINNING: RICHARD JACKSON, PT, OCS

It is hard to say just when the Kenya project started. Maybe 40 years ago when I spent two years there as a Peace Corps volunteer. I taught physical therapy at Kenya Medical Training College (KMTC) in Nairobi. The relationships that were formed at that time continue to have a positive influence on today's activities.

Anna Jackson, my wife and business partner, and I have spent a number of years building a multi-office practice. When we arrived at a point where we could think of more than business survival, we decided to look at creative ways to develop our staff. What experience could we create that would give them a vehicle to serve others and simultaneously make significant changes in their view of the world and their role in it? We decided to create an international volunteer experience in a developing country for our clinical staff. We wanted to help them develop and flourish in this world and in the profession while serving others internationally. We also wanted to do something of long term, sustainable benefit for physical therapists in a developing country and through them to affect positive change in that country's health care. We believe strongly that "*when you find your way in this world, help others to find theirs.*"

There was a bit of serendipity regarding the Kenya project. It began with a chance meeting at the World Congress of Physical Therapy (WCPT) conference in Amsterdam in 2011. I met a physiotherapist who was one of my students at KMTC almost 35 years earlier. He invited us to Nairobi to see if we could help in the development of a Bachelor of Science (BSc) upgrade for the diploma holders in Kenya. Kenyan physiotherapists go to school for 3 years right out of high school and receive a diploma, not a bachelor's degree. The WCPT has deemed that the minimum standard of education for a physical therapist is the BSc degree.

During our first meeting in Nairobi with administrators at KMTC, we determined that the process of upgrading a Kenyan diploma through an American University was expensive and laborious and did not necessarily teach physiotherapists to be better clinicians. The Kenyans emphasized that if they could not get an American BSc, they would like a program that upgraded their skills and education. We decided to work on the BSc upgrade later and within the Kenyan educational system. Before the first meeting concluded, we developed the construct for an 18-month Orthopedic Residency Program with an emphasis on Orthopedic Manual Therapy (OMT). Classes would be two weeks long taught by American educators. We would send a lead teacher and a teaching assistant for each class. Classes would be held every 3 months and cover 6 areas of orthopedic study: Clinical Reasoning, Cervical/thoracic, Lumbopelvic, Shoulder/arm/hand, Knee/hip, Foot/ankle. KMTC agreed to grant a Higher (Advanced) Diploma to our OMT graduates. In addition, we would send clinical mentors to teach our students during their regular patient care. Each cohort consisted of approximately 20 Kenyan physiotherapists. We decided to have 2 to 3 cohorts running each year. The program launched in 2012. Finally, during the first two years we identified Kenyans who would begin as teaching assistants; they were projected to take over teaching duties by 2018. They would need to become faculty members at KMTC so discussions were started early in how to embed this program into KMTC and how budgeting would be handled.

We accomplished a lot in those first meetings. Normally it would take a lot longer to get so much done but the structure of The Jackson Clinics Foundation allowed us to make decisions without consulting an administrative board or committee. We are essentially self-funded and Anna and I are the only two officers in the Foundation. Our

Richard Jackson and students.

experience in Kenya and Ethiopia points out important lessons that we have learned in developing foreign-based programs. First, time with decision makers in the country is limited. This fact required us to be able to make decisions and even improvise quickly. It is nearly impossible to get effective communication when you are separated by 8,000 miles. Second, it is essential to have your resources in order. Financial strength is a critical component to program development. Developing countries do not have resources to spend without going through the next budget cycle. A primary advantage we have had is that our programs have had minimal cost to the schools we have worked in. We do expect some contribution on their end, such as housing, but the primary costs have been shouldered by our Foundation.

It was essential at the outset to know who all of the stakeholders were. It took subsequent trips to meet with everyone but it was necessary. This took us to various levels of administration from faculty to ministry governance.

Once the project was outlined, a Memorandum of Understanding (MOU) was drafted and signed by all involved. This document clearly outlined who was responsible for what. In Kenya, KMTC agreed to supply housing, teaching space, and class recruitment. The Head of the Physiotherapy Department (HOD) would be the coordinator on the ground. KMTC also agreed to grant a Higher Diploma to graduates. They agreed to supply in-country transportation. The Jackson Clinics Foundation (TJCF) agreed to recruit and transport teachers, assistant teachers, and mentors. TJCF was responsible for curriculum development, tracking attendance and grades, and all necessary testing. An MOU is a guideline and is built on trust. There are no legal "teeth" in an MOU.

When we established our foundation, it was necessary to determine our mission, vision, philosophy, and goals. Goals needed to be specific and clearly indicate the objectives of each goal. The completion requirements of participants had to be defined. The "endgame" had to be determined. Projects need to have a beginning ***and*** an end. We feel strongly that the end must be clearly sustainable or there is no point in beginning. We planned months in advance and realized that good outcomes can take years. We were prepared for the long run, which meant clear expectations of our own financial commitments.

When we launched in 2012, we planned forward a number of years in advance. That included our own trips, at least 4 per year, to meet with stakeholders and students to ensure that everything was running smoothly. Programs fail when organizers are not on the ground tending to details. In addition to the above, curriculums needed to be developed and teachers needed to be recruited. There was a lot of up front work to be completed and Ben Keeton, PT, DPT, our Director of Clinic Operations, did most of this. Classes needed to be scheduled, mentors needed to be scheduled, and volunteers needed to be oriented to the country and program.

We learned something important at first contact with our Kenyan and Ethiopian students. They have consistently demonstrated a high degree of intellect and an impressive enthusiasm for learning. We realized that what was lacking was access to new ideas. The internet is still hard to come by and the internet does not teach an organized, programmed didactic and manual skills education. This was true for Kenya and Ethiopia. Access was all they needed to soar in their profession. They do spend their lean resources on tuition to participate in the program. Student tuition pays the teacher's accommodations. This is a hardship for them but it also makes them personally invested. Some students are sponsored by their employers. All students have to commit 8 weeks a year to attend courses. This effectively eliminates any personal leave they may accrue. For at least half of the students this involves long journeys to Nairobi, finding housing, and being away from family. The program is expensive for them and requires numerous sacrifices. They gladly do this for the education they receive. I cannot express how grateful our students are for anything that is done for them. It is safe to say that their enthusiasm and commitment has a profound effect on our volunteers.

A key component to success has been the volunteers who have travelled on their own time to freely give of their education and skills. Without volunteers, there would not be a project. Many people have gone multiple times, often to both countries. The number of heroes in our program is too long to list here. The personal effect on our staff members has been transformational, giving them a new view on their role in this world, and new understandings regarding wealth and poverty. This has had a very positive effect on our core business. A special thanks goes to Shala Cunningham who has repeatedly travelled to Kenya to study our program outcomes. Finally, the Head of Department at the Physiotherapy school at KMTC, Daniel Kangutu Muli, has shouldered the administrative burden of starting this new program without reimbursement and without complaint. He is committed to the advancement of the profession in Kenya. I doubt that any project like this can survive without a person "on the ground" who is committed to the success of the program.

We have just started our seventh cohort, and this year, 100% of the courses are taught by Kenyans. TJCF is sending university professors from the United States to monitor the classes and to help educate the Kenyan teachers in teaching methodology. The curriculum and course syllabus and schedules are preprogrammed. KMTC has hired one full time teacher for the program and will hire a second soon. We have hired a Kenyan full-time to mentor students and graduates who do not live in Nairobi. Mentorship is a key to the success of any residency and it seemed that the only way to get the people who live in the countryside mentored was to hire someone to do it. This is something that will need to be taken over by KMTC in 2019. Finally, we have recently launched a program to teach all of the other core subjects in physical therapy that are now being taught by University professors from the United States. The future of our foundation in Nairobi will be outlined by Anna Jackson later in this paper.

Daniel Kangutu and Richard Jackson.

PROGRAM OUTCOMES: SHALA CUNNINGHAM, PT, DPT, PHD, OCS, FAAOMPT

In order to assess if the goals of the program were being met, evidence-based outcome measurement became essential. A combination of quantitative and qualitative measures were used to perform the educational program evaluation. The assessment included both learning outcomes and the participants' perceptions. Three participant goals were chosen for the primary assessment. The goals included higher diploma graduates will (1) demonstrate the ability to examine and evaluate patients, arrive at a physical therapy diagnosis, determine prognosis, and develop interventions for patients according to the APTA Description of Specialty Practice Orthopaedics, (2) report professional development and career advancement, and (3) achieve improvements in patient outcomes. In addition, barriers and facilitators for participation in the program were explored to allow for ongoing adaptations to the provision of the education to support student success.

To examine the OMT program's influence on clinical reasoning development, a pre- and post-test design was used to compare the clinical reasoning skills of residents at the initiation of the residency program and following completion of the residency program. Similar to residency programs in the United States, a live patient examination was used as a clinical performance evaluation. Furthermore, interviews of the participants explored the clinical reasoning process used during the live patient examination. The use of both an objective assessment and interview allowed for the evaluation of perceptible and imperceptible elements of clinical reasoning. Perceptible elements of clinical reasoning include the interaction of the therapist with the patient and the performance of tests and measures to determine a patient's impairments. Imperceptible elements include the therapist's rationale for the choice of objective measurements and the development of hypothetical diagnoses.

To examine the perceptible elements, a live patient examination assessment tool was developed using two rounds of data collection for the determination of the tool's validity and 3 rounds of data collection for determination of interrater reliability. The assessment tool was derived from the practice dimensions of the DSP Orthopaedics and used the format of the Assessment Tool for Physical Therapists: Orthopaedics provided by the American Board of Physical Therapy Specialties. The final tool included 64 items with 3 levels of scoring: unsatisfactory performance, satisfactory performance, and not applicable. Not applicable was used when the assessment or treatment was not appropriate for the patient presentation. Categories on the assessment tool included examination, evaluation, diagnosis, prognosis, and intervention. Following the live patient examination, semi-structured individual interviews with the residents explored how the resident determined the hypothetical diagnosis and the reasoning for the intervention provided.

Residents also completed a professional development and career advancement survey. The survey was based on a questionnaire created by Smith et al and Jones et al to determine the impact of residency education on the professional development of residents in the United States. The survey was adapted for the Kenya residency program to assist with the interpretation of items by the residents. The adapted survey included demographic information and 19 items related to the residents' professional development and career advancement. The survey used a 5-point Likert scale ranging from major positive to major negative. Cronbach's alpha for the questions regarding professional development was 0.864 and 0.712 for the questions regarding career advancement.

Interviews with the residents sought to explore barriers and facilitators for completion of the program. Furthermore, past graduates and their employers were interviewed to explore the influence of residency training on clinical practice. The semi-structured interviews were performed by an investigator not associated with the program's administration to limit bias. The phenomenology approach was used to analyze the data. Information from the interviews was coded and general themes identified by the primary investigator. NVivo for Mac was used to arrange codes. Thick descriptions and narratives of the participants were provided to inform the themes. To ensure credibility of the themes, member checks were also performed.

The results of each of the outcomes were triangulated to provide an overall assessment of the program. There has been a significant improvement in the residents' clinical reasoning development from the initiation of the program until the completion of the program. During the final live patient examination, residents collected additional cues (subjective and objective) to guide their hypothetical diagnosis and interventions based on the patients impairments. Residents collected an average of 36.1% of the available cues in the history and examination at the initiation of the program. At graduation, the residents assessed 81.3% of available cues. Furthermore, residents demonstrated a significant improvement in the ability to identify relevant data, prioritization of limitations, development of a hypothetical diagnosis, screening for medical referral, and selection of the intervention approach. This is directly related to cue interpretation and hypothesis generation within the hypothetical-deductive reasoning model. During the interviews, the residents discussed using a combination of hypothetical deductive reasoning and narrative reasoning to determine a hypothetical diagnosis and develop a treatment plan that is consistent with the patient's explanatory model for the pathology. This enabled the resident to value all of the patient's symptoms and not the tissue response to testing alone.

On the surveys, residents noted improvements in professional development and career advancement similar to residents in the United States with a positive influence of the residency program on the ability to use a logical clinical reasoning process, perform a systematic clinical examination, determine the nature of the patient problem, diagnose complex patients, treat effectively to achieve projected outcomes, treat in a time efficient manner, and perform overall patient management. Dissimilarly to residents in the United States, the Kenyan residents have not consistently seen an improvement in salary and contributions to research have been limited to the use of evidence-based practice. During the interviews, residents noted that the residency training was not accepted as formal advanced training, therefore, promotions and increases in salary were not available within the current pay structure based on highest degree earned.

Past graduates and their employers were interviewed about the impact of the program on patient care. Past graduates have noticed a decrease in patient visits per episode of care and improved patient outcomes. Graduates and employers also reported an increase in number of referral sources. Furthermore, as patient outcomes improved, residents became mentors to their colleagues by providing consults for difficult patient cases. Graduates have also offered continuing education to colleagues and peers within their institutions to assist with the development of the profession within their communities.

Individual interviews with the residents sought to explore barriers and facilitators for completing the program. The residents faced multiple barriers for participation including travel to the residency site, financial costs associated with the residency, and securing time off of work in two-week increments. To offset these barriers, the residents found support through social networks including family, employers, fellow residents, and the residency program itself. The program has been able to increase the support of residents by using an onsite administrator and providing additional mentoring throughout the program and following graduation.

As the program has progressed, adaptations based on outcome measurement has allowed for improved provision of the education and increased resident support. Continued program assessment will be crucial to ensure that positive outcomes continue when the program is taught solely by Kenyan instructors associated with KMTC in 2019. Sustainability is achieved by ensuring the continued quality of the education through objective feedback to Kenyan teachers by United States based university instructors, and by supplying detailed curriculums, syllabi, tests, course schedules, and ongoing support to the Kenyan instructors. Dedicated instructors have been hired by KMTC and ongoing mentorship of students and graduates will be ensured.

THE REVOLUTION OF PHYSIOTHERAPY PRACTICE IN KENYA: DANIEL KANGUTU, PT, MSC, HDOMT, HOD PHYSIOTHERAPY DEPARTMENT KMTC

The Kenya Medical Training College (KMTC) established under an act of parliament, is a State Corporation under the Ministry of Health entrusted with the role of training various middle level health disciplines including Physiotherapy in the health sector.

Physiotherapy in Kenya started in 1942 in an informal apprenticeship arrangement under a renowned orthopaedic surgeon, William H. Kirkaldy Willis. This was to mitigate the injuries and disabilities that came about as a result of the two world wars of 1914 – 1918 and 1939 – 1945. It was not until 1966 that the first formal 3-year diploma course was started with assistance of the British Government.

The clamor to upgrade our training from diploma level to bachelor's degree started in mid 1990s with no success. It was not until the middle of 2011 when I met Richard Jackson on his way from Ethiopia and we discussed informally about upgrading Physiotherapy training in Kenya. After this first encounter my feeling was two-fold—excitement and skepticism. First, excitement because I met someone who shared the same vision and action plan for improving Physiotherapy training in Kenya. Second, skepticism because of the challenges I imagined we would face from education administrators who previously had shown not one iota of willingness in supporting previous such initiatives.

When we discussed the proposal with the KMTC administration, it was taken positively. The challenge was that the institution is not mandated by law to offer bachelor programs unless it collaborates with a credited university. This proved to be unattainable because of the logistics and expenses involved. Instead we opted to start Orthopaedic Manual Therapy (OMT) as a higher diploma program that is aimed at improving knowledge and clinical skills of the Physiotherapist.

Starting off, the program faced many challenges. Many Physiotherapists adopted a wait-and-see kind of attitude. This was due in part because this was an unknown program to them and secondly, they expected a Bachelor's degree and not another diploma. I had to use several tactics to get the first cohort to start the training.

The training brought a paradigm shift in the management of musculoskeletal conditions. The effects were noticeable and swept across our health care facilities leading to an increased demand for the training. Now the program attracts not only those with diploma training but also those with a Bachelor's degree as well as a Masters. Currently there is a clamor to decentralize the training from Nairobi and establish other centers across the country.

This program has achieved a lot in terms of the number of graduates and the outcomes of the training has been noticed by the patients/clients, employers, and the community. The graduates of this program are demanding advanced training but my biggest challenge is what kind of certification would it be? Which institution would offer the certification? There is a need for the law to be changed so that KMTC can offer trainings for higher qualifications other than diplomas so that such programs can progress to the highest level possible.

A GRADUATE'S PERSPECTIVE: MARTIN OTIENO ONG'WEN, PHYSIOTHERAPIST

I was almost a year out of physical therapy school and I had been practicing in a private clinic where I had some mentoring from one of the most skilled clinicians we have in Kenya. My goal at the time was to be a better clinician, to gain all the knowledge I could get so that I could be in a position to be of some help to the people who looked up to me as a medical professional. In Kenya, the autonomy of practice comes by the mere fact that one is in the health field. In short you are called a doctor regardless of the position you have in a facility. I had to always humbly decline that name at the time since I did not feel deserving.

Joining the Orthopedic Manual Therapy program gave me the courage, the meaning,

Martin Otieno, student teaching.

joy, and pride of calling myself a Physiotherapist. My practice as a Physio has grown tremendously, from making decisions that turned out to save people's lives, to making their saved life worth living. I would say that has humbled me not just as a Physio but also as a person who people in need come to for help.

"I have learnt that I still have a lot to learn" Maya Angelou once said and this to me is a continuous realization. I joined the program because I wanted to learn more. I was hungry for knowledge, and looking for avenues that would help me change how I treated my patients. Physiotherapy for me at the time was getting boring and getting into a routine that did not have any tangible changes for my patients. The short-term relief and feel good effect after modality based therapy was exciting, but there was little or no problem solving. I could not answer the hard question from my patients "daktari will I ever get better?" My frustration always kept me asking questions, reading, looking things up, but I still did not get that far. I did hear of the program from Mr. Daniel Kangutu, from my mum (who is a physio), and a few colleagues. I was at the time contemplating doing a Physiotherapy degree and hearing the stories about the OMT program did get me excited to join.

When I joined the program, I had no idea what was going to happen. I had been reading a lot of textbooks at the time on Physiotherapy that talked about certain processes of evaluating, assessing, and treating patients, processes that we had not quite been taught how to go about in college. I was for the most part excited to join since I had looked up the lecturers coming to teach the program and had come across some of their names on the textbooks that I did read. I was at the time really fed up of administering treatments that did not show any form of tangible improvement. During my clinical rotations at the outpatient department, I had wondered why patients with low back pain had such huge files. I had wondered how the treatment method was just the same, why nobody was questioning the process despite the lack of improvements in patient's lives and why we still did the things we did that did not actually change anything. I had wondered why nobody was asking questions. I needed answers and my expectation was that I would get these answers in the Orthopedic Manual Therapy classroom.

I realized that this was going to be a life changing moment for me on the first day of class when I met Dr. Joe Godges and Dr. Kevin Pozzi. They asked the exact same questions that I had in my mind at the time, "why don't our patients get better? What can we do about it?"

Joining the OMT program was the best thing that ever happened to me as a Physiotherapist. Meeting all sorts of experienced trainers from different parts of the United States, therapists from both academia and the clinical world, as well as those involved in research was invaluable. I got the chance to meet up to almost 50 therapists with a great deal of knowledge in the Physiotherapy world. My clinical skills shot through the roof. I became more aware of things, I started to listen more, to understand what my patients were going through. I would say I became more aware. Every moment with my patients became exciting experiences not just for myself but for them as well. They got better faster, they got educated, and I had learned the answers to their questions. Not only that, I learned different ways of answering them depending on what they needed to know and how to guide them through the information. The most fulfilling aspect of it were the short texts of gratitude, the small gift cards and small gifts that I did get from them. They appreciated my care.

I developed a strong relationship with people, my communication skills got better, and I could now explain to people what a Physiotherapist is and what we do. I got confident and I started to teach the skills I had to other therapists I came across. I came to understand that teaching was the best way to learn. At first it was a challenge but with the continuous classes and mentorship it started looking like something I could get good at. So, I kept going to classes and felt that I could not miss any OMT offering.

At the beginning of the program (OMT) we were met with resistance, lots of resistance, from our peers. It was too much and at times I did feel like giving up. We kept pushing. Gradually, we started to gain respect from our peers and other medical professionals. I attribute this success to our patients. They spread the word that things were changing in Physiotherapy. Consequently, the OMT therapists started to get noticed. Other physiotherapists started to ask questions. They wanted to know where we received the training. They wanted to join the team. That was when we realized that we did get more than we had bargained for. Our expectations had not only been met but exceeded. We had answers that were valuable to our patients, but also were able to earn respect of our peers and even teach them what we knew.

A year ago I got employed by the Jackson Clinics Foundation to do mentoring for the Physiotherapists who had graduated from OMT and the OMT students working in the rural areas of Kenya. This was the turning point in my life as a Physiotherapist, the baptism by fire of being the first therapist to do a mentoring program in rural Kenya. It was a new step in the education system in Kenya. It was a humbling moment in my life, from the challenges it came with to the numerous joys that came later. Going to the rural areas made me realize how huge an impact the program had on patients. Our therapists could pick up potential red flags, do evaluations, and demonstrate sound clinical reasoning. They can design comprehensive treatment plans, all due to OMT education.

The conversations with doctors changed. There were times when Doctors did not have a clue what Physiotherapists did. Space allocation for Physiotherapy clinics in the hospitals was not a much-needed priority. That has since changed. We are starting to see interactions between therapists and doctors becoming synchronous and jointly aimed at our patients' welfare. The impact is massive. The gap is being bridged, there is progress. Sometimes we feel it is slow, but the impact is a big one. I would say, as Professor Rob Landel told us in class, "FIGHT ON."

The program is viewed in two ways. (1) As one of the best things that ever happened to Physiotherapy in Kenya and East Africa with a little bias of my own opinion. It is appreciated so much that employers of Physiotherapists recommend that those who apply for a job be OMT trained. (2) On the other hand, it is viewed as a threat to other on-going programs related to higher learning centers that offer Physiotherapy services. Regarding this I would say that "there is no positive growth that does not come without some healthy competition."

I do not think there would have been a better program that could have changed the scope of Physiotherapy practice in Kenya. The changes are tremendous. The patients can attest to that. For example, it is getting very difficult for a therapist who is not OMT-trained to see patients who have been treated by an Orthopedic Manual Therapist. The doctors and orthopedic surgeons are starting look for OMT-trained therapists to assist in seeing their patients. The number of referrals from other specialists has grown as has the number of patient-patient referral.

KENYA'S FUTURE IN PHYSIOTHERAPY: ANNA JACKSON

It is hard to discuss the future of the Kenyan program without taking a moment to reflect on how we got there. Our original vision and mission, nearly 7 years ago was to find a course of action to upgrade diploma physiotherapists in Kenya to a Bachelor's degree. Simple, right? No, wrong! The struggle to get where we are and the path to where we are headed is truly a testament to our flexibility, perseverance, and patience.

Our vision began with a simple invitation to come to Kenya, visit the Kenya Medical Training College (KMTC), meet with a few key personnel and begin the discussion of upgrading the current 3-year physiotherapy diploma to a bachelor's degree. It became clear that the vision of the upgrade would be met with a variety of barriers, seemingly impossible to overcome. So, we flexed our brains and decided to add a program for diploma graduates to learn and grow practical skills. The Higher Diploma in Orthopedic Manual Therapy (OMT) was born, consisting of 6 key courses over 18 months. Curriculums were written and volunteers from American Universities and The Jackson Clinics came to teach. An impact was and still is being made! Skills have markedly improved. Patients see and know the difference. From one to two and now 6 cohorts totaling more than 100 dedicated students have graduated from KMTC with their OMT. All the while, we have held on to the original vision, to upgrade the diploma graduates to bachelor's degrees. Each time we have travelled to Kenya, we have continued to meet with various doctors, administrators, and educators to discuss some course of action to move towards a path to this upgrade. I am so pleased that this path has finally been revealed.

Last fall, Richard Jackson was on a teaching trip to Kenya and was told by Daniel Kangutu, KMTC's Physiotherapy department head, that there was potential for a meeting with the acting Vice Chancellor of an organization called African Medical Research and Educational Foundation (AMREF). This meeting was intriguing because AMREF had just been granted the credentials as an International University. That said, we have been to a lot of meetings that were intriguing but have ended with empty results. Richard told Daniel, "if the guy shows up" which in Kenya is like a 50/50 chance, "come to the classroom and give me a sign, I'll break from class and come out to meet him." Well, the gentleman did show up, Richard entered the room and the formalities of introduction began. The acting Vice Chancellor, introduced himself as Peter Ngatia. Richard gave the typical Kenyan greeting, squinted his eyes a bit and said "Peter Ngatia?" (Richard recalled that when he was a Peace Corp volunteer in Kenya back in the late 70s he had worked with a teacher by the same name. This individual actually worked with Richard for a year to take over the course material that Richard had written and was teaching at the time. This teacher was and is Peter Ngatia.) Peter looked back at Richard, with a thoughtful expression and replied, one matured man looking at another, "You are Richard Jackson! I wasn't sure, so many years ago." Of course, it is a wonderful thing to realize that this path to a bachelor's upgrade had seeds sown nearly 40 years ago.


Peter Ngatia and Richard Jackson.

The AMREF supports Kenya's movement towards sustainable development goals under 3 pillars: training, health service delivery, and health care financing. The AMREF has been sending students to various Kenyan educational institutions for years and made a decision that by opening their own university they could better control costs and the level of education provided to its students. That afternoon Peter, Richard, and Daniel began the most fruitful discussions to date. Indeed a path has been paved via AMREF's International University (AMIU) for the KMTC physiotherapy diploma students to upgrade to a bachelor's degree. Patience has paid off.

All of the time and energy students of the OMT program have dedicated will be considered. Graduates that have taken the course work from our advance diploma program will have their course work accepted towards the bachelor's degree. This degree is focused on professional development and not so much on the general education of the students. We have our work cut out for us with this wonderful development. Curriculums have been outlined (many thanks for Dr. Cheryl Footer), volunteer teachers are being called to service, and so this new direction begins! Now that we see a bachelor's degree is possible, we believe our vision now extends to finding the path for Master's and Doctoral degrees.

The KMTC Higher Diploma in OMT will continue to be offered. KMTC has hired one of our OMT graduates, Erastus Osewe to manage and teach in this program. This valuable program has been fully integrated into the KMTC physiotherapy program. In addition, we have lunched an educational program in Rehabilitation at KMTC that will cover the non-orthopedic areas of physical therapy (neurology, pediatrics, geriatrics, cardiopulmonary, integumentary). We have also set in motion mentoring for the OMT graduates that live in the rural areas of Kenya. Martin Ong'wen, a passionate physiotherapist and graduate of this program, is traveling to mentor and ensure skills taught are not forgotten.

Another truly unique program was started last year. Shenandoah University is sending rising third year DPT students to Kenya through our Foundation and KMTC to be mentored by our OMT graduates. Normally students are sent to developing countries to teach and to treat. In this case, they are being sent to be mentored and to learn. This is very exciting to our Kenyan counterparts. The tables have been turned and they are quite proud of that fact.

In July 2018, the First Annual Meeting of OMT graduates is to take place at the beautiful AMREF conference center. These 100 + OMTs will gather try to answer the next big question, "What is the Future of OMT?"

Truly our deepest gratitude lies with the many volunteers and students who continue to make this journey with us. Their ability to ebb and flow with the tides of challenge and change is admirable. We will continue to be flexible, patient, and persevere. Our students are our inspiration. It is through these amazing individuals that we see the difference being made with patients, it is working! Teach One, Treat Many. Their future is so bright!

Pilot Study: Influence of Immobilization Period Prior to the Start of Rehabilitation on Foot Function and Foot Muscle Atrophy

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ABSTRACT

Background and Purpose: Ankle fractures are the most common fracture and are often treated with surgery and immobilization. Severity of fractures and the course of recovery are both highly variable. Up to 36% of patients report a suboptimal outcome in function after ankle fracture. The purpose of this study was to examine if the length of immobilization or the duration of wait time prior to beginning rehabilitation was associated with atrophy of the foot muscles or to the patient's perceived function. **Methods:** Fifteen patients with ankle fractures completed an outcome measure after terminating immobilization. Diagnostic ultrasound was used to examine the foot and leg muscles. **Findings:** Muscle atrophy was significant. Neither length of immobilization nor a delay in initiating treatment were strongly correlated to foot muscle atrophy or perceived function. **Clinical Relevance:** A foot specific exercise program can address muscle atrophy found after ankle fracture. **Conclusion:** Fracture type and other variables are likely influencing muscle size and perceived function.

Key Words: ankle, fracture, intrinsic, ultrasound

BACKGROUND AND PURPOSE

Ankle fractures are the most common fracture of the foot and ankle.[1] Often ankle fractures are treated with surgery followed by a period of immobilization.[2,3] Their prognosis is mixed with some people experiencing a quick recovery and others resulting in long-term chronic problems.[4-6] For example, at 10-year follow-up one study found that 36% of patients had a fair or poor outcome reporting impairments in overall function, pain, gait, and range of motion.[5] Other studies document more positive outcomes.[4,6] A recent systematic review of 30 studies documented average expected recovery is 86% at 1 year.[6] At the start of rehabilitation, usually the point when immobilization is terminated, patients average functional ability is extremely low, 20% of normal.[6] This remarkably low functional status drives many patients to seek guidance from physical therapy and is thought to be connected to the length of immobilization and severity of trauma (unimalleolar, bimalleolar, or trimalleolar fracture).[6] However, a uniform presentation of patients relative to functional status, ankle range of motion (ROM), or strength post immobilization after an ankle fracture is not typical.[7]

The specific effects of immobilization are well documented,[7-11] leading to expectations of greater impairments and length of recovery as a consequence of longer immobilization. In fact, reducing or minimizing immobilization is currently a research priority for patients with ankle fracture.[2,3] Protocols mirror this focus varying immobilization length and weight bearing during immobilization post ankle fracture.[2,3] Painter et al[7] showed wide variation in immobilization length, perceived function, and dorsiflexion ROM after ankle fracture. This study was consistent with other larger studies on limitations in ROM post ankle fracture.[12] While ROM is important to ankle function,[13] current data suggests pain and dorsiflexion ROM may only account for a small percentage of the variance in activity limitations.[14]

The calf and foot musculature are also affected by the length of immobilization after ankle fracture.[9-11,15] Several studies document muscle atrophy during immobilization.[9-11,15] Length of immobilization, whether weight bearing is allowed or not, and fracture type (ie, severity of soft tissue damage) may influence muscle atrophy. Psatha et al[9] studied muscle girth during cast immobilization using magnetic resonance imaging (MRI). An MRI demonstrated total muscle volume decreases of 17% and changes in muscle fiber directions (ie, pennation angle). It is notable that atrophy slowed when partial weight bearing was initiated. Shaffer et al[10] found subjects immobilized for 8 weeks demonstrated decreased plantar flexion peak torque on cast removal. In another study, muscle hypertrophy after immobilization resembled controls following a period of rehabilitation; however, plantar flexion torque deficits remained. Unexplored in these studies is the influence of fracture type and fixation methods. Surprisingly, a high level study, suggests no benefit to supervised exercise programs for uncomplicated ankle fractures over advice alone.[16] Improved understanding of the influence of fracture (type) and treatment variables (length of immobilization) may improve understanding of when rehabilitation holds strong benefits for patients. For example, fractures of the fibula may have preferential effects on the fibularis longus and brevis muscles. And, longer periods of immobilization may affect more distal foot muscles (intrinsic/extrinsic) as well as ankle plantar flexors. Foot muscle atrophy is of interest because new studies note foot muscle function influences ankle plantar flexion function, a major muscle group for walking.[17-19]

While ankle fractures constitute a wide range of injuries and prognosis, if impairments such as ROM and muscle atrophy are primarily the result of immobilization, their severity at initiation of physical therapy would be related to the length of immobilization. Further, rehabilitation after ankle fracture is not always recommended despite the significant loss of function.[16] The influence of a delay in initiating rehabilitation is unclear. While advice is as effective as supervised therapy for some patients, delays in starting rehabilitation may prolong disability in other patients.[16] Understanding how the length of immobilization and delay in initiating treatment after immobilization influence patient status would be useful from a clinical view point as variables separate from trauma (ie, fracture type).

The purpose of this study was to examine if the length of immobilization or the delay after termination of immobilization in initiating rehabilitation was associated with muscle atrophy specific to foot muscles and perceived foot function (ie, Foot and Ankle Ability Measure [FAAM]). The initial hypothesis were (1) that muscle size and foot function would decrease as the length of immobilization increased (length of immobilization would be negatively correlated to foot muscle atrophy and FAAM); (2) that muscle atrophy and foot function would be negatively influenced by delay in initiating rehabilitation (delay initiating physical therapy would be negatively correlated to foot muscle atrophy and FAAM); (3) that foot muscle size would be significantly lower in the involved versus the uninvolved side at the start of rehabilitation; and, (4) that fibularis muscle size would be significantly lower specific to patients that had ankle fractures involving the fibula.

METHODS

Subjects

A convenience sample of 15 patients (4 male, 11 female) with ankle fractures were recruited using flyers placed in orthopedic clinics and by word of mouth. The general inclusion criteria were: (1) 18 to 65 years of age, (2) diagnosis of an ankle fracture (any type), and (3) as soon as possible following discontinuation of their immobilization device. Patients were screened by a physical therapist for exclusion criteria consisting of (1) musculoskeletal or nervous system injuries of the uninvolved limb over the last year that would affect either lower extremity during walking, and (2) diabetic neuropathy affecting the foot.

Foot and Ankle Ability Measure

Patients were asked to rate their current function using the Foot and Ankle Ability Measure (FAAM). The FAAM is a region-specific, patient-reported outcome measure used to assess physical performance among individuals with a range of leg, foot, and ankle musculoskeletal disorders.[20,21] It is comprised of a 21-item activities of daily living subscale. Patients' score the FAAM using a Likert scale. Scores are tallied with a higher score representing a higher level of ability. The FAAM has been determined to be a reliable and valid measure of physical function in patients with impairments of the leg, ankle, and foot.[20,21]

Muscle Size Measures

Diagnostic ultrasound is a validated approach to documenting changes in foot muscle size.[22,23] A diagnostic ultrasound unit (Philips Affinity model 50G, Phillips, Inc. N.V) with a 50-millimeter linear array probe was used to collect abductor hallucis cross sectional area (CSA) and fibularis longus/brevis muscles (Figure 1). Consistent with published data,[22,23] the cross section of the abductor hallucis muscle was taken perpendicular to the anterior/posterior axis of the foot just anterior to the medial malleolus. For the fibularis muscles a cross section was obtained midway from the fibula head to the medial malleoli similar to other studies.[22,23] Although this does not distinguish between fibularis longus and brevis, this is a valid measure for their combined CSA.[22] Previous studies have used ultrasound (US) images of these muscles in controls and subjects with flatfoot.[22-25] After adjusting for magnification (NIH ImageJ), circumference was traced manually and CSA recorded. Despite preliminary testing on normal subjects, in 5 patients the US examiner was unable to capture an adequate image of abductor halluces muscle. And, for practical reasons, inclusion of the fibularis longus/brevis muscle was only included in 5 patients.

Statistical Analysis

Descriptive analysis of the patient data, length of immobilization, delay from when immobilization ended and the initial physical therapy appointment (delay in initiating physical therapy), FAAM and muscle size variables were tabulated. To examine relationships between length immobilization (hypothesis #1) and delay in initiating physical therapy (hypothesis #2) Pearson correlation coefficients were first considered. When there was no relationship, scatter plots were examined visually to examine the individual data points. Even though the sample size was small (n=15), there was sufficient variability in the data to find strong correlations (r>0.65) if one existed. To evaluate the degree of muscle atrophy, the uninvolved and involved side abductor hallucis CSA was compared using a paired t-test.

FINDINGS

Fifteen consecutive patients with ankle fractures were included in this study (Table 1). Four were male and 11 female; ages 18-63 years with a mean age of 36.3 years. The mean body mass index (BMI) was 27.1 with a range of 22.9-40.6. Five patients were classified as having a normal BMI, 8 were classified as overweight, and 2 were classified as obese. Patients were enrolled in the study a mean of 17.5 days after discontinuing use of an immobilization device. The range of days after discontinuing immobilization was 1-121. None of the patients had received physical therapy or other restorative interventions at the time of their enrollment into the study.

All patients reported a traumatic event

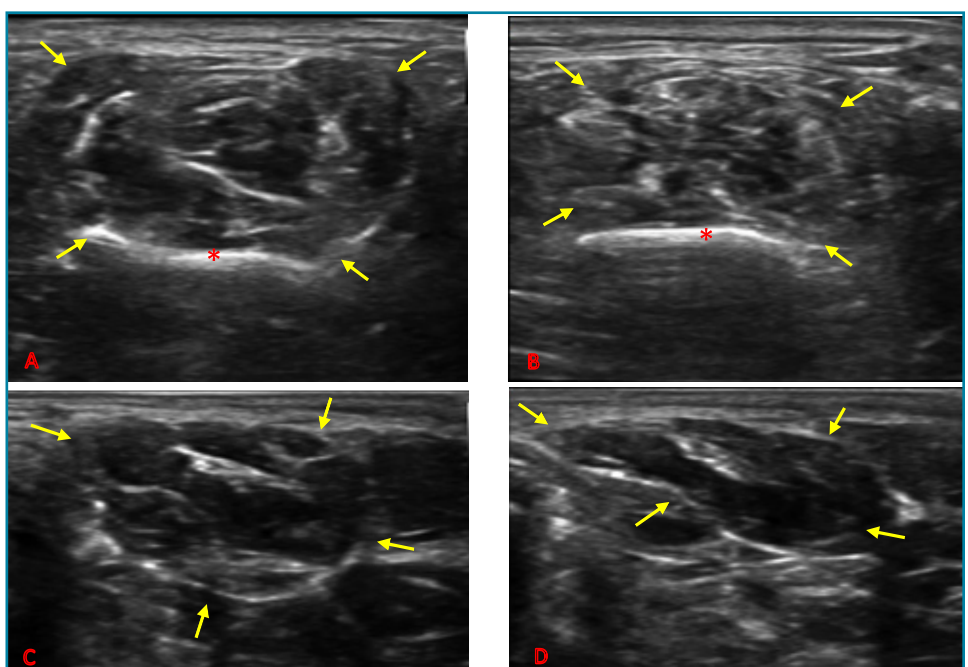

Figure 1. A, Cross sectional area fibularis uninvolved limb subject 2. Arrows indicate margins of muscle, *fibula. B, Cross sectional area fibularis involved limb subject 2. Arrows indicate margins of muscle, *fibula. C, Cross sectional area of abductor hallucis muscle uninvolved side, subject 1. Arrows indicate margins of muscle. D, Cross sectional area of abductor hallucis muscle involved side, subject 1. Arrows indicate margins of muscle.

Table 1. Patient Demographics and Injury Descriptors

Patient	Age (Year)	Sex	Height (cm)	Weight (kg)	Mechanism of Injury	Fracture Description
1	18	F	157.48	56.70	horse fell on top of her	distal fibular fracture
2	43	M	177.80	86.18	waterskiing	fracture talus, peroneal retinaculum tear
3	63	F	154.94	97.52	slipped on step	ankle dislocation, fibular fracture, deltoid sprain
4	54	F	167.64	72.57	twisted on stairs	tibia/fibula fracture
5	38	F	162.56	77.11	slipped on ramp	Maisonneuve fracture
6	50	F	167.64	68.03	stepped into hole	talar fracture
7	26	M	180.34	74.84	landing from high bar	deltoid ligament sprain grade 3
8	17	F	160.02	61.23	slid into 3rd base	distal fibular fracture
9	20	F	182.88	92.99	stepped off bike	fibular fracture
10	35	F	165.10	70.31	fainted & fell down	distal fibular fracture
11	46	M	180.34	83.91	jumped in river	Lis Franc fracture
12	21	F	157.48	81.19	fell off truck bed	trimalleolar fracture w/dislocation
13	63	F	160.02	62.60	slipped while hiking	fibular fracture, deltoid sprain
14	47	M	180.34	89.81	cutting wood	fibula fracture
15	48	F	170.18	72.57	fell from horse	open tibia/fibula fracture

Abbreviations: cm, centimeters; F, female; kg, kilograms; M, male

resulting in a fracture (see Table 1). The majority of the mechanisms of injury involved sports (8) and inclines/stairs (4). The fibula was the most frequently injured bone. All patients were immobilized after sustaining their injury. Open reduction with internal fixation was used to treat fractures in 10 patients; 1 patient had a reconstruction of the lateral retinaculum; 4 had casting without surgery. The total length of immobilization (Table 2) ranged from 35 to 189 days with a mean of 69.5 days. Excluding one patient with an exceptionally long immobilization (189 days), the mean length of immobilization was 61 days. The mean duration of non-weight-bearing time was 45.5 days (35-56 days). The mean duration of partial weight-bearing time was 20.9 days (1-77 days).

The FAAM was completed by all patients and was used to assess their self-perceived functional capacity related to their ankle fracture episode. Scores ranged from 16% to 82% with the mean score being 51.1% (see Table 2). Excluding the outlier previously mentioned, the range was 20% to 82% with a mean score of 53.6%.

Delay in initiation of physical therapy but not length of immobilization showed a moderate correlation to perceived function (Figure 2). There was no strong correlation between immobilization length and perceived function (r=-0.2, 0.47). The scatter plot showed no clear trend (r=0.37, p=0.19) even with the outlier removed (length of immobilization = 189) (Figure 2). There was no correlation between delay in initiation of physical therapy and perceived function (r=-0.32, p=0.24). However, the scatter plot showed one outlier (delay in initiation of rehabilitation = 121 days) (Figure 2). When this value was removed, there was a moderate relationship between delay in initiation of physical therapy and perceived function (r=0.51, p = 0.06).

The CSA of the abductor hallucis and fibularis muscles (brevis and longus in combination) were significantly lower on the involved side (Table 3, Figure 1). There was a significant difference in abductor muscle size (n=9) between the uninvolved and involved limb ($p < 0.01$) (Figure 3). Expressed as a percent, the abductor hallucis (n=9) demonstrated a mean of 28.5% less CSA on the involved side compared to the uninvolved with a range of 3.1% to 49.9%. However, abductor halluces muscle atrophy (n=9) was not correlated with the length of immobilization (r=-0.24, p=0.54) or the delay in initiation of mobilization (r=0.49, p=0.18). The scatter plots showed no outliers (Figure 4). A post hoc analysis showed that to determine a significant correlation of r=0.49 a sample of 30 subjects would be needed. Fibularis muscle CSA (n=5) was also significantly different from uninvolved to involved side ($p<0.01$) (Figure 5). Expressed as a percent, the fibularis (longus and brevis combined) had a mean score of 33.1% less CSA on the involved side with a range of 17.3% to 47.3%.

CLINICAL RELEVANCE

The findings of this pilot data are that length of immobilization is likely not strongly correlated to perceived function or foot muscle atrophy. This study examines a diverse set of patient with a diagnosis of ankle fracture similar to a previous study.[7] Although length of immobilization varied (35 to 189 days), it did not correlate strongly with perceived function or muscle atrophy (see Figures 2 and 3). Although this data is not powered to detect more moderate correlations, this data suggests that the correlations may not be sufficiently strong enough to be of use clinically. Other features such as trauma and type of fracture may also be relevant as well as patient behaviors (ie, activity levels) (Table 1). Somewhat unexpectedly, there was conflicting data on the influence of a delay in initiating physical therapy. Patients that delayed initiating rehabilitation showed a trend toward improved perceived foot function (Figure 2). However, muscle atrophy showed a trend toward increasing with longer delays to initiation of rehabilitation (Figure 3). Although this pilot data is not conclusive, it highlights the likely weak association of length of immobilization and delays of initiating treatment on perceived function and muscle atrophy in a pragmatic sample. It also raises the possibility that the more important

Table 2. Immobilization and Function

Patient	Total Duration of Immobilization	NWB type (weeks)	PWB type (weeks)	# of days post-immobilization to time of study	FAAM (%)
1	5	boot (5)	WBAT aircast (3)	21	80
2	12	cast (7)	boot (5)	24	70
3	6	cast (6)	WBAT (1)	4	47
4	7	cast (1) boot (6)	WBAT	5	51
5	14	boot (7)	boot (7)	18	51
6	16	cast (3) boot (2)	brace (11)	11	75
7	9	boot (8)	boot (1)	7	35
8	9	boot (9)	WBAT	2	60
9	8	boot (8)	unsure	29	61
10	6.5	cast (6.5)	crutches (1.5 days)	1	20
11	8	cast (7)	boot (1)	2	32
12	6	cast (6)	boot TTWB (3 days)	3	43
13	12	boot (6)	boot (6)	5	82
14	7	cast (7)	WBAT	10	45
15	27	cast (3) boot (20)	splint (2)	121	16

Abbreviations: FAAM, Foot and Ankle Ability Measure; NWB, non-weight bearing; PWB, partial weight bearing; TTWB, toe touch weight bearing; WBAT, weight bearing as tolerated

factor may be ankle fracture type (ie, severity of injury) or other management issues.

The immobilization length varied more than in previous studies, however, it was not associated with perceived function or muscle atrophy. Six of our 15 patients were immobilized for a period of 63 days or greater (63-189 day range, mean 105 days) (Table 2). The longest immobilization period (189 days) was an open fracture associated with osteomyelitis (outlier). This data was consistent with marked deficits in perceived function.[6] Length of immobilization, although varied did not influence perceived function in this small sample (see Figure 2). Similarly, muscle atrophy did not show a correlation with length of immobilization (see Figure 3). Other studies addressing muscle responses after fracture examined patients immobilized for shorter periods of time (42-56 days). What is not mentioned in these studies is the weight-bearing status of the patients, which may mitigate muscle atrophy.[9] Overall, the 15 patients had a mean of 66.4 total days of modified weight bearing (45.5 days non-weight-bearing, 20.9 partial weight-bearing) (Table 2). The 20.9 days of partial weight-bearing in these patients may have decreased the degree of muscle atrophy.

The delay in initiating treatment showed no strong correlation with perceived function or muscle atrophy. To our knowledge, no studies examined the delay in initiating treatment after an ankle fracture. Likely, this variable only applies to the select patients who attended physical therapy and not other patients who do NOT attend rehabilitation.[16] Nevertheless, 14 patients showed a trend toward improved perceived function with a longer delay (Figure 2). In an interesting finding, foot muscle atrophy showed the opposite trend toward greater atrophy with the longer delay (Figure 3). This finding is interesting because of the new focus on the potential impact of foot muscle atrophy on ankle function. However, delays in initiating rehabilitation did not strongly influence either muscle atrophy or perceived function.

Foot muscle atrophy was significant (see Figure 1), approximating the degree of atrophy observed in previous studies of the calf muscles. This is the first study to our knowledge to directly examine foot muscle atrophy associated with ankle fracture. The difference between involved to uninvolved side in muscle size (25%) for the abductor halluces (n=9) (see Figure 4, Table 3) were approximately equal or greater than previous studies of calf muscle atrophy due to cast immobilization after ankle fracture.[9,11,15] Although a small sample (n=5), fibularis muscle size was similarly different side to side (33%) (Figure 5, Table 3). It is interesting to consider the potential association of fibularis muscle atrophy with fibularis fractures. Because the fibularis bone is commonly involved in ankle fractures both distal (malleoli) and proximal (Maisonneuve), this data raises the possibility of selective atrophy of the fibularis muscle group and could be examined in future studies. The potential importance of foot muscle atrophy (fibularis and abductor halluces) is underscored by new studies identifying effective rehabilitation programs for patients with foot problems.

Recommendations for rehabilitation of the ankle following fracture include the use of exercises specific to the foot and barefoot weight bearing (Table 4). It has been demonstrated that increases in abductor halluces muscle CSA of 12.9% to 16.7% and increases in first metatarsophalangeal (MTP) flexion force (34.5%-44.4%) were obtained with an 8-week, 5 days per week exercise program along with 2 hours of barefoot weight bearing.[19] In this study, participants with asymptomatic flatfoot performed exercises such as toe spreading, foot doming (short foot) seated and in standing, and posterior tibialis activation (ankle inversion) against a resistance band. Participants also spent 2 hours per day (5 days per week) barefoot performing a variety of daily tasks such as cooking, walking inside the home and house work. In addition to a positive training effect on the foot intrinsic muscles as evidenced by

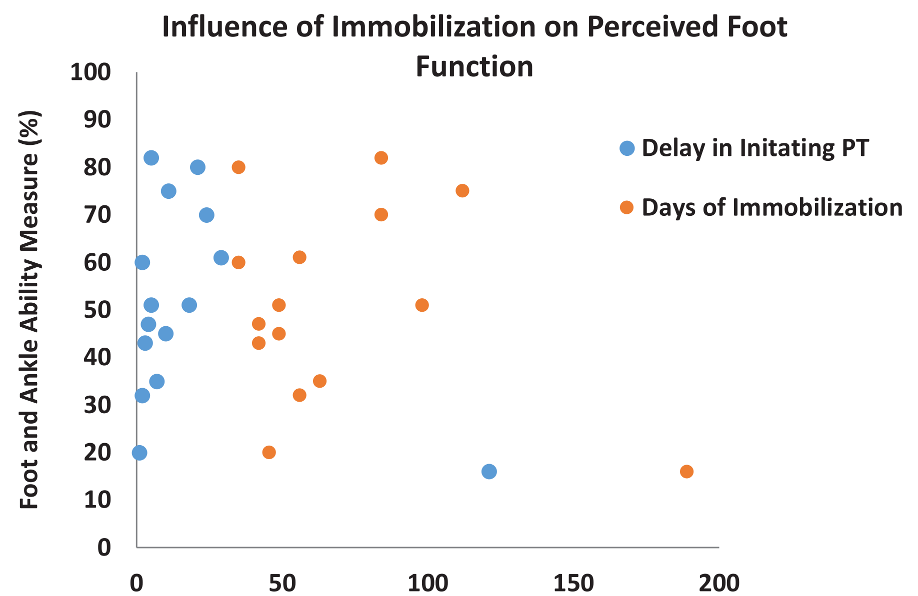

Figure 2. Scatter plot showing the relationship between number of days after immobilization that the evaluation occurred and foot function (blue) and days of immobilization and foot function (orange).

Table 3. Muscle Size

Patient	Muscle			
	Abductor Hallucis		Fibularis*	
	CSA In/Un cm²	% difference	CSA In/Un cm²	% difference
1	1.67/2.66	37.28	3.19/3.85	17.27
2	1.34/1.82	26.39	2.39/4.53	47.29
3	1.24/1.53	18.53	2.76/4.11	32.87
4	0.92/1.67	45.06	3.43/4.97	30.88
5	1.09/1.99	45.14	2.98/4.73	37.03
6	1.23/1.31	5.89		
7	1.72/1.77	3.10		
8	1.74/2.33	25.55		
9	1.14/2.28	49.93		

Abbreviations: cm², centimeters squared; CSA, cross sectional area; In, involved; Un, uninvolved
*Fibularis, longus and brevis

increased CSA and first metatarsophalangeal flexion force, ankle function improved without training of the calf muscles.[19] Participants achieved a significant increase in heel rise height and repetitions without ever performing exercises for the calf. A foot specific exercise routine as outlined above would directly address the deficits in muscle size observed in this study of patients with ankle fractures. An additional benefit of foot intrinsic exercise is that they may be performed while in an immobilization device whenever the healing process permits muscle activation to occur.

Limitations

This pilot study is not conclusive, however, was powered to detect stronger correlations (r>0.65). The sample size and variability of ankle fracture type contributed to significant heterogeneity consistent with other studies.[7] Future studies may consider other variables to stratify patients after ankle fracture into variables important to prognosis (ie, fracture type and performance variables).[12,18,26-28] Although a majority of patients do well post ankle fracture, rehabilitation is long and a significant number of patients suffer long-term problems.[5,6] Identifying what prognostic factors influence recovery is valuable to clinicians and patients.

CONCLUSIONS

This small pragmatic sample showed little utility in clinicians noting the length of immobilization or delay in initiating physical therapy after immobilization. Fracture type and other variables are likely influencing perceived function and muscle size. However, perceived function and foot muscle atrophy at the start of rehabilitation demonstrated marked deficits. Whether providing patient education or participating in a supervised exercise program, clinicians should consider remediating the perceived function and foot muscle atrophy as part of their integrated approach to rehabilitation after an ankle fracture.

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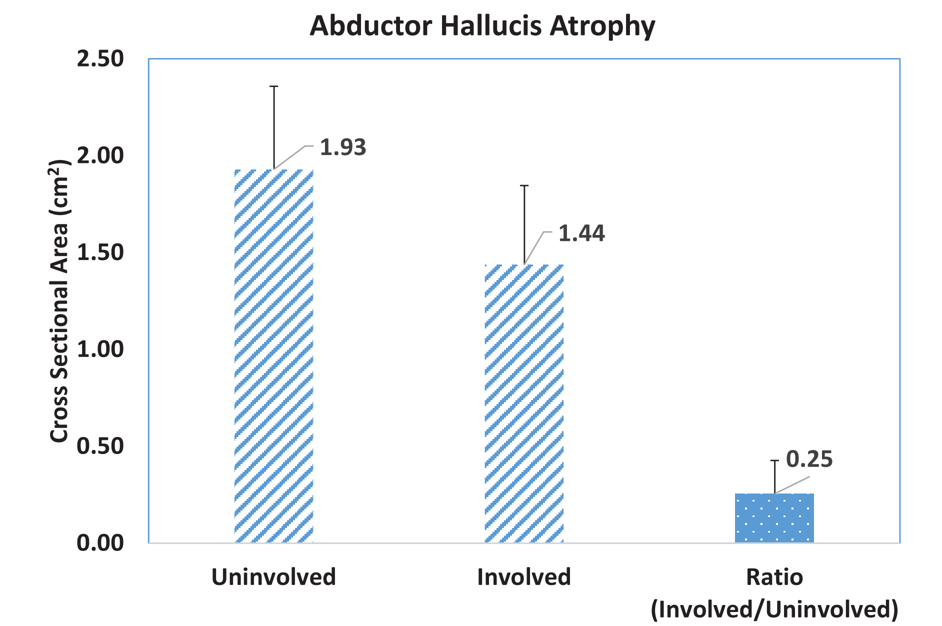

Figure 3. Abductor hallucis muscle girth measures (cm²) of the involved side, uninvolved side, and ratio (involved/uninvolved).

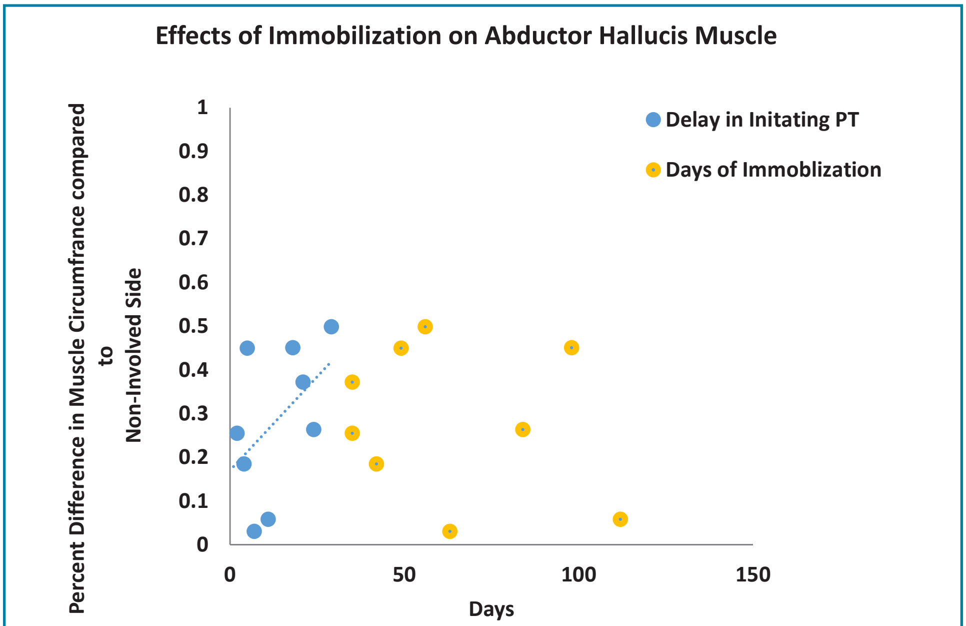

Figure 4. Scatter plot showing the relationship between days after immobilization that the evaluation occurred and abductor hallucis muscle circumference (blue) and days of immobilization and abductor hallucis muscle circumference (yellow).

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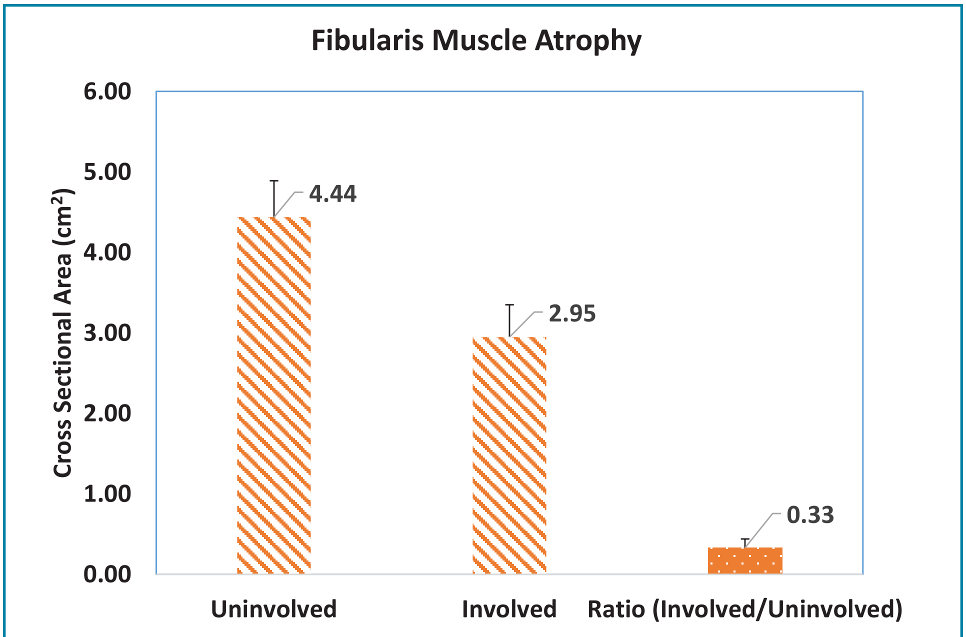

Figure 5. Fibularis muscle girth measures (cm²) of the involved side, uninvolved side, and ratio (involved/uninvolved).

Table 4. Recommendations for Ankle Fracture Rehabilitation

Impairment	Intervention	Evidence to inform clinical decisions	References
Decreased plantar flexion torque	Uphill treadmill walking, resistance training for gastrocsoleus complex	24.4% - 32% atrophy of plantar flexors post immobilization	9-12,15
Decreased ankle dorsiflexion	Joint mobilization, static stretching	Significant decrease in ankle dorsiflexion immediately following immobilization and up to 14 months post immobilization	7,12,28
Difficulty with stair climbing, walking	Joint mobilization, passive stretching, proprioceptive training resisted plantar flexion, walking	Decreased plantar flexion torque and fatigue post immobilization	7,10
Decreased balance	Proprioceptive training	Significant loss of balance control 14 months post fracture	26
Difficulty with heel rise	Foot specific exercises	Significant loss of heel rise height and reps post immobilization; significant increase in heel rise performance with foot specific exercises	19,28
Strength and mobility related to ankle eversion	Resistance training for fibularis	Up to 47% decrease in cross section area of fibularis seen in fracture of fibula	19

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- These Clinical Practice Guidelines (CPGs) are currently being revised/updated?
  - Low Back Pain – updating the initial 2012 guideline
  - Shoulder Pain and Mobility Deficits: Adhesive Capsulitis – updating the initial 2013 guideline
  - Ankle Stability and Movement Coordination Impairments/Ankle Ligament Sprain – updating the initial 2013 guideline
  - Non-arthritic Hip Joint Pain – updating the initial 2014 guideline
  - Heel Pain / Plantar Fasciitis – updating the revision from November 2014
  - Neck Pain– updating the revision from July 2017
- These Clinical Practice Guidelines (CPGs) are currently being developed?
  - Knee Injury Prevention
  - Carpal Tunnel Syndrome
  - Work Rehabilitation
  - Patellofemoral Pain Syndrome
  - Elbow Epicondylitis
  - Distal Radius Fractures
  - Shoulder Instability
  - Hip Fracture
  - Post Concussion Syndrome
  - Medical Screening in Management of Common Musculoskeletal Conditions
  - Prevention of Chronic Pain Associated with Common Musculoskeletal Conditions
  - Pelvic Pain
- For all the news on CPGs check out: https://www.orthopt.org/content/practice/clinical-practice-guidelines

ORTHOPAEDIC SECTION

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Decreased Balance and Injury Risk in Adolescent Baseball Pitchers

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ABSTRACT

Background and Purpose: Deficits in pitchers dynamic balance is associated with declines in pitch mechanics and injuries like ulnar collateral ligament tears. Little evidence correlates pitching fatigue and dynamic balance. This study describes injury risk classification in baseball pitchers as it relates to their declined dynamic balance. **Methods:** Thirty male, adolescent baseball pitchers with no recent injuries participated. The Y Balance Test was administered pre- and post-pitching and injury risk classification was calculated. **Findings:** Y Balance Test composite scores demonstrated statistically significant decreases pre- and post-pitching using paired t-tests on stance limb (mean difference = 3.146, 95% CI .393 – 4.898, p>.001) and lead limb (mean difference = 4.340, 95% CI 2.555 – 6.125, p>.000). **Clinical Relevance:** Youth baseball pitchers show declines in functional balance. Medical and conditioning personnel may need to provide injury prevention screening and training. **Conclusion:** Youth pitching leads to significant balance deficits. Nearly all participants' pre-pitch balance indicated potential benefits from injury prevention programs.

Key Words: injury prevention, Y Balance Test, youth athletes

INTRODUCTION

Baseball pitching injuries in the young athlete are a serious concern for parents, coaches, and medical professionals.[1-3] Among high school players, the incidence of elbow pain reported is 58% and the incidence of shoulder pain is between 29% and 35%.[1] In order to prevent injuries, coaches rely on assessing the following risk factors: pitch counts, pitch mechanics, and the athlete's overall fitness level.[1-6] Currently the only objectively measurable injury prevention mechanism in place for coaches to follow during the season is pitch counts, which includes counting the number of pitches in a game, season, and year and referring to age charts to see how many pitches a pitcher of that age should be allowed to pitch.[7,8]

The kinetics of a baseball pitch requires energy from ground reaction forces to transfer energy up the kinetic chain from the legs, through the body, culminating in energy transferred to the baseball as it is released.[3-6] The goal of the kinetic chain is to transfer maximum force through ground reaction forces and distal segment to the baseball.[9] Lower extremity force production is vital for increased ball velocity. If there are alterations in the force production of the lower extremities, shoulder and elbow injuries can occur.[3,9] Therefore the ability to use the lower extremities properly during a pitch is vital to keeping the shoulder and elbow of a baseball pitcher injury free.

It has been demonstrated that deficits in an athlete's dynamic balance in a preseason screening are a good predictor of lower extremity injury during the season.[10,11] Additional research demonstrated differences in decreased dynamic balance scores in collegiate-level baseball players when tested during the pre-season. When comparing those who did and did not suffer ulnar collateral ligament tears, dynamic balance may have played a role.[12] However, there is a paucity of evidence on how dynamic balance is affected as an athlete fatigues during the course of a practice or game. Hence the purpose of this study is to determine if a baseball pitcher's dynamic balance declined with pitching in games and/or practice bullpens. A secondary purpose was to see if pitching and possible balance declines affected injury risk classification.

METHODS

This study was approved by the John Muir Health Institutional Review Committee and all participants gave informed consent prior to any data collection or analysis.

Participants

Youth league and high school baseball pitchers involved in organized baseball teams/leagues were recruited to participate. Inclusion criteria required participant to (1) pitch for a youth/high school organized baseball team, (2) speak and read English, and (3) complete an informed consent procedure (one parent signature, student participant assent). Any active injury at time of consent was the only exclusion criteria. Participants were assigned a study ID number to maintain confidentiality on the data collection instruments.

Demographic data

Demographic data was collected after informed consent, and consisted of age, height, weight, hand dominance, leg length, and years pitching. A soft tape measure was used to measure leg length. Pitch counts were recorded by the researcher and verified with the coach for each participant during each measurement session.

Y Balance Test

The primary measure in this pilot study was the Y Balance Test.[10,13] This is a dynamic test of standing balance performed in single limb stance bilaterally. Participants complete 3 directional reaches with each limb: anterior, posterior-lateral, and posterior-medial. The excursion of each limb is recorded in centimeters with 3 attempts in each direction recorded. The longest distance in each of the 3 directions is combined for a composite score. Studies have found excellent test-retest reliability[10] and inter- and intrarater reliability[13,14] in high school athletes. Immediately prior to pitching, instruction in the Y Balance Test was given by the primary researcher to ensure participants' understanding of the test, and used as practice. The Y Balance Test was then administered to participants and recorded prior to a practice bullpen or game and again immediately at its conclusion.

Injury risk classification

The Move2Perform software[15] (Move2Perform, Evansville, IN) used the directional composite scores to determine injury risk classification specific to baseball pitchers. This software uses an injury prediction algorithm composed of the composite Y Balance Test scores, leg length, age, height, and sport to determine an injury risk classification. Risk classifications were defined as optimal, slight deficit, moderate deficit, or substantial deficit.

Data Analysis

Sample size was calculated a priori to find moderate correlation (0.05) and was found to be 30 participants. Descriptive statistics were calculated for demographic data of participants. Pitch counts were compared to age-matched norms.[7,8] Paired t-tests were used to compare changes in pre- and post-pitching Y Balance Test composite scores for each lower extremity. Analyses were conducted using SPSS (IBM Corp, Armonk, NY.). Statistical significance was determined using confidence intervals (95%) and $p < 0.05$.

RESULTS

Thirty male adolescent baseball pitchers aged 10-18 years (mean=13.70, SD=3.03) consented and participated in this study. The mean pitch count for the participants was 30.03 (SD = 11.30) with a pitch count range of 15 to 62 pitches per game or bullpen. No participants exceeded the established pitch count thresholds based on age.

Y Balance Test composite scores demonstrated statistically significant decreases pre- and post-pitching using paired t-tests on stance limb (mean difference = 3.146, 95% CI .393 – 4.898, p > .001) and lead limb (mean difference = 4.340, 95% CI 2.555 – 6.125, p > .000) (Table 1). To account for right vs left handedness, the stance limb was defined as ipsilateral to handedness and lead limb was contralateral to handedness.

Determination of injury risk based on the Move2Perform results showed 96.7% (n=29) of participants were classified as suboptimal before pitching with 40% at slight deficit, 50% with moderate deficit, and 6.7% in the substantial deficit category (Figure 1). After pitching 28.6% of those who could move to a higher injury risk classification (n=28) showed further decline, while 10.3% improved to a lower risk category and 63.3% stayed in the same injury risk classification (Figure 2). Of note, only one participant pre-pitching and two participants post-pitching were classified as optimal.

DISCUSSION

Even in a small, otherwise healthy population of youth baseball pitchers a significant decrease in pre- and post-pitching dynamic balance deficits were noted, possibly putting players at risk for injury. Garrison et al[12] in a study of baseball players noted Y balance test anterior reach differences between sides of greater than 4 cm were 2.5 times more likely to experience a lower extremity injury. Given the lower extremity requirements for normal pitching mechanics, differences such as those seen in this pilot study raise concern for injury, especially considering these differences were noted within a game or pitching bullpen. When considering the potential for cumulative changes over the length of the season, these one-time changes are significant and should be considered when devising programs for pre-season conditioning or maintaining healthy players over the course of a season. Additionally, dynamic balance control might be an impairment to be monitored during rehabilitation of injured players to determine readiness and safety for return to play.

Another significant finding of this pilot study was that these changes in dynamic balance were noted in youth pitchers who stayed within established pitch counts based on age.[7,8] Even with relatively low pitch counts in participants, these youth pitchers demonstrated significant decreases in balance in both lower extremities. Coaches use pitch counts to help prevent injuries but impairment-level changes in balance were still present, which may increase a player's risk for injury.

Using the testing protocol in this study nearly all participants' (n=29) pre-pitch balance scores classified them as at risk for injury. Consideration for pre-season testing and condition programs are aimed at assessment and improvement of dynamic balance. Its improvement may be beneficial for youth pitchers. Especially concerning was the finding that 28.6% of participants increased their injury risk after limited pitching. Clearly endurance of dynamic balance could be improved in this subset of participants. The interesting finding that 3 participants (10.3%) improved their injury risk profile after pitching may warrant that more study is needed to explore potential causes. These data imply that many youth baseball pitchers could potentially benefit from an injury prevention program aimed at dynamic balance and balance endurance.

Study Limitations

This was a pilot study with a small number of participants; replication with a larger sample may be beneficial. Move2Perform software injury risk profiling has only been validated in subjects with non-contact lower extremity injury, which may be a limitation to this study.[16] Also a more rigorous study design with varied measures is needed, especially for investigating the potential benefit of prevention and interventions aimed at improving dynamic standing balance for pre- and in-season baseball performance. Also the cut-off values (risk classifications) used in the software and any sampling limitations when comparing to other study samples may need to be further validated.

CLINICAL APPLICATIONS

Within the design of this study, healthy youth baseball pitchers demonstrated decreased dynamic balance bilaterally post-pitching. Declines in balance scores were seen despite pitching within age-established pitch counts. Increased classification risk for injury before a game/bullpen with potential to worsen after pitching within age-established pitch count limits was seen in the majority of participants in this pilot study. These changes may increase injury risk during practice or games or over the course of the season. Health care providers may be uniquely suited to address both functional balance deficits and injury risk. Injury prevention testing and interventions may benefit youth baseball pitchers. Physical therapists should be part of providing these services.

Table 1. Y Balance Test Paired t-test Results

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	SD	SEM	*Lower*	*Upper*	t	df	Significance (2-tailed)
Stance Limb	3.146	4.692	.875	1.393	4.898	3.672	29	.001
Lead Limb	4.340	4.781	.873	2.555	6.125	4.973	29	.000

Abbreviations: SD, standard deviation: SEM, standard error of means; t, t-test; df, difference

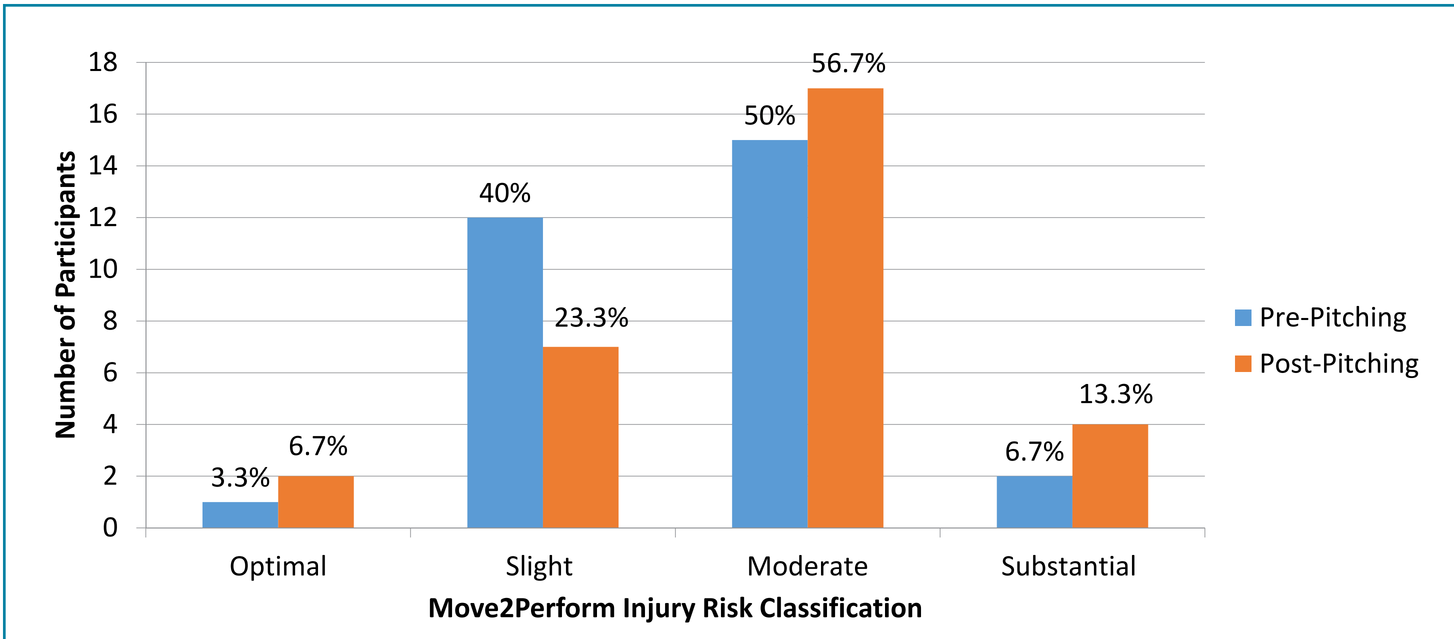

Figure 1. Participant's injury risk classification.

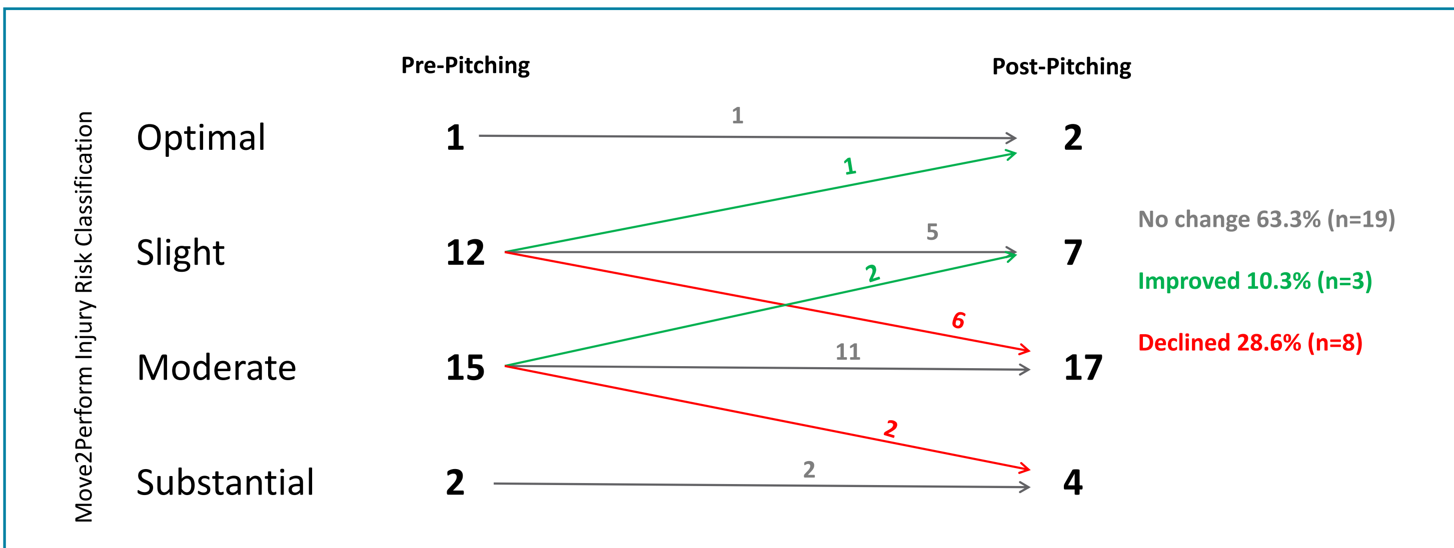

Figure 2. Changes in injury risk classification after pitching.

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Activity Assessment in Adults with Amputation

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ABSTRACT

Background: Physical activity (PA) can lead to improved balance, strength, and ambulatory function in adults who have undergone lower limb amputation (LLA). **Purpose:** The purpose of this study was to determine the accuracy of 5 PA monitors for posture, step count, and PA in adults with unilateral transtibial amputation (TTA). **Methods:** Adults (N=7) with unilateral TTA wore PA monitors concurrently. Four 6-minute counter-balanced activity phases were completed. **Findings:** For posture, no differences were found across monitors. For steps, only one PA monitor was valid across phases. For minutes of PA, no monitors were consistently accurate across phases. **Clinical Relevance:** Determination of a valid PA monitor will provide clinicians with an objective measure of PA engagement. Assessment of PA engagement may help guide clinician recommendations when working with adults with LLA, or more specifically TTA. **Conclusion:** This study provides important framework for assessment of PA accumulation and time in sedentary behaviors.

Key Words: accelerometer, pedometer, validation

INTRODUCTION

Physical activity (PA) is known to prevent onset of chronic disease and obesity.[1,2] Currently, 150 minutes/week of moderate PA or 75 minutes/week of vigorous PA is recommended for otherwise healthy adults.[3] Physical activity recommendations for adults with disability or chronic conditions state that 150 minutes/week, or as much activity as the disability or condition will permit, is ideal.[4] Individuals with lower limb amputation (LLA) may be at increased risk for chronic disease due to physical inactivity or decreased levels of PA following amputation surgery; therefore, it is particularly important to accumulate as much PA as possible.[5-7] Emerging research has shown that a sedentary lifestyle in which extensive sitting is typical is deleterious to health.[8-10]

In addition to risk reduction for chronic disease, PA can lead to independent living and enhanced levels of function, notably in overall balance and strength, in those with LLA.[11-13] Lower limb amputation can affect neuromuscular control and coordination. In addition, LLA may affect routine activities of daily living and general function, which may explain the decrement or alteration in PA behaviors for those with LLA.[14] Thus, it is imperative for health care providers and clinicians to better understand *actual* PA levels in adults with LLA. To gain insight into PA behaviors in an adult population with amputation, researchers must bridge the current gaps in the existing body of evidence. To date, few studies have used PA monitors to assess PA in adults with LLA.[15]

Physical activity monitors provide an objective mode to measure the amount and nature of PA, physical inactivity, or posture (ie, sitting, standing, walking, etc). They may also be used to substantiate self-reported PA engagement to determine habitual PA levels. While self-reported PA data is both inexpensive and feasible, it is subjective and usually results in over- or under-reporting of PA time, intensity, and frequency.[16] A more objective method of PA assessment is needed to actively address any disease disparities related to physical mobility, or lack thereof, associated with amputation. Researchers must determine whether a PA monitor is accurate in a controlled setting prior to their use in a free-living environment. The monitor must first be demonstrated to be accurate in a controlled environment in the population of interest. Many objective PA monitors have feedback mechanisms that allow the user to track PA behaviors. Studies have shown that ability to quantitatively track PA and having a goal for daily PA volume are associated with beneficial health outcomes, such as reduced body mass index (BMI).[17]

As previously stated, few PA monitors have been used to assess movement in adults with traumatic LLA.[17-20] However, a large body of research has evaluated PA monitors in children, adolescents, and adults of various weight statuses and health conditions.[21-26] Further, PA monitors that have been determined valid for use in some populations; however, have not been valid for use in other populations.[25,27-29] When considering a population that may have altered gait patterns, it is reasonable to assume that PA monitors and their respective metrics should be evaluated in a controlled environment before these devices are adapted to other scenarios.[29]

The purpose of this study was to determine convergent validity of 5 PA monitors in ambulatory men and women between the ages 21 and 64 with traumatic LLA, specifically, adults with unilateral transtibial amputation (TTA). The following PA monitors were included: the Yamax Digi-Walker SW-200 (DG; Yamax Corporation, Tokyo, Japan), the ActiGraph GT3X (AG; ActiGraph, LLC, Pensacola, FL), *Activ*PAL (AP; PAL Technologies Ltd, Glasgow, UK), the SenseWear Armband (SWA; BodyMedia, Pittsburgh, PA), and the Intelligent Device for Energy Expenditure and Activity (IDEEA; Minisun, Fresno, CA). Specific outcomes were posture (sitting and standing), steps, and time (minutes) in sedentary, light physical activity (LPA), and moderate physical activity (MPA).

METHODS

Participants

Eligibility criteria included ambulatory adults ages 21 to 64 years with (1) TTA who self-reported that they could independently perform routine activities of daily living without assistive devices (other than prosthesis), (2) no history of smoking, cardiovascular disease, hypertension, stroke, or neuromuscular disorders, and (3) a BMI <30.0 kg/m^2. Participants were excluded if they had a medical history of any of the abovementioned conditions, had a BMI ≥30.0, or had an amputation due to chronic disease, which may indicate cardiovascular disease, diabetes, or congenital defect, rather than trauma.

Study Design

The university institutional review board approved this cross-sectional pilot study. All participants visited the research laboratory once to complete informed consent and HIPAA forms to be familiarized with the measures and protocol before baseline values were obtained. Validity was determined during 4 counterbalanced 6-minute phases: sitting, standing, a light self-paced walk that represented LPA, and a brisk self-paced walk that represented MPA. A random number generator was used to determine the order of phases for each participant. A minimum 2-minute washout period was provided between each phase. This period allowed monitors to register no activity and the participants' heart rates to return to baseline before beginning the subsequent phase. Reference criteria for comparing the sitting, standing, and walking phases were stopwatch-recorded time, direct observation of standing and hand-tallied steps, respectively. The sit and stand phases were conducted inside the laboratory. Self-selected walking phases took place in an interior, climate-controlled, continuous hallway (Figure 1).

Intensity range for the LPA and MPA phases was determined using the heart rate reserve (HRR) calculation, target heart rate (HR) range = (HRmax - HRrest) x % intensity/100) + HRrest,[30] based on resting HR. For each participant, target HR was calculated for the LPA and MPA phases (20-39% and 40-59% of HRR, respectively).[31] Beats per minute (BPM) were calculated for the high and low end for both LPA and MPA for each participant. Participants were familiarized with the order of the phases and the measurements prior to beginning. For reference, a flow chart of procedures and matrix of assessed metrics is provided in Table 1.

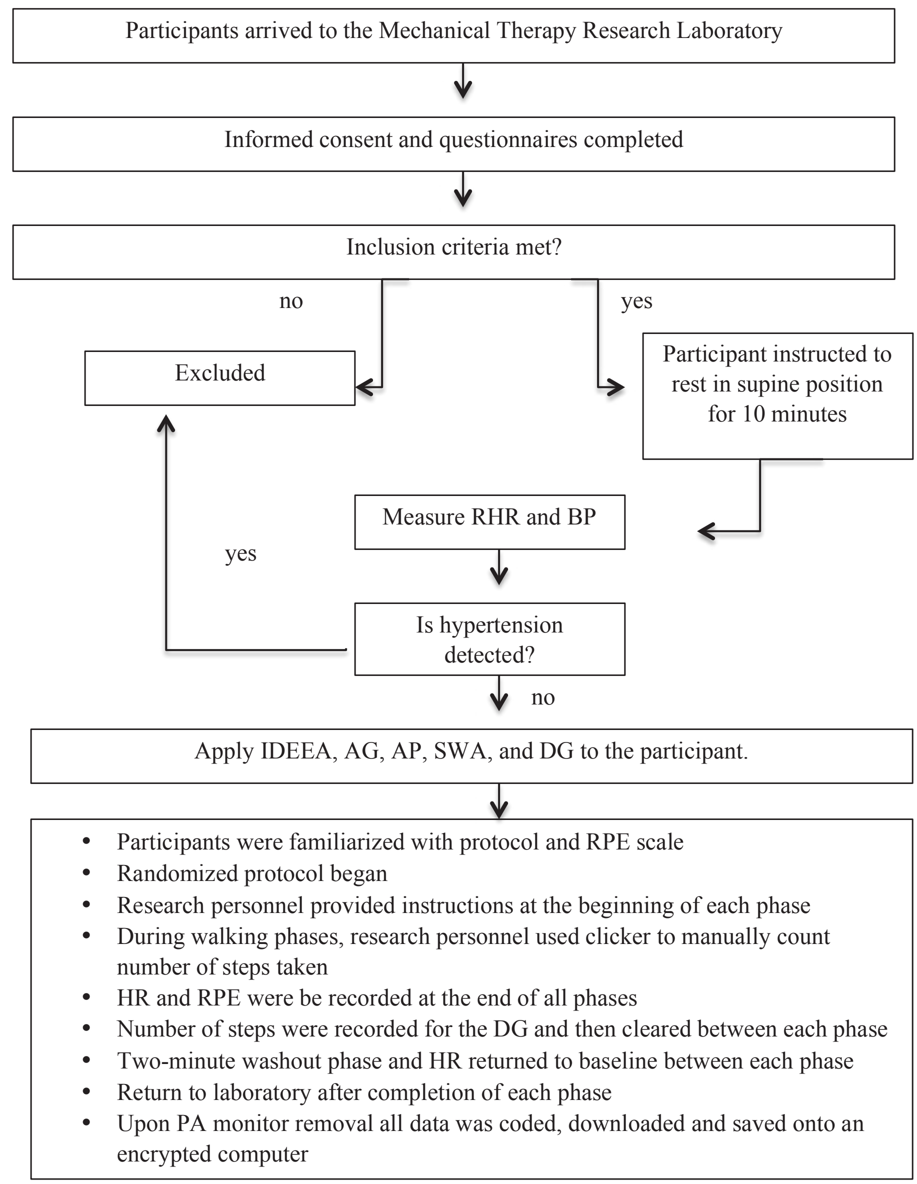

Figure 1. Study design schematic.

Measures

Direct observation of posture and hand-tally of steps

Participant posture was directly observed during each phase. The observer noted deviations in posture, and recorded all postures and hand-tallied steps. Direct observation was used as the reference criterion for the sitting and standing phases. Actual time spent sitting and standing was compared to the 6-minute assigned sitting and standing phases. A hand-tally was used as the step count reference criterion for each phase. The same researcher monitored participants throughout all phases and used a clicker to obtain hand-tallied steps.

Yamax DigiWalker SW-200

The Yamax DigiWalker SW-200 (DG) is a waist-mounted pedometer that measures steps. In the present study, the DG was clipped to an elastic belt at the participants' right hip. For accurate recording of steps at each phase, the PA monitor was reset to zero prior to beginning each phase. The DG has been evaluated in both controlled and free-living environments in adult population ages 20 to 91 without amputation, disability, or chronic conditions.[32-36] In controlled environments, the DG has been assessed via treadmill at varying speeds, in both standardized protocols and protocols with self-selected walking paces, as well as in a travel setting,[32,33] and in free-living environments at self-selected walking speeds.[34] In addition, the DG has been tested in an adult population with Parkinson's disease.[36] Findings from the above cited studies have cohesively reflected increased accuracy at increased speeds, with

Table 1. Matrix of Analyzed Metrics and Respective Criterions for Physical Activity Monitors

Instrument	Steps	Minutes of Physical Activity	Posture
Yamax DigiWalker SW-200	X	N/A	N/A
SenseWear Armband	X	X	N/A
ActiGraph GT3x	X	X	N/A
*Activ*PAL	X	X	X
IDEEA	X	X	X
Criterion	Hand-tally	Stopwatch	Direct Observation

This table presents metrics measured by each physical activity monitor used.
Not Applicable (N/A): device or tool does not measure in the listed metric.
X-mark: metric was measured by respective monitor(s).

a tendency toward under-counting at slower speeds. The DG is generally deemed an appropriate monitor in populations without disability or chronic conditions.

ActiGraph GT3x

The ActiGraph GT3x (AG) is a waist-mounted, triaxial accelerometer, which measures time in PA, classifies intensity, and estimates steps. The AG was worn directly next to the DG on an elastic belt. The belt was fitted to each participant based upon each PA monitor's user instructions. Movement was recorded in 15-second time intervals, operationally defined as epochs. The AG is unique among the PA monitors used in the current study due to its ability to tailor cut-points for PA estimates based on a given population. The majority of other available PA monitors have proprietary cut-points that are manufacturer-owned and, generally, non-disclosed. The Freedson cut-points for activity intensity are frequently used to analyze data collected in adults. However, these cut-points have not yet been validated in an adult population with amputation.[37] The AG has been tested in various controlled and free-living environments, and has consistently been found to be a valid and reliable monitor for PA assessment in healthy, non-amputee populations.[28,38-41]

Data treatment

For the recorded time filter for each 6-minute PA phase per participant, AG data were analyzed using the Freedson equation in ActiLife Software Version 6. ActiLife cut-points were defined as: "sedentary"<100 counts per minute (cpm), "lifestyle" 100-760 cpm, and "light" 100-1961 cpm.[42] Sedentary and lifestyle categories were collapsed and analyzed into sedentary, light, moderate, and vigorous categories.

SenseWear Armband

The SenseWear Armband (SWA) was worn on the right triceps. An elastic band was used to keep the monitor in place. Although the SWA contains an accelerometer and thus is capable of step estimation and estimation of time in moderate to vigorous PA, most studies have focused on the validity of the other data outputs, such as sleep length and quality, and energy expenditure.[43-45] To date, no studies have tested the validity of the accelerometer functions for time (minutes) in moderate to vigorous PA, and only one study has tested the validity of step count in the SWA.[24] In the controlled environment designed to mimic activities of daily living, SWA underestimated steps in an adult population with rheumatoid arthritis.[24]

Data treatment

The SWA records data each second. Data for the SWA were downloaded and analyzed using SenseWear Professional 7.0 Software with the provided proprietary equations. The SWA data output is in metabolic equivalents (METs); this is used to determine time in various intensities. Metabolic equivalents are a metric that permits researchers to obtain the desired outcome (intensity). The SWA does not classify intensity according to the MET values presented in the compendium.[46] However, since raw MET values are provided in the SWA output, the minutes could be reclassified using 'My Data Properties' to be consistent with the MET classifications of sedentary < 1.5 METs, light 1.5 to ≤ 2.9 METs, moderate 3.0 to ≤ 5.9 METs, and vigorous ≥6.0,[46] thus allowing direct comparison of congruent minutes in intensity across PA monitors.

*Activ*PAL

The *Activ*PAL (AP) is an inclinometry (ie, can detect sitting vs standing) monitor and accelerometer (speed of movement across various axes), which measures time in PA, classifies intensity and posture, and estimates steps. This PA monitor was placed on the right thigh directly above the Intelligent Device for Energy Expenditure and Activity (IDEEA) using the monitor stickie provided with the unit. The AP is frequently used in both free-living and controlled environment research to determine breaks from sedentary behaviors via posture (sitting, standing, or stepping) in healthy populations.[47-51] In addition, this PA monitor has been used in populations with impaired physical mobility, such as hip fractures, neuromuscular impairment from stroke, and adults in an inpatient status.[52,53] Overall, the *activ*PAL appears to be an ideal monitor, if sedentary activity is the measure of interest for all populations.

Data treatment

Data for the AP were downloaded to *Activ*PAL Software Version 7.1.18 and exported to an Excel sheet in which minute-by-minute analyses of step count were recorded. The AP does not classify intensity according to the compendium values presented for METs.[46] However, the AP provides an Excel output for raw data, including the MET values. This output allowed us to obtain the METs data for each 15-second epoch and average those values to classify each minute's intensity. Each minute was then equated to the compendium-defined PA intensity[46] and was consistently defined the same as the SWA, to allow comparison of equivalent units. Minutes for each registered intensity by type of PA monitor were recorded by phase for each 6-minute phase per participant, to permit comparisons of the desired end-point, intensity classification. Postures were coded (0=Sedentary/Sitting, 1=Standing, 2=Stepping) and minutes per phase for each PA intensity were recorded in the data set.

Intelligent Device for Energy Expenditure and Activity

The IDEEA, system is a 5-sensor biaxial accelerometry monitor, that counts steps, detects PA modalities (sitting, standing, running, or jumping), measures PA intensity and duration and other parameters of gait patterns. These activities are recorded on a second-to-second basis (ie, 1-second epochs), and has been validated in a variety of populations without amputation.[51,54-57] While the large number of sensors and their accompanying wires make this PA monitor impractical for free-living PA assessment, its precision and accuracy provide a high level of versatility and accuracy. These features and the IDEEA's ability to discriminate between a wide variety of activities (like walking vs. stair climbing) has resulted in its use as a criterion measure for PA assessment. Since the IDEEA assesses a wide variety of specific activities (such as stair climbing), this monitor has often been selected as a criterion measure for PA assessment. With the participant in supine, the IDEEA was placed directly below the AP sensor. All sensors were placed according to manufacturer instructions.

Data treatment

Proprietary data for the IDEEA were downloaded and analyzed using the accompanying Minisun ActiView 2 software. All data were obtained from the user software. "Sitting" and "standing" were the only two categories used for the sit and stand phases. "Stepping" was considered the light self-selected pace walk. "Walking" and "jogging" were categorized as the moderate self-selected pace walk. No other output terminologies for the LPA and MPA phases were applicable.

Analyses

Frequencies, means, and standard deviations were calculated for the participant descriptive data. Under- and over-counting were calculated for each participant for each phase. Mean absolute error (MAE) and mean absolute percent error (APE) were calculated for steps and minutes of LPA and MPA to further examine error. The MAE was calculated by subtracting the variable of interest (steps or minutes) from the criterion (objective monitoring instrument– criterion = error). The value was then converted to an absolute (ie, the direction of error was removed) to circumvent compression and underestimation of error.[32] For example, if the DG registered 15 steps and 20 steps were manually counted, the error is -5, but the absolute error is 5. The absolute error for each PA monitor on each participant was calculated and averaged across all participants to create the MAE. Absolute percent error was calculated by dividing the absolute error into the criterion value, then multiplying by 100 [(error/criterion)*100].[58] Continuing with the example, if the MAE was 5, and the criterion was 20 [(5/20)*100] the APE would be 25%. The absolute percent error for each PA monitor on each participant was calculated and averaged across all participants to create the mean APE.

Repeated measures analysis of variance (RMANOVA) tests were used to compare all metrics (steps, LPA, MPA) from applicable PA monitors to the appropriate criterion. Post-hoc pairwise comparisons were used to determine whether significant differences were attributed to inter-PA monitor differences or differences between PA monitor and criterion measures. For posture, chi-square and confidence intervals were used to determine any significant differences between observer-recorded time and PA monitor-determined time in a given posture (sitting or standing). For each test, statistical significance was determined at $\alpha = 0.05$.

RESULTS

Descriptive Data

Means and standard deviations were calculated for age, weight, height, BMI, resting blood pressure, resting heart rate, and HRR (Table 2).

Posture

A paired t-test revealed no difference between observer-recorded times for sitting and standing compared with the AP and IDEEA, the only tested PA monitors that measure posture. For the AP time spent sitting and standing when compared to observed time sitting and standing, results are $t = 2.036$, $p = 0.097$ and $t = 1.181$, $p = 0.291$, respectively. For the IDEEA time spent sitting compared against observed time sitting, results are $t = 1.181$, $p = 0.291$. For IDEEA time spent standing, the standard error of the difference was zero. Therefore, no data could be computed due to perfect agreement.

Steps

In Table 3 means ± standard deviations, MAE, and mean absolute percent error (MAPE) for steps measured by each monitor are recorded. A RMANOVA found no statistically significant differences between PA monitors for steps in the sitting and standing phases compared with the hand-tally step criterion, $F(5) = 1.096$, $p = 0.354$ and $F(5) = 5.714$, $p = 0.075$, respectively. There were differences between PA monitor-recorded steps versus step criterion for LPA ($F(5) = 424.957$, $p < 0.001$) and MPA ($F(5) = 2716.568$, $p = 0.007$) phases. Pairwise comparisons for LPA determined that only the SWA significantly differed from the criterion ($t = 3.276$, $p = 0.017$), due to under-counting. Pairwise comparisons for moderate PA determined that the AG, AP, SWA, and IDEEA significantly differed from the criterion (AG: $t = 4.058$, $p = 0.007$; AP: $t = 2.979$, $p = 0.038$; SWA: $t = 3.971$, $p = 0.007$; IDEEA: $t = 2.845$, $p = 0.036$) due to under-counting. The DG did not differ from the criterion.

Table 2. Descriptive Characteristics (n=7)

Gender	
Male	86%
Age (years)	29.7 ± 6.0
Weight (lbs)	178.13 ± 15.31
Height (in)	83.5 ± 14.1
BMI	26.3 ± 2.1
Resting Blood Pressure (mmHg)	
Systolic	113 ± 4
Diastolic	75 ± 4
Resting Heart Rate (bpm)	60 ± 15
Calculated Heart Rate Reserve (bpm)*	
Light Intensity Range 20-39%	92-114 ± 5-8
Calculated Heart Rate Reserve (bpm)§	
Moderate Intensity Range 40-59%	115-137 ± 5-6

This table presents descriptive characteristics and baseline values (mean ± standard deviation) obtained from all participants (n=7).

*Light intensity range is the percent at which all participants' heart rate reserve was calculated; means and standard deviations for the range are presented.

§Moderate intensity range is the percent at which all participants' heart rate reserve was calculated; means and standard deviations for the range are presented.

Table 3. Means ± Standard Deviation, Mean Absolute Error, and Mean Absolute Percent Error for Steps Across All Phases

	Sit			Stand		
Device	Steps	MAE	Mean APE	Steps	MAE	Mean APE
Hand-tally	1 ± 2	*	*	0 ± 1	*	*
DG	1 ± 2	0.14 ± 0.38	0%	0 ± 0	0 ± 0	0%
AG	3 ± 3	2 ± 2	0%	1 ± 1	1 ± 1	0%
AP	5 ± 11	5 ± 10	216%	1 ± 2	1 ± 2	17%
SWA	5 ± 12	4 ± 10	80%	1 ± 2	2 ± 2	14%
IDEEA	0 ± 0	1 ± 2	17%	0 ± 0	0 ± 1	17%
	LPA			MPA		
Device	Steps	MAE	Mean APE	Steps	MAE	Mean APE
Hand-Tally	648 ± 51	*	*	762 ± 46	*	*
DG	611 ± 61	40 ± 51	6%	741 ± 87	31 ± 57	4%
AG	583 ± 99	63 ± 75	10%	665 ± 58	97 ± 63	12%
AP	636 ± 54	103 ± 226	17%	738 ± 42	138 ± 270	18%
SWA	542 ± 93	103 ± 78	16%	635 ± 57	127 ± 85	16%
IDEEA	587 ± 87	62 ± 60	10%	656 ± 81	110 ± 94	14%

Abbreviations: MAE, mean absolute error; APE, absolute percent error; LPA, light physical activity; MPA, moderate physical activity

This table presents the mean ± standard deviation, MAE and mean APE for steps across all phases for all participants when compared to the hand-tally criterion for the DigiWalker (DG), ActiGraph GT3X (AG), *Activ*PAL (AP), SenseWear Armband (SWA), and IDEEA.

*Asterisk is filled in where the standard error of the difference was zero.

Minutes

Table 4 presents means ± standard deviations, MAE, and MAPE for minutes in LPA and MPA for all monitors compared with the stopwatch-recorded criterion. There were significant differences between stopwatch-recorded LPA (minute criterion) and PA monitor-recorded LPA, $F(4) = 3106.864$, $p < 0.001$. Pairwise comparisons showed that all PA monitors differed from the criterion and under-counted minutes (AG: $t = 23.486$, $p < 0.001$; AP: $t = 24.597$, $p < 0.001$; SWA: $t = 16.202$, $p < 0.001$; IDEEA $t = 364.405$, $p < 0.001$). Stopwatch-recorded MPA and PA monitor-recorded time in MPA significantly differed ($F(4) = 149.498$, $p < 0.001$). Pairwise comparisons showed that the AG, SWA, and IDEEA significantly under-counted compared with the criterion (AG: $t = 3.164$, $p = 0.019$; SWA: $t = 3.873$, $p = 0.008$; IDEEA: $t = 3.297$, $p = 0.022$). *Activ*PAL did not differ from the criterion.

DISCUSSION

The purpose of this pilot study was to examine validity of 5 commonly used PA monitors that have not been validated in adults with unilateral TTA. The narrow body of available evidence for valid PA assessment in adults with amputation demonstrates a gap in the literature and represents an interdisciplinary problem for researchers and clinicians alike. Physical activity after amputation is essential for functional recovery, prevention of atrophy and disease, and maintenance of residual limb volume. Currently, little objective information is available to provide insight into PA habits following amputation surgery.[59] While some PA monitors (Patient Activity Monitor and DigiWalker SW-700, StepWatch3 Activity Monitor) have been used to assess PA, the available evidence for valid PA monitors results in both narrow selection and limited measurement of PA metric (ie, steps vs minutes vs posture). The present study is a step toward bridging PA monitor availability because it (1) used PA monitors that have not yet been tested in adults with TTA, (2) addressed new and remaining questions from this study and others, and (3) selected monitors that are commonly used in research but are also translatable to a clinical setting. Our findings provide a foundation for future directions and insights for researchers and clinicians by identifying PA monitors that accurately measure various intensities, metrics, and postures in adults with TTA.

Various modes of PA, such as steps, posture, and minutes in a given PA intensity, were tested for validity in one pedometer and 4 different accelerometers. Overall, accuracy varied based upon the outcome/metric selected to quantify PA. For accelerometry, more research is needed, as no monitor was valid across all intensities. These findings demonstrate that monitor validity in a population without amputation ***is not*** transferrable to a population with amputation. For posture, the IDEEA and AP were both valid. This information may prove useful in research and clinical practice to help reduce sedentary and/or physically inactive behaviors, as these behaviors have their own unique subsets of disease risk. From a clinical perspective, the AP represents a cost-effective user-friendly PA monitor for patients and clinicians and would allow clinicians to objectively quantify sedentary behaviors. For steps, the DG was valid across all phases. The DG provides a cost-effective PA monitor and is accurate for determination of daily step count. Determination of step count would be beneficial from a clinical perspective as daily steps are considered reflective of total daily PA. The use of the AP and DG would provide further insight into the lifestyle behaviors and PA accumulation in a population with amputation.

For accuracy of PA monitor-recorded time in sitting and standing postures versus direct observation, the IDEEA had greater accuracy (83-100%) than the AP (50-

Table 4. Means ± Standard Deviation, Mean Absolute Error, and Mean Absolute Percent Error for Minutes in Light Physical Activity and Moderate Physical Activity

	LPA			MPA		
Device	**Minutes**	**MAE**	**Mean APE**	**Minutes**	**MAE**	**Mean APE**
Stopwatch	6.00 ± 0	*	*	6.00 ± 0	*	*
AG	0.44 ± 0.60	5.56 ± 0.60	93%	3.38 ± 2.19	2.62 ± 2.19	44%
AP	0.50 ± 0.55	5.50 ± 0.55	92%	5.50 ± 0.55	0.50 ± 0.55	8%
SWA	1.00 ± .82	5.43 ± 0.79	83%	3.86 ± 1.46	2.14 ± 1.46	36%
IDEEA	0.02 ± 0.04	5.98 ± 0.04	100%	5.75 ± 0.19	0 ± 0	18%

Abbreviations: MAE, mean absolute error; APE, absolute percent error; LPA, light physical activity; MPA, moderate physical activity

This table presents the mean ± standard deviation, MAE and mean APE for minutes in LPA and MPA when compared to the stopwatch criterion for the ActiGraph GT3X (AG), *Activ*PAL (AP), SenseWear Armband (SWA), and IDEEA

*Asterisk is filled in where the standard error of the difference was zero.

100%). However, the AP was still accurate for posture, as it correctly detected time spent sitting and standing for all participants for the full 6-minute phase. The greater accuracy observed in the IDEEA can likely be attributed to the greater number of sensors thus, greater PA monitor sensitivity. This PA monitor sensitivity allowed for detection of more erratic movements, such as fidgeting or swaying, while participants were seated or standing. While these movements were captured on the IDEEA, they did not contribute to a disruption in posture. For example, a participant could stand with both feet in the same position for the entire 6-minute phase, but shift their weight from one foot to the other. While no steps were taken, these types of movements were registered on the IDEEA more frequently than on the AP. We did not objectively account for these erratic movements because there is no research indicating how to record this type of movement and compare the results using these specific PA monitors. Posture is an area of amputation research that has not yet been studied using the AP. While much of the emphasis in adults with amputation is on rehabilitation and return to an individual's normal activities of daily living, newer research has found that exercise and PA may not be enough to compensate for an otherwise sedentary lifestyle.[60] Therefore, future studies should consider assessing posture in addition to PA levels in adults with amputation.

For step count, the DG had the least amount of absolute error (17.8 ± 27) and percent error (54%), and did not significantly differ from the criterion in any of the phases. The DG is also the most affordable ($15 per monitor) and focused PA monitor used here, as it measures only steps. All remaining PA monitors had greater absolute error and percent error, and significantly differed from the criterion in the LPA and MPA phases. All PA monitors had a tendency to under-count steps. The consistency of the DG in our study agrees with previous findings on the DG in adults with amputation, albeit using a different model.[19] This confirmation will enable researchers and clinicians to make recommendations on an accurate PA monitor for a population with LLA.

No PA monitor was valid for minutes across all 4 phases. However, it should be noted that many PA studies show that monitor validity decreases as speed decreases.[27] For the LPA phase, no PA monitor correctly captured and identified minutes and intensity. This is not entirely unexpected, as this finding is prevalent in PA monitor research when slower speeds are examined.[61,62] For MPA, only the AP correctly captured and identified minutes and intensity. All PA monitors had a tendency to under-classify minutes in a given intensity, which is consistent with their tendency to undercount steps. Our findings did not result in identification of an accurate accelerometer, unlike studies that used the Patient Activity Monitor[29] and Stepwatch3 Activity Monitor,[20] an accurate accelerometer. However, this discrepancy may be to differing study designs or PA monitor algorithms. One way to address accelerometer validity between the differing results of the Patient Activity Monitor and the Stepwatch3 Activity Monitor may be to compare the accelerometers used here against the Patient Activity Monitor or Stepwatch3 Activity Monitor.

User feasibility and outcomes of interest are also important to consider. For example, the IDEEA costs over $5,000 and involves precise placement of multiple sensors with connecting wires. Use of the IDEEA is feasible in a controlled environment with an experienced researcher, but is highly impractical in a free-living setting, due to the financial expense should equipment be damaged and participant burden. The SWA, while easy to wear around the bicep and affordable ($120 per monitor), was not valid in determining steps or PA intensity. The AG ($250 per monitor) was not valid for steps, LPA, or MPA for this population. However, the user friendliness of the PA monitor and the software (ie, adjustable cut points rather than proprietary formulae) could allow for improvements and development of specific intensity cut-points in future research in adults with TTA. The AP was valid for 3 of 4 phases (sitting, standing, and MPA). Its ability to correctly classify posture and time within that posture makes it an appropriate PA monitor to assess sedentary time or physical inactivity. Further, the AP was accurate for MPA. However, its inability to capture LPA poses a barrier, as this intensity may most accurately reflect a substantial proportion of this population's time.

The DG was valid for steps across all phases, even though the DG's technology is less advanced than the other PA monitors used. Benefits of the DG include its cost-effectiveness, user-friendliness, and simple output. Steps per day have been linked to minutes of PA accumulated, which may make the DG a suitable proxy for PA in this population. Behrens et al[63] found that approximately 10,000 steps/day was equivalent to the 150 of MPA/week recommended in the national PA guidelines.[5,63] The DG was valid across all phases and is a feasible PA monitor. Since steps are equated to MPA, this finding provides an excellent starting place for PA assessment in adults with TTA.

Strengths

Strengths of this study included the measurement of posture, intensity classification of performed activities, and the range of sophistication of PA monitors (ie, DG vs IDEEA).[9] The counterbalanced phase design allowed the researchers to determine that the validation, or lack thereof, was a result of the PA monitor, rather than due to the order of phases. We focused specifically on non-obese, ambulatory adults with unilateral LLA with no history of chronic disease conditions. Since this study was tightly controlled and phases counterbalanced, our findings are more easily attributed to the PA monitors in this population, rather than intra-participant variance or PA monitor error.

Limitations

The small sample size may be viewed as a limitation. However, the literature is limited in content related to the population under study, and especially in the area of PA assessment. Therefore, the purpose of this study was to expand the current baseline of acceptable PA monitors for future research in PA assessment for adults with amputation. Further, since the related body of literature is small, many studies involving amputation expand their criteria to include the following: amputation as a result of trauma, chronic disease or congenital defect; Syme's, transfemoral, and TTA; unilateral and bilateral amputations; and various disease and weight statuses. We sought a sub-population (previously described) in an attempt to control for any potential confounders, such as gait differences between unilateral or bilateral amputation, or transfemoral amputation versus TTA. Even with many of the above not controlled for in other research studies, many sample sizes are still relatively modest. With this context in mind, we propose that the sample size be viewed not as a limiting factor, but as a strength due to the amount of control for confounding variables yielded by our approach. Additionally, this study is not generalizable to a free-living setting as all the PA modes were tested in a controlled laboratory environment; however, this research may be used in future studies to determine PA monitor selection, PA modes to measure, and validity of available and valid PA monitors.

Future Directions

Including PA monitors not yet tested, expanding the type of amputation (both site and cause), other physical impairments resulting from musculoskeletal trauma, comparing valid PA monitors in children versus adults, and the incorporation of common work activity tracking monitors (ie, Garmin, FitBit) in future work would provide more insight into this population. Expanding the protocol to include simulated activities of daily living or using valid PA monitors in a free-living environment should be considered. Our findings serve as a preliminary basis for future studies.

CONCLUSIONS

Adults with amputation are at an increased risk for various chronic diseases that develop due to excessively sedentary behavior. Physical activity is one way to diminish disease risk. However, this population has reported barriers for PA engagement, which may lead to low accumulation of PA.[11] The purpose of the present study was to examine the validity of PA monitors for the measurement of various PA metrics, including steps, posture, and minutes in various PA intensities, in an amputation population. Key findings included (1) the IDEEA and AP were both valid for posture assessment, (2) the DG was best for step measurement, and (3) the AP was best for measuring minutes in PA intensities. No other PA monitors were valid for LPA or MPA, but all 4 accelerometry monitors were valid for sitting and standing phases. Future research should include a broader selection of PA monitors, expanded recruitment criteria, and incorporation of free-living PA.

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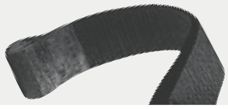

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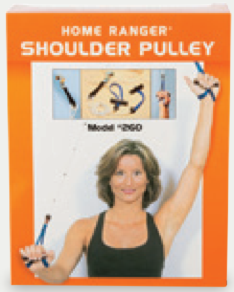

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Complex Regional Pain Syndrome in a Female High School Athlete

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ABSTRACT

Background and Purpose: Chronic regional pain syndrome is a painful and disabling condition that often occurs following surgery or trauma. Chronic regional pain syndrome has been reported in <7% of clavicle injury cases. **Case Description:** The patient is a 15-year-old female high school athlete who presented with an insidious onset of left clavicle pain since 2011. She underwent surgery in 2011 for excision of a lesion in the middle one-third of her left clavicle. Four years later, in 2015, she presented with symptoms of chronic regional pain syndrome. **Interventions:** Interventions included diagnostic testing, blood work, surgery, conservative physical therapy, trigger point dry needling, total motion release therapy, and iron supplementation. **Outcomes:** Outcomes were assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. **Clinical Relevance:** This case study describes complications of complex regional pain syndrome and use of less traditional physical therapy methods to improve shoulder active range of motion and strength.

Key Words: clavicle, total motion release, trigger point dry needling

BACKGROUND

Chronic regional pain syndrome (CRPS) is a painful and disabling condition that often occurs in response to surgery or trauma.[1-3] Patients with CRPS display an increased nervous system response to an injury or surgery, resulting in pain and an autonomic nervous system response.[4] Clinical diagnosis of CRPS involves pain, sensitivity issues, including hyperesthesia or allodynia, vasomotor and/or pseudomotor changes, loss of motor control or range of motion (ROM), and trophic changes.[1] The pathology of CRPS is not well understood. It is thought to be related to a disturbance in "sympathetically mediated vasomotor control, together with maladaptive peripheral and central neuronal plasticity."[5-8] Sandroni et al[9] reported an incidence of 21 cases per 100,000. Chronic regional pain syndrome has been shown to be more common in females vs males.[2]

Clavicle fractures have been estimated to account for approximately 34% to 45% of shoulder injuries.[10,11] Research suggests that 69% to 81% of clavicle fractures occur in the middle one-third of the clavicle while only 17% occur in the lateral one-third.[12] Left clavicle injuries are more common than right.[13] Complex regional pain syndrome has been only documented in approximately 7% of cases associated with clavicle injuries.[14]

Guidelines have recommended various physical therapy treatments for CRPS. These include but are not limited to joint mobilization/manipulation, desensitization, ROM, hydrotherapy, and electrotherapy.[15-17] A review of best practice guidelines recommend the use of desensitization therapy, a treatment that emphasizes the "graded introduction of noxious stimulus" as a means of decreasing allodynia.[4] Studies have demonstrated that desensitization techniques can result in decreased pain, allodynia, and improved pressure tolerance.[18]

Trigger point dry needling (TDN) is a new type of conservative treatment gaining attention in the field of physical therapy. It has been shown to be an effective treatment in treating musculoskeletal injuries involving muscular trigger points and or nerve pain or allodynia. Trigger point dry needling is a manual therapy procedure where thin monofilament needles are inserted into the skin and muscle in areas of myofascial trigger points to manage neuromusculoskeletal pain and movement impairments. Prior research has shown that TDN relieves pain and decreases muscle tightness. Trigger point dry needling can be used as a form of desensitization by targeting affected nerves.[19,20] Trigger point dry needling has been shown to be effective in treatment of neck and shoulder myofascial pain.[3,21] Trigger point dry needling has been shown to provide pain relief via stimulation of "sensitized muscle nociceptors, decrease in metabolic mediators, and increase in microcirculation."[22]

Total motion release (TMR) therapy is a form of rehabilitation focusing on using the contralateral limb to improve ROM in the ipsilateral limb. Prior research has shown that neural coupling occurs with movement between upper and lower limbs.[23,24] Total motion release therapy is based on concepts similar to neural coupling. Total motion release therapy emphasizes Isaac Newton's 3rd law of motion, "to every action there is an equal and opposite reaction." The screening process involves 6 key movements. The goal is to identify those movements that are restricted and on which side. Tightness and weakness on one side of the body eventually lead to restrictions in other areas of the body.[25] Through these concepts, TMR therapy teaches patients the basic principles of movement to help them treat their own pain by using their good side vs their painful side. Total motion release has been shown to be an effective way to increase shoulder ROM. One study demonstrated increased shoulder internal rotation and external rotation following a TMR specific warm-up routine in athletes.[26]

CASE DESCRIPTION

History

The patient is a 15-year-old high school female track and soccer athlete with medically diagnosed CRPS in her left clavicle region following an insidious onset of symptoms in her left shoulder in May 2011. The patient demonstrated limited left shoulder flexion to 140° and abduction active ROM to 120°. The magnetic resonance imaging (MRI) of the left clavicle and sternoclavicular joint revealed a small nidus at the upper cortex of the left clavicle. The patient underwent surgery 5 months later in November 2011 for excision of a lesion in the middle third of her left clavicle. Following the procedure, the patient wore a shoulder sling for 2 weeks. The patient did not undergo formal physical therapy following surgery but gradually weaned herself from the sling and resumed normal physical activities as tolerated. Symptoms in her left clavicle continued periodically over the next 2-½ years with a return to sports and gym activities. By December 2014 the patient's symptoms had worsened in the left clavicle area. The lab tests, x-rays, blood tests, and electromyography were all negative for any anomaly. At this time, there was no indication that the patient's iron levels were abnormal. The patient had 160° of shoulder flexion and 120° of shoulder abduction active ROM. Physical therapy was ordered by her physician in August 2015 due to continued left clavicle pain.

Examination-initial evaluation

Pain

Pain was assessed using a verbal 0 to 10 pain scale (0/10 was considered no pain and 10/10 was considered emergency room pain). Upon initial evaluation, the patient reported her pain as 2/10 at rest and 6/10 with activity. The patient described her pain as achy and throbbing in nature that gradually increased with activity including push-ups, running, and throwing activities. She further reported that her left clavicle was so sore that she could not touch it.

Range of Motion

The ROM measurements were taken using standard goniometric techniques[25]; in standing for shoulder flexion and abduction, and the internal and external rotation were measured in the supine position. The ROM results obtained at initial evaluation can be found in Table 1.

Muscle Strength

Manual muscle testing revealed 4/5 strength in the patient's left shoulder for shoulder flexion, extension, internal rotation, external rotation, and abduction. Middle and lower trapezius strength was limited to 3+/5 on the left. Left elbow and wrist strength was 5/5.

Palpation

Palpation of the patient's anterior-medial, central, and anterior-lateral clavicle was extremely sensitive to light touch. The patient's clavicle was swiped with the tip of the therapist's hand, and the patient "flinched" with pain.

Posture

The patient demonstrated a slouched sitting posture with rounded shoulders and a forward head position. The patient's left scapula was in a protracted and upwardly rotated position.

Special Tests

The patient demonstrated positive Neer's, O'Brien's, crossover, and Hawkins-Kennedy shoulder tests in sitting. The Disabilities of the Arm, Shoulder and Hand (DASH) was also administered at initial evaluation so as to assess outcomes at discharge.

Neurological Examination

Sensation

The patient demonstrated decreased light touch sensation on the middle one-third of her left clavicle. Light touch sensation testing resulted in 5/10 pain. The patient was unable to tolerate 2-point discrimination testing.

DIAGNOSIS

Diagnosis was made according to the *Guide to Physical Therapist Practice*[27] Patterns 4D: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Connective Tissue Dysfunction, 4E: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Localized Inflammation, and 4I: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated With Bony or Soft Tissue Surgery.

PROGNOSIS

Trigger point dry needling and TMR therapy were integrative in restoring active ROM and strength to the patient's left shoulder. Posture education was an important part of recovering left scapular control and strength. The patient's visit to Mayo Clinic was integral in identifying that the patient's blood iron levels were abnormal. The injection of corticosteroids in the soft tissue surrounding patient's middle one-third of her left clavicle was recommended by the specialists at Mayo Clinic and imperative in her recovery.

GOALS

In accordance with patient's desires, the goals established at initial evaluation included return to recreational sports and gym class, restore left shoulder active ROM to normal values, improve left shoulder and scapular muscles strength for return to sports, and decrease left clavicle pain and decrease dependence on pain medications for daily activities.

INTERVENTION

Conservative physical therapy management included TDN, TMR therapy, scapular strengthening, desensitization therapy, and posture education. To facilitate desensitization, the procedure used was rubbing a soft cotton ball on the patient's left clavicle starting laterally and moving medially as tolerated for 5 to 10 minutes 3 times a day. As desensitization occurred, the patient progressed to soft cotton materials and ultimately progressing to rougher objects.

When TDN was initiated, the patient did not tolerate any needles in her soft tissue around the left clavicle. Half inch monofilament dry needles were initially placed in the patient's left C3/4 and C5/6 left cervical paraspinals with an in/out technique. Further 0.5" and 1" needles were placed in her left upper trapezius and levator scapula muscles as indicated by tissue depth. Other areas where TDN was administered included anterior, middle, and posterior deltoid muscles using 1" needles. The dry needles were inserted into the patient's tissue until resistance was felt and left in until the skin area around each needle became red and demonstrated a positive "flare" response. See Figures 1, 2, and 3. As TDN sessions progressed, dry needles were inserted in the patient's left clavicle subclavius and pectoralis major muscles starting laterally and moving medially as desensitization occurred. By the end of physical therapy treatment, the patient was able to tolerate .5" dry needles inserted directly into the soft tissue surrounding the middle one-third of her left clavicle.

Table 1. Active Shoulder Range of Motion at Initial Evaluation

Flexion	140°
Abduction	140°
Internal Rotation	45°
External Rotation	65°

Total motion release therapy was integrative in regaining the patient's left shoulder active ROM. A combination movement approach of shoulder flexion, abduction and trunk rotation was used to facilitate increase in left shoulder ROM. The patient performed 2 to 3 sets of 5 repetitions of each exercise 2 to 3x/day as instructed. As the patient's left shoulder pain decreased, scapulothoracic strengthening was added to her home exercise program (HEP). These exercises included seated press ups, prone I, W, T, and Y exercises on a Swiss ball, wall push-ups with a plus motion, and bilateral shoulder active ROM in the scapular plane with weights ranging from 1 to 3 lbs.

OUTCOMES

Physical therapy outcomes were measured using the DASH questionnaire. The DASH is a 30-item (10-item for Quick DASH) scale examining the degree of difficulty of physical activities related to an arm, shoulder, or hand injury. The DASH examines the degree of difficulty of each activity related to pain, numbness, stiffness, and its impact on social activities. A 10-point change in the DASH score has previously been identified as a minimally important change.[28] At initial evaluation, the patient scored 64 on the Quick DASH outcomes measure demonstrating 64% impairment in use of her left shoulder.

Figure 1. Trigger point dry needling to upper trapezius and levator scapula muscles.

Figure 2. Trigger point dry needling to anterior, middle, posterior deltoid muscles, deep radial and lateral antebrachial cutaneous nerves.

Figure 3. Trigger point dry needling to left clavicle.

Results

At discharge from physical therapy treatment in December 2016, the patient demonstrated improvements in active ROM, strength, sensitivity, sitting posture, and pain in her left shoulder and clavicle. The active ROM values for the patient's left shoulder can be found in Table 2. The patient's left shoulder strength improved to 5/5 for all motions except external rotation which was limited to 4+/5 and the scapular muscle strength improved to 4+/5, with the exception of her lower trapezius strength, which was limited to 4/5. Special tests to the left shoulder that were negative included the Neers, cross-over, Hawkins-Kennedy, and O'Briens. The patient demonstrated no sensitivity to light touch in her lateral left clavicle. Decreased sensitivity was noted to light touch in the middle one-third of her left clavicle, but firm pressure reproduced a pain rating of 5/10. The patient's pain level at rest was 2/10 and 5/10 with sports activities including running and soccer. The patient's DASH score improved from 60% to 20% impairment. Upon discharge, the patient was able to lift 5 lb overhead with her left shoulder, lie on her left side for sleeping, and resume athletic activities and gym class.

Table 2. Active Shoulder Range of Motion at Discharge

Flexion	185°
Abduction	180°
Internal Rotation	92°
External Rotation	90°

DISCUSSION

This case study described a unique way to manage CRPS in a female high school athlete. Complex regional pain syndrome has been documented in approximately 7% of cases associated with clavicle injuries and included emerging physical therapy interventions such as TDN and TMR therapy.[14] Trigger point dry needling was important in providing the desensitization that this patient needed to manage the long-standing CRPS. It is not yet clear how TDN can be effective in treating symptoms of CRPS, but it is known that TDN can be used as a form of desensitization by targeting affected nerves.[19,20]

Total motion release therapy was integrative in restoring the patient's active ROM in her left shoulder. A combination of right shoulder active ROM and trunk rotation were instrumental in improved left shoulder active ROM. The most restrictive motions on the left shoulder were repeated on the right shoulder (flexion, abduction, external/internal rotation). Each motion was performed 5 repetitions, 2-3 sets, 2-3x/day. Trunk rotation exercises were performed to the least restricted side for 5 seconds, 5 repetitions 2-3x/day. As the movements became easier, resistance bands and weights were added for an increased challenge. The improved left shoulder active ROM with TMR therapy allowed for the ability to begin strengthening scapular and shoulder muscles.

A noteworthy collaborative effort by a team of physicians at the Mayo Clinic in August 2016 included: Lab (blood) studies, EMG, and other diagnostic testing. The blood tests were positive for decreased Ferritin levels of 8 ng/ml with normal ranging from 12-300 ng/ml for males and 12-150 ng/ml for females. Based on these findings, the team at the Mayo Clinic placed her on iron supplementation and also administered iron with infusion, resulting in the Ferritin levels rising to 62 ng/ml after one week. She was also given a cortisone injection in soft tissue surrounding the middle one-third of her clavicle. She continued physical therapy to regain strength in her left shoulder.

The collaboration of many health care professionals is what made this patient's case a success. This collaboration was integral in determining the root of this patient's problem and achieving desired outcomes of increased ROM and strength in her left shoulder. It is unclear what caused her blood Ferritin levels to drop so low, but the infusion was necessary to restore her levels to within normal limits. Trigger point dry needling helped manage her pain and desensitize her nerves, and TMR helped keep her from getting a frozen shoulder.

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Wooden Book Reviews

Rita Shapiro, PT, MA, DPT
Book Review Editor

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

Sacroiliac Pain: Understanding the Pelvic Girdle Musculoskeletal Model, Riczo Health Education, 2018, $12.95
ISBN: 9781942798132, 36 pages, Soft Cover

Author: Riczo, Deborah B., PT, DPT, MEd

Description: This book covers sacroiliac pain, a medical diagnosis and functional impairment that physical therapists in orthopedic outpatient clinics encounter virtually on a daily basis. It offers outstanding online videos of basic pelvic balancing exercises that patients can easily follow. **Purpose:** The purpose is to provide a good understanding of sacroiliac dysfunction (SD), empowering patients with self-management of the pain while encouraging a whole-body wellness. At the same time, it offers an educational tool that healthcare providers can use for the care of their patients with sacroiliac pain. **Audience:** This is a resource for both physical therapists who want to provide their patients with simple yet detailed understanding of SD and patients who want to take control of their condition to improve their function while embodying the wellness concept that is encompassed in movement based on anatomical science. F**eatures:** The first of the book's three sections provides basic education in structural and functional anatomy that healthcare providers can use to teach their patients. Section 2 describes the pelvic girdle musculoskeletal method of self-screening and offers simple yet specific exercises that are also available to view in the video demonstration. It also provides a step-by-step progression founded on evidence-based practice. Section 3 anticipates many questions that patients have and offers answers in a simple and upbeat manner that empowers individuals' self-awareness and total body engagement for overall well-being while managing SD. **Assessment:** In this book, Dr. Riczo connects very well with patients, offering them both a comprehensive and a simple understanding of their symptoms and anatomical correlation to function. This user-friendly book is a gem that succeeds in clarity yet provides scientific accuracy from other books, which are outstanding but somewhat complicated for patients.

Rita B Shapiro, PT, MA, DPT
Naval Health Clinic Annapolis

Exercises for Perfect Posture: The Stand Tall Program for Better Health Through Good Posture, Hatherleigh Press, 2017, $15
ISBN: 9781578266951, 121 pages, Soft Cover

Author: Smith, William, MS, NSCA-CSCS, MEPD; Burns, Keith, MS, CSCS; Volgraf, Christopher, CSCS

Description: This book addresses posture, evaluation, screening, related maladies, success stories as a result of improving postural awareness, exercises, and sample postural exercise programs. **Purpose:** The purpose is to provide comprehensive information about poor posture, how it is attained, and interventions. Treatment of poor posture is described using foam rolling, self myofascial release techniques, stretching exercises, and strengthening exercises. The book successfully meets its objectives using diagrams and descriptions of these exercises/techniques. **Audience:** An appropriate audience is exercise physiologists, personal trainers, or new graduate clinicians, but lay people also will be able to understand this material. The authors are all exercise physiologists and certified strength and conditioning specialists from the National Strength and Conditioning Association. **Features:** The book details what good and bad posture is and how it is attained anatomically. A section describes common medical conditions resulting from poor posture as well as success stories from postural modifications. These stories discuss results of the programs which were implemented for gaining proper posture as well as lessening pain. A brief section on posture assessment discusses screening techniques, but it lacks some necessary detail. The book uses text descriptions and pictures of various exercises (self myofascial release using a foam roller, stretching, and strengthening exercises). **Assessment:** The authors accomplish their main objective in providing education and an exercise regimen to promote postural awareness. The book is appropriate for anyone who performs postural assessments. It lacks some detail regarding the anatomical basis and assessment of proper posture, although the book should suffice for readers in the general population.

Christopher D. Blessing, MS, MPT, OCS, CSCS
University Medical Center of Princeton at Plainsboro

Perturbation Treadmill Training in Parkinson's Disease: A Novel Approach for Neurological Rehabilitation, Springer, 2018, $59.99
ISBN: 9783658205423, 34 pages, Soft Cover

Author: Klamroth, Sarah

Description: This is a published master's thesis based on the author's research evaluating Parkinson's disease patients' postural control and gait adaptations following a single session of treadmill training with perturbations. **Purpose:** The author wants to establish any predictors that might explain differences in motor adaptations by the study's participants. **Audience:** The author appropriately targets an audience of scientists, professionals, and students in the fields of rehabilitation, neurology, and sports science. Research scientists might find this article worthwhile as a stepping-stone for future research. Therapists treating Parkinson's disease patients in related fields may find the article about the development of a future novel treatment approach interesting. **Features:** Except for an informative preface, this book is in standard medical journal article format. The introduction provides a general overview of recent treadmill training research on patients with Parkinson's disease. The method and results section are thorough and contain relevant tables and graphs. The book concludes with a comprehensible discussion section that determines there are positive effects using this treatment approach for Parkinson's disease patients, along with identifiable predictors across the participants to explain motor adaptations. **Assessment:** This book is especially useful for medical researchers specializing in Parkinson's disease and treatment to use as a stepping-stone for future treatment inquiries. Practitioners in the field of neurology, rehabilitation, and sports science will find this article useful as a general overview of recent Parkinson's treatments using treadmills and possible future treatment initiatives to come.

Jennifer Hoffman, PT, DPT, OCS
Select Rehabilitation

Congratulations 2018 Awardees

The American Physical Therapy Association (APTA) has announced the 2018 Honors and Awards Program recipients. The following members of the Orthopaedics Section have been selected by APTA's Board of Directors to receive the following awards:

Catherine Worthingham Fellow of APTA
Mark D. Bishop, PT, PhD, FAPTA
Josh A. Cleland, PT, PhD, FAPTA
James M. Elliott, PT, PhD, FAPTA
Gregory E. Hicks, PT, PhD, FAPTA
David Levine, PT, DPT, PhD, FAPTA
Susan L. Michlovitz, PT, PhD, FAPTA
Kim A. Nixon-Cave, PT, PhD, FAPTA
Samuel R. Ward, PT, PhD, FAPTA

Lucy Blair Service Award
Meryl J. Alappattu, PT, DPT, PhD
Secili DeStefano, PT, DPT
Martha E. Eastlack, PT, PhD
Steven W. Forbush, PT, PhD
Kathleen "Jake" Jakubiak Kovacek, PT
Robert F. Landel, PT, DPT, FAPTA
Peter J, McMenamin, PT, MS

Societal Impact Award
Michael T. Eisenhart, PT
Richard Jackson, PT, OCS

Humanitarian Award
June E. Hanks, PT, DPT, PhD
Theresa M. Spitznagle, PT, DPT

Eugene Michels New Investigator Award
Deepak Kumar, PT, PhD, OCS

Jack Walker Award
Sonja Karin Bareiss, PT, PhD
Mary Kent Hastings, PT, DPT, ATC
Robin L. Marcus, PT, PhD, OCS
Michael Jeffrey Mueller, PT, PhD, FAPTA

Helen J. Hislop Award for Outstanding Contributions to Professional Literature
Steven Z. George, PT, PhD, FAPTA

Dorothy E. Baethke-Eleanor J. Carlin Award for Excellence in Academic Teaching
Josh Alan Cleland, PT, PhD

Signe Brunnström Award for Excellence in Clinical Teaching
Dyanna Marie Haley-Rezac, PT, DPT, OCS

Federal Government Affairs Leadership Award
Linda John, PT

Minority Faculty Development Scholarship Award
Jeremy D. Houser, PT, DPT, OCS

Mary McMillan Scholarship Award for Physical Therapist Students
Ryan Maddrey, SPT
Leah Huber Wright, SPTA

Mary McMillan Scholarship Award for Physical Therapist Assistant Students
Manoah J. Carrel, SPTA

Minority Scholarship Award for Physical Therapist Students
Aaron Bess, SPT
Kyongho Pak, SPTA

Award recipients were recognized during the Honors & Awards Ceremony held at the NEXT 2018 Conference and Exposition in Orlando, Florida, this past June.

Leaders, Innovators, Changemakers: Merging Pain Science with Movement Science

A Recap of AOM 2018

See what our Baltimore attendees had to say…

"Best continuing ed I have taken in 14 years of practice. Groundbreaking, life-changing evidence I could take directly into the clinic on Monday. Minimal "clinical evangelism" about the latest and greatest "new" approach to treatment, as is seen in many continuing ed courses. Firmly rooted in reality, and the evidence, and pitched perfectly at the intelligent practitioner, whose time is precious."

"The quality of the information was superb. It was just enough material to absorb and integrate into practice. The two days - and attempt to integrate the material - was commendable."

"I really loved being in the presence of so many committed and excellent professionals. I forget sometimes the number of exceptional researchers and clinicians there are in the field of physical therapy. I am proud and humbled that I get to sit in the same room as them."

The Orthopaedic Section hosted the 6th Annual Meeting at the beautiful Renaissance Baltimore Harborplace Hotel on April 26-28, 2018. The primary theme was merging pain science with movement science in the treatment of chronic pain problems. On both days, the format of the meeting started with a 2½-hour general session, followed by a series of 90-minute breakout sessions. New this year was a panel discussion at the end of both days dedicated to the discussion and integration of the content delivered at the course.

On the first day, the general session featured pain experts Kathleen Sluka who spoke about mechanisms of pain, Steve George who discussed psychologically informed practice, and Stephen Wegener who presented on patient engagement skills. Each of the speakers and their lab instructors (including Jason Beneciuk, Tara Jo Manal, and Carolyn McManus) went into more detail regarding the "how to" skills acquisition during their respective breakout sessions.

On the second day, the general session featured movement experts Skulpan Asavasopon who discussed the cognitive-biomechanical approach to knee and low back pain by focusing on hip movement impairment; Linda Van Dillen who spoke about motor skill training to improve long-term outcomes for low back pain; Marcie Harris Hayes who presented on the intraarticular pre-arthritic hip disorder relationship with movement system impairments; and Phil McClure who addressed shoulder pain classification and its relationships to pain and movement. Similar to Day 1, the Day 2 speakers and their lab instructors (including Jason Tonley, Nancy Bloom, Vanessa Lanier, and Brian Eckenrode) focused on more detail regarding the "how to" skills acquisition during their respective breakout sessions.

Many participants (including experts, seasoned clinicians, and early career clinicians) commented on why this is now their "go-to" conference due to the intimate setting that allows attendees to interact with experts face-to-face to learn clinical pearls and practical nuances and apply cutting edge research findings to practice. These personal interactions are unique in bringing the evidence alive and allowing quick application to the clinic.

We are excited to announce that next year, the meeting will be held on April 5-6, 2019 at the Omni Interlocken Resort in Denver, Colorado. The theme will be "Performance Enhancement Across the Lifespan." Plan to attend by adding it to your calendar now.

GREETING MEMBERS!

Respectfully submitted by,
Caroline Furtak, PT, MSPT, CEAS, CWcHP

SAVE THE DATE

The OHSIG is happy to announce two one-hour Occupational Health webinars have been scheduled for Quarters 3 and 4. These exclusive webinars are free to OHSIG members. Specifics on sign up and call in information will be emailed to OHSIG members.

Thursday, September 20th at 11:00 CST
Topic: **Functional Capacity Evaluation Course**
Presenter: Steve Allison, PT, DPT, OCS
To provide FCE examiners with an advanced understanding of best practice guidelines for determining an individual's effort level during functional capacity testing.

Thursday, October 25th at 11:00 CST
Topic: **Advanced Concepts in Job Analysis: Physical Demands Validation**
Presenter: Steve Allison, PT, DPT, OCS
To provide occupational health physical therapists with a best practices approach for conducting job analyses and validating the physical demand requirements.

Dr. Steve Allison has over 20 years of experience in the specialty practice of functional capacity testing and job analysis consulting. He is recognized as an expert witness in the areas of functional capacity evaluation testing and orthopedic physical therapy in Federal, District, and workers' compensation courts in Louisiana. Dr. Allison is a service disabled Gulf War veteran. He is the CEO of Functional Capacity Experts, LLC and Disability Management Group, LLC located in Bossier City, Louisiana.

The OHSIG BOD held its quarterly meeting during the CSM in New Orleans on Wednesday, February 21, 2018.

TOPICS OF DISCUSSION

American College of Occupational and Environmental Medicine (ACOEM) has requested comments on several guidelines one of which is "Initial Approaches to Treatment" with an effective date of June 30, 2018. ACOEM is initiating a work group related to development and promotion of functional outcomes in value-based care. We hope to be represented on that working group. National Occupational Research Agenda (NORA) requested comment related to traumatic injury prevention in service industries.

Defining documents in Occupational Health PT practice can be found on the OHSIG webpage and are now titled "Current Concepts in Occupational Health." Link: https://www.orthopt.org/content/special-interest-groups/occupational-health/current-concepts-in-occ-health. These documents define fundamental interventions for practice within the context of work. Each topic has been or is currently being reviewed and updated. The topics and their progress to date:

Functional Capacity Evaluation: update completed

Injury Prevention and Ergonomics: update completed and published in the last edition of the *Orthopaedic Physical Therapy Practice* magazine

Work Rehabilitation (continues to be updated and refine its concepts): The group expects to finalize the document in Q2.

Legal and Risk Management: we are currently seeking task force lead and members. Please contact a Board member if you are interested in spearheading this group.

OPPORTUNITIES FOR MENTORING

At our OHSIG Meeting at CSM this year student PTs voiced interest in accessing mentoring opportunities with our members. As a direct result of this request, we will initiate a casual mentoring program.

For Prospective Mentors: please register your intent by contacting Caroline Furtak at ckfurtak@gmail.com.

We anticipate a longer-range plan developed around our goals of establishing an entry-level curriculum for the physical therapist in the occupational health environment. Francis Kistner (Research Chair) is working to define this curriculum. Developing this curriculum will assist PT schools with effectively introducing this topic into their programs.

CHANGING OF THE GUARD

Outgoing Nomination Chairperson is Katie McBee, Incoming Nominating Committee Chair is Lori Deal. Katie McBee will return as a Nominating Committee member.

PREVENTION AND WELLNESS

Prevention and wellness is a key component of working in the occupational health setting. Businesses and corporations of all sizes seek help to reduce costs associated with work-related injuries, chronic diseases, and unhealthy habits. The Council on Prevention, Health Promotion, and Wellness in Physical Therapy was established in January 2018. The council is a community for physical therapists (PTs), physical therapist assistants (PTAs), and students who are interested in incorporating prevention, health promotion, and wellness as an integral aspect of physical therapist practice, as well as in promoting and advocating for healthy lifestyles to reduce the burden of disease and disability on individuals and society. If you want to participate in the council, start by subscribing to the APTA Hub Community (http://communities.apta.org/p/co/ly/gid=182). You will connect with council members, stay up-to-date on resources and opportunities, and join in the conversation about prevention, health promotion, and wellness in physical therapist practice.

ARE YOU A MEMBER OF OUR CLOSED FACEBOOK GROUP??

If not, **come and join the conversations!!**

Here is the link to the Facebook group:

https://www.orthopt.org/content/special-interest-groups/occupational-health/become-an-ohsig-member

Sharing some of what has been discussed on the OHSIG closed Facebook page:

Effectiveness of Workplace Interventions in Return-to-Work for Musculoskeletal, Pain-Related and Mental Health Conditions: An Update of the Evidence and Messages for Practitioners

Cullen KL, Irvin A, Collie F, et al

ABSTRACT

Purpose: The objective of this systematic review was to synthesize evidence on the effectiveness of workplace-based return-to-work (RTW) interventions and work disability management (DM) interventions that assist workers with musculoskeletal (MSK) and pain-related conditions and mental health (MH) conditions with RTW. **Methods:** We followed a systematic review process developed by the Institute for Work & Health and an adapted best evidence synthesis that ranked evidence as strong, moderate, limited, or insufficient. **Results:** Seven electronic databases were searched from January 1990 until April 2015, yielding 8898 non-duplicate references. Evidence from 36 medium and high quality studies were synthesized on 12 different intervention categories across 3 broad domains: health-focused, service coordination, and work modification interventions. There was strong evidence that duration away from work from both MSK or pain-related conditions and MH conditions were significantly reduced by multi-domain interventions encompassing at least 2 of the 3 domains. There was moderate evidence that these multi-domain interventions had a positive impact on cost outcomes. There was strong evidence that cognitive behavioral therapy interventions that do not also include workplace modifications or service coordination components are not effective in helping workers with MH conditions in RTW. Evidence for the effectiveness of other single-domain interventions was mixed, with some studies reporting positive effects and others reporting no effects on lost time and work functioning. **Conclusions:** While there is substantial research literature focused on RTW, there are only a small number of quality workplace-based RTW intervention studies that involve workers with MSK or pain-related conditions and MH conditions. We recommend implementing multi-domain interventions (ie, with health care provision, service coordination, and work accommodation components) to help reduce lost time for MSK or pain-related conditions and MH conditions. Practitioners should also consider implementing these programs to help improve work functioning and reduce costs associated with work disability.

Open access article link: https://link.springer.com/article/10.1007%2Fs10926-016-9690-x

THE IMPACT OF OPIOID PRESCRIPTIONS ON DURATION OF TEMPORARY DISABILITY

By David Neumark, Bogdan Savych, Randall Lea, MD

Study link: https://www.wcrinet.org/reports/the-impact-of-opioid-prescriptions-on-duration-of-temporary-disability

PEARLS FROM THE STUDY

Patients with multiple opioid scripts are out of work 3 times longer than patients with no opioid scripts.

Patients can be weaned off opioids within two years and successfully return to work.

Don't forget to bookmark the Occupational Health Special Interest Group Website:

https://www.orthopt.org/content/special-interest-groups/occupational-health

OS SIG

ORTHOPAEDIC SECTION, APTA

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President's Letter

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

Summer is here! This season is a great time for planning. The Performing Arts SIG leadership will be meeting this summer for strategic planning. Stay tuned for upcoming news as a result of this work together.

We had a very good Emergency Medical Responder (EMR) course, led by Tara Jo Manal. We netted over $750 towards our encumbered funds from this course. Thank you, Tara Jo, for teaching and collaborating with the PASIG. We hope to do this again. If you are interested in a future EMR course, contact Rosie Canizares.

Please remember to renew your APTA and Orthopaedic Section membership, and when you do, renew your PASIG membership too. PASIG membership is free to all members. We need you to help move our profession forward!

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

One of the great joys we have experienced in the PASIG is the validation of the Description of Fellowship Practice (DFP) from the American Board of Physical Therapy Fellowship and Residency Education (ABPTRFE). Please enjoy the following reflection and case report by the first Performing Arts Fellow in the United States, Tessa Kasmar.

From the Inside of the Performing Arts Fellowship

Tessa Kasmar, PT, DPT
Performing Arts Fellow-in-Training
The Ohio State University Wexner Medical Center

My name is Tessa Kasmar and I am the country's first Performing Arts Physical Therapy Fellow-in-Training at The Ohio State University (OSU) Wexner Medical Center. This program is one that very much aligns with my passion for working with dancers in combination with the guided mentorship from experts in the field. For those of you interested in a similar path, I will give you a background on how I got here and my experience in the Performing Arts Fellowship.

My interest in working with dancers stems from my long history as a pre-professional dancer – the initial spark that led me to the physical therapy profession. Throughout my education and professional training at Marquette University, I sought experiences and opportunities that allowed me to incorporate my interest and passion for dance into my physical therapy practice. As a physical therapy student, dance medicine experiences were both rare and competitive. This inspired me to establish the Marquette University Dance Medicine Clinic, which allowed me to work under the mentorship of a faculty member with 20 years of dance medicine experience. I was able to perform injury evaluations, biomechanics assessments, workshops that underlined injury prevention and strengthening, develop a pointe readiness assessment for young dancers, and create a journal club interest group. This helped me secure a spot as a Sports Medicine Intern with the Milwaukee Ballet for further hands-on experience in treating dancers. For my final clinical affiliation I secured placement at Body Dynamics, Inc. in Falls Church, VA allowing me exposure to the Washington Ballet, an integrative approach to patient management, and the incorporation of Pilates-based methods.

While all of these experiences reinforced my area of interest, I was not really sure where to go from there. I wanted to learn from experienced clinicians and have guidance in working with this unique population. I pursued an Orthopaedic Residency Program at OSU due to my desire to further refine my orthopedic clinical skills and become a well-rounded clinician with improved clinical reasoning and diversified experiences. I was intrigued by OSU's residency program due to the incorporation of teaching and research into the curriculum, as well as the presence of an established Performing Arts Medicine Team. Although time to incorporate my interest in working with dancers was scarce throughout my residency, the team presented opportunities for me to become involved.

Fortunately, the Performing Arts Fellowship at OSU was granted candidacy status and looking to start their first fellow around the time that I would be completing my residency. I was attracted to the fellowship because it was the exact experience I had been searching for. It would allow me the mentorship I wanted while I managed the needs of a dancer while also incorporating the management of other performing artists, including figure skaters, gymnasts, and musicians. I applied to the program without hesitation and was thrilled when I was offered the position as the first Performing Arts Fellow-in-Training.

The Performing Arts Fellowship is a 12-month program incorporating mentored clinical practice, weekly didactic curriculum in the form of lecture and lab, and outreach participation for various performing artists. These 3 components make up the heart of the fellowship and foster a more intentional pathway to pursuing a position in the field. Tiffany Marulli, PT, DPT, OCS, is the Fellowship Director as well as my primary mentor in the clinic. Tiffany has a strong background in classical ballet herself and has had the opportunity as a clinician to work with Broadway dancers among others in New York City.

As my primary mentor, Tiffany typically spends 1 to 3 hours with me in the clinic each week mentoring me while I manage the care of performing artists. She fosters and challenges my clinical reasoning and motion analysis skills required for the performing artist. Her job is to provide constructive feedback and stimulating discussion on movement impairments and treatment techniques specific to the unique needs of dancers and how best to return them to performance. We typically share a caseload, which presents us with more opportunities to discuss the management and progression of these patients. I have learned other important considerations for the dancer throughout this process, including nutrition, sports psychology programs, and management of the adolescent dancer. With Tiffany's mentorship, my evaluation and treatment of the dancer has evolved significantly since beginning the program.

While my clinical work is primarily dance-focused, the didactic curriculum helps to fill in the gaps of the performing artists I do not see as frequently in the clinic. Faculty members assist in leading labs and lectures with video and written supplements from the Harkness Center for Dance Injuries, APTA, and other evidence-based material crucial for the treatment of the performing artist. Didactic material is offered during 2-hour weekly lectures providing information on different types of dancers, musicians, figure skaters, and gymnasts. I am also expected to present two of these didactic lectures. My recent presentation on the evaluation and management of the instrumental musician's elbow, wrist, and hand was a great learning experience to better understand the specific demands of their art, challenging me to understand topics with which I am less comfortable.

One component of the fellowship which I am most excited about is the ability to perform outreach for performing artists. For dancers, this includes weekly coverage with BalletMet at the company and the theater for performances, weekly injury checks at OSU's Department of Dance for the collegiate dancers, and presentations on injury prevention and self-care for other Columbus-area groups. Acute management at BalletMet has been an eye-opening way to learn that as prepared as you may think you are for an acute injury, there are always things you wish to improve upon moving forward. This outreach is also what best helps me to familiarize myself with the demands and needs of our musicians, figure skaters, and gymnasts. I am expected to find and market to at least one group for each of these performing artist subsets and present a lecture or workshop to the artists based on what each program's director and I decide is most beneficial for the group. I am still in the beginning phases for most of these presentations, but I can not think of a better way to introduce these artists to what physical therapists have to offer than to go out into the community and educate them.

As the first soon-to-be-accredited Performing Arts Physical Therapy Fellowship in the country, this has been a learning experience for everyone involved in the process. It has been very collaborative in nature in that my feedback is important for the program's growth and to further strengthen areas of improvement for our future fellows. The faculty consists of expert, dedicated, and passionate clinicians who strive for the growth of this fellowship program as well as performing arts physical therapy, and I am honored to be a part of the process. I hope to carry forward everything I have learned and continue my growth as a sub-specialized clinician with a professional ballet company or in an area with a strong performing arts prevalence.

A Unique Cause of Lisfranc Instability: A Descriptive Case Report

Tessa Kasmar, PT, DPT
Performing Arts Fellow-in-Training
The Ohio State University Wexner Medical Center

This report describes the progression of a dancer's stress fracture into a Lisfranc injury. The goal of this report is to present conservative treatment and indications for potential surgery for this dancer.

CASE HISTORY

The patient is a 19-year-old female professional ballet dancer. She started having pain between the 1st and 2nd metatarsals of her right foot that was aggravated with jumping, relevé, and full pointe. The pain was sharp at times with jumping and a dull ache or soreness following dancing. The dancer tried Tylenol, ice, and massage to manage her symptoms without significant relief. Believing that her pain was muscular in nature, she continued to dance and experienced increased foot pain and difficulty weightbearing following the landing of a jump. The dancer was evaluated by a physician who diagnosed her with a minimally displaced fracture at the base of the 2nd metatarsal following imaging. She was taken out of dance and placed in a CAM boot for 8 weeks. She was also referred for a nutritional consult, DEXA scan, and physical therapy. The dancer was released to barre two weeks prior to initiating physical therapy and denied pain during or after dance or with other weight-bearing activities. Continued limitations included jumping, pointe-work, and partnering. The patient's medical history included secondary amenorrhea, female athlete triad syndrome, and history of stress fracture.

IMAGING

X-ray report: "There is a stable minimally displaced second metatarsal base fracture" (Figure 1).

MRI report: "Mildly displaced intraarticular fracture of the second metatarsal base consistent with Lisfranc type injury although the ligament fibers are grossly intact. No evidence of Lisfranc subluxation" (Figure 2).

PHYSICAL THERAPY EVALUATION

At evaluation, the patient demonstrated 5/5 hip and knee strength bilaterally and full ankle ROM and strength, with exception of right ankle plantar flexion 4/5. The patient demonstrated impaired proprioception of the right foot and ankle in relevé position with eversion and increased medial and lateral ankle movements noted. No tenderness to palpation throughout the foot or midfoot region was noted, including the 2nd metatarsal. The patient denied numbness and tingling. Eversion-abduction test and squeeze test were negative. On observation, the patient demonstrated increased interdigital space between the 1st and 2nd digits of the right foot compared to the left in weight-bearing (Figure 3), which she reported was not present prior to injury. The patient's goal was to return to dance participation and performance fully.

Figure 1. Nonweight-bearing anterior-to-posterior oblique radiograph of the right foot with minimally displaced fracture at base of the 2nd metatarsal (arrow).

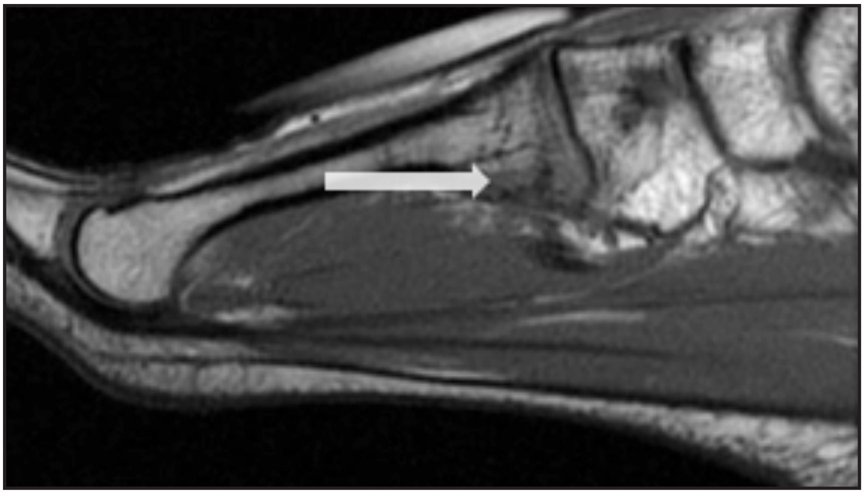

Figure 2. T1-weighted sagittal MRI of right foot with minimally displaced fracture at base of the 2nd metatarsal (arrow).

Figure 3. Visible widening of the interdigital space of the right foot between the 1st and 2nd digits in weight bearing.

RETURN TO DANCE

The patient attended 9 visits for 9 weeks to address ankle weakness and proprioceptive deficits in end-range positions (relevé), hip and core strengthening, and return to dance with plyometric and pointe progressions. A general outline of physical therapy progression is highlighted in Table 1. At visit 8, the dancer reported point tenderness at the base of the 2nd metatarsal following auditions but no pain with weightbearing. Her physician and physical therapist recommended returning to the CAM boot outside of dance and wearing supportive shoes when not dancing. Dance participation was not restricted unless the patient experienced pain or soreness during or following dance. Repeat x-rays indicated normal healing. The patient met all physical therapy goals and returned to full dance participation and performance without midfoot pain or bony tenderness. The patient continued to wear the CAM boot intermittently to offload the foot secondary to dancing 7 days/week due to auditions. This was preventative in nature and the dancer was instructed in weaning out of the boot fully by the attending physical therapist and physician.

NEW-ONSET SYMPTOMS

Six weeks after discharge from physical therapy, the patient reported new onset symptoms of pain in the distal 1st metatarsal of her right foot that she reported "spiraled up" toward the base of the 1st metatarsal. This pain started following a weekend of auditions and she reported having pain with weightbearing after

Table 1. Physical Therapy Progression

	Weeks 1-2	Weeks 3-4	Weeks 5-6	Weeks 7-9
Manual Therapy	STM; TCJ distraction			STM FHL
Balance	Airex, Bosu (flat shoes, relevé): with devéloppé to 45°	Jumps to Airex	Dynadisc; preps to passé en pointe	Bosu: with rond de jambe en l'air, développé to 90°
Proprioception	BAPs board; PWB perturbations in relevé	Bosu rocks (flat shoes); 4-way resisted relevé	Bosu rocks (flat shoes and relevé); unstable surface in pointe shoes	Leg press with Dynadiscs
Foot & Ankle Strength	Resisted ankle 4-way; foot intrinsics	Turning progression (technique shoes)	Progression of previous	Progression of previous
Hip & Core Strength	Hip abductors; external rotators	Resisted hip 4-way rotators	Resisted hip 4-way on Bosu	Standing resisted clamshell on Bosu
Plyometrics	PWB jumps; FWB DL jumps	FWB DL jumps; FWB SL jumps	FWB SL/DL jumps (increased height)	FWB DL jumps (increased height an contacts); hop testing
Pointe-work		PWB, barre	Turning, jumps	
Dance Participation	Centerwork; no jumping	Warm-up jumps, barre en pointe; petite allegro, mark rehearsal	Turning en pointe, modified grande allegro; partnering rehearsal	Full: progress to full grande allegro height
Outcomes	DFOS 66% LEFS 82%		DFOS 95% LEFS 100%	DFOS 100% LEFS 100%

Abbreviations: STM, soft tissue mobilization; TCJ, talocrural joint; PWB, partial weight bearing; FWB, full weight bearing; DL, double-leg; SL, single-leg; DFOS, Dance Functional Outcome System; LEFS, Lower Extremity Functional Scale; FHL, flexor hallucis longus returning home. The dancer said her symptoms resolved following acupuncture but was sent to be evaluated by her referring physician. Repeat imaging was performed and a referral was made to the foot and ankle specialist for further evaluation of the Lisfranc joint due to continued reports of mild pain with dancing. The imaging findings are reported below. An avulsion from the Lisfranc ligamentous insertion was suspected and the patient was referred for repeat MRI.

X-ray report: "3 weight-bearing views of bilateral feet were independently reviewed and compared to prior MRI right foot and demonstrate healed 2nd metatarsal base fracture with interval widening between medial and middle columns of the midfoot" (Figure 4).

Figure 4. Weight-bearing anterior-to-posterior radiograph of bilateral feet with interval widening between the medial and middle columns of the right midfoot.

CONCLUSION

This case describes a unique source of Lisfranc instability and the progression of a stress fracture at the base of the 2nd metatarsal into a Lisfranc injury based on the insertion point of the Lisfranc ligament at the displaced fracture segment. The dancer will be continuing her professional career and is currently undergoing surgical consult and decision-making to best address her current deficits and prolong her professional career.

The Foot and Ankle Special Interest Group (FASIG) receives inquires throughout the year from various groups ranging from journalists to industry representatives to provide input on foot and ankle related topics. A recent inquiry questioned the impact of foot and ankle function on mediating fall risk for older adults. This is an interesting question and has a growing focus from government related agencies, industry, and the scientific community. Many clinicians can likely concur that complaints of foot pain are common in our older patients and may be associated with impaired balance and falls.

Perhaps a place to start is the Center for Disease Control and Prevention (CDC) program called Stopping Elderly Accidents, Deaths, and Injuries (STEADI) (www.cdc.gov/steadi/). In fact, the program logo includes a footprint perhaps underscoring the relevance this might have. In the STEADI risk factor document, gait and balance problems and muscle weakness are listed as intrinsic risk factors but not specific to the foot and ankle. However, foot and ankle disorders are specifically listed as having effective clinical interventions to modify fall risk. Next, in the brochure outlining what you can do to prevent falls there are 4 steps: (1) talk with your health care provider about fall risk and prevention, (2) exercise to improve your balance and strength, (3) have your eyes and feet checked, and (4) make your home safer. From this it seems that the STEADI guideline does seem to identify and promote screening for foot problems and intervening with referrals to a foot specialist.

These guidelines and public advocacy documents are supported with literature that reports changes in tissue biomechanics, age-related changes in joint range of motion, strength, and dynamic foot function. Aging has been shown to cause changes in the heel pad including greater stiffness, dissipation of more energy, and reduced recovery of height after a load has been removed.[1,2] It has been hypothesized that these changes may lead to symptoms in the older foot while younger feet can withstand loading thousands of times a day without pain. Studies have shown that ankle and subtalar motion may be reduced by 12% to 30% in older people and more recently older people were found to have 32% less dorsiflexion range of motion at the first metatarsophalangeal joint than younger people.[3-5] One of the most characteristic features of aging is reduced muscle mass with reports between 20% and 40% loss in individuals between the ages of 30 and 80 years.[6] Muscle weakness tends to be in the lower extremities more than the upper extremities and progresses from distal to proximal making the feet and ankle particularly susceptible to atrophy.[7] Loss of strength may be associated with difficulties rising onto the toes, and toe weakness may impair the grasping functions of the toes to aid in balance. Also, atrophy of toe muscle may play a role in the development of toe deformities. However, emerging evidence indicates that age-related reductions in foot and ankle range of motion and strength may be at least partly ameliorated by targeted foot and ankle exercise programs in older people.[8]

Evidence of a lower medial longitudinal arch in older individuals may also have implications for dynamic foot function. Data across 619 people show higher values on the foot posture index (FPI) indicating a more pronated foot and lower arch as individuals age.[9] Coupled with a lower arch structure kinematic studies have shown an increase in midfoot and metatarsal stiffness. Together with a plantar flexed calcaneus these changes are consistent with a reduction in foot function for pushing off while walking in older adults.[10] Using a pull-off hip strategy in favor of a push-off ankle strategy may be a function of aging consistent with changes seen in the distal lower extremity including loss of range of motion and weakness.[11] In a recent study of 80 older adults over the age of 75, the presence of a lower arch in males was associated with measures of postural deterioration explaining up to 30% of variance.[12]

Age-related changes in foot structure and mechanics is linked to postural instability but these changes may be further exacerbated in the presence of certain diseases. Most clearly the evidence for diabetes and foot-related changes in structure and sensation have been linked to falls. The prospective study by Richardson et al[13] suggests that loss of ankle proprioception is the greatest predictor of falls when coupled with hip weakness in subjects with diabetes. Other conditions that cause foot deformity such as hallux valgus, tibialis posterior tendinopathy leading to flatfoot, or ankle arthritis have also been associated with balance impairment.

Physical therapists, as well as other medical professionals, who commonly treat foot-related pain and dysfunction are likely to see patients with impaired balance and perhaps a history of falls that can be addressed through management of the foot and ankle problems. The CDC and other groups are encouraging the use of medical professionals that can address foot and ankle-related pain and dysfunction to minimize falls. Physical therapists may be well positioned to manage these patients using a range of intervention strategies to address vision, vestibular, proprioceptive, and other specific foot and ankle related pathologies. Patient education on "foot checks" and good footwear are encouraged. Additionally, some evidence suggests improved balance with custom ankle foot orthoses are thought to provide additional mechanical and proprioceptive stability to the ankle and foot.[14] Ankle orthoses are commonly used for select patient populations but there is some evidence they may benefit many aging adults to improve their balance.

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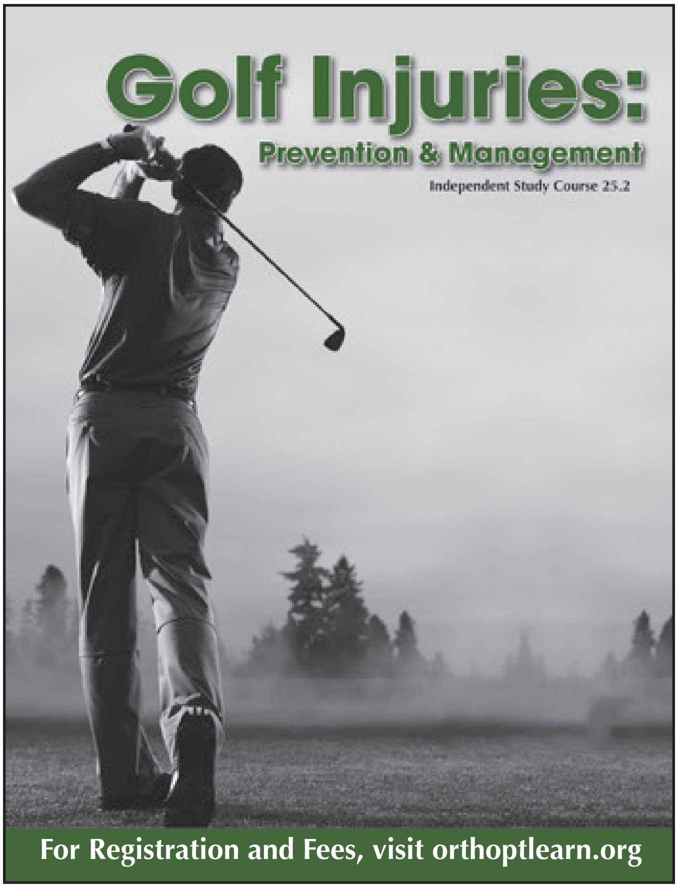

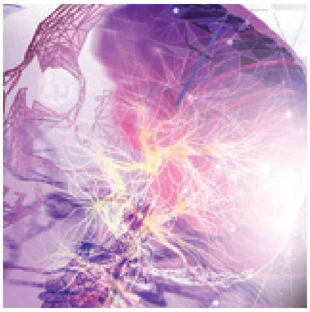

President's Message

Carolyn McManus, MSPT, MA

Despite the central role pain plays in the lives of patients seeking our services, pain curriculum across DPT programs in the United States remains highly variable in both time devoted to the subject and specific content. To address the need for curriculum standards, an interprofessional work group developed pain competencies that were endorsed by ACAPT in 2014. The competencies are in the following areas: Multidimensional Nature of Pain, Pain Assessment and Measurement, Management of Pain, and Clinical Conditions. In tandem with these competencies, the International Association for the Study of Pain (IASP), an international multidisciplinary organization dedicated to the study of pain, updated physical therapy curriculum guidelines for pain education. These guidelines, available since 1991, are periodically updated, with the most recent update in 2018 by a Task Force of physical therapists from the United States, Australia, and Sweden. This group included PMSIG members Kathleen Sluka, PT, PhD, Steve George, PT, PhD, and Joel Bialosky, PT, PhD. Guidelines can be found at:

https://www.iasp-pain.org/Education/CurriculumDetail.aspx?ItemNumber=2055

To move forward with establishing consistent guidelines in the pain curriculum in DPT programs that are essential to meet the needs for effective pain management in the United States, the Florida Chapter of the APTA proposed a motion (RC 43-18) to the House of Delegates recommending that the APTA endorse and promote the integration of the interprofessional pain competencies and IASP physical therapy curriculum guidelines into education, practice, and research initiatives, where feasible. APTA members may view the motion at: http://communities.apta.org/p/do/sd/sid=4561. The PMSIG Board reviewed both the interprofessional pain competencies and IASP Guidelines and made the recommendation to the Orthopaedic Section Board of Directors to co-sponsor Florida's motion to the House of Delegates. The House of Delegates debated and discussed the motion at their annual meeting in June. The outcome of the PMSIG recommendation to the Orthopaedic Section Board of Directors and the vote on the motion by the House of Delegates was not known at the time of this writing. Independent of the outcomes, the PMSIG Board endorses and encourages the integration of the pain competencies and IASP curriculum guidelines into DPT curriculum.

In addition to the PMSIG Board identifying the IASP as a scholarly resource for physical therapy curriculum guidelines for pain, the PMSIG will have several members represented in programming at the upcoming IASP 17th World Congress to be held in Boston, September 11 – 19, 2018. This conference brings together experts from around the globe practicing in multiple disciplines to share new developments in pain research, treatment, and education. The PMSIG presenters include:

- Kathleen Sluka, PT, PhD, will present a World Congress plenary session, "Does Exercise Increase or Decrease Pain? Underlying Mechanisms and Clinical Implications."
- Adriaan Louw, PT, PhD, will present a key note at the Pain, Mind and Movement SIG (PMM SIG) Satellite Symposia "Pain Neuroscience Education in Clinical Practice: State of the Art and Future Avenues."
- I will present a workshop session, "Mindfulness and Pain: Relearning to Move with Awareness," at the PMM SIG Satellite Symposia.
- Katie McBee, PT, DPT, OCS, will present two poster abstracts: (1) Prevalence of High Risk Patients and Data Trends in Orebro Change Scores for Musculoskeletal Conditions in a National Outpatient Physical Therapy Setting and (2) Assessment of Core Health Professional Curriculum and Elective Pain Neuroscience on Student Pain Neurophysiology Knowledge.
- Nora Stern, PT, MS, will present a poster abstract, Changing the Conversation About Pain: Development and Testing of a Novel Online Pain Continuing Medical Education Program.

It is an honor to have PMSIG members contributing to this international program. I hope you will consider attending. You can learn more about the IASP World Congress and preconference Satellite Symposia at: https://www.iaspworldcongressonpain.org.

In April, the Orthopaedic Section sponsored their Annual Meeting in Baltimore that brought together experts from the fields of pain and movement to examine the integration of the current knowledge of pain science with movement science as applied to the low back, hip, knee, and shoulder. PMSIG members Kathleen Sluka and Steve George were among the presenters. The program was very well received. The common feedback I heard was (1) how much participants enjoyed the afternoon hands-on sessions that focused on translating scientific insights into the practice of effective treatment strategies and (2) how the group size made for an intimate experience that provided participants multiple opportunities to interact with presenters. I hope you will join us next year!

The PMSIG Board welcomes your participation in PMSIG activities. If you have suggestions, interest in contributing to PMSIG activities, would like to write an article for the PMSIG section in OPTP, or contribute a clinical pearl or research topic to our monthly emails, please contact any PMSG Board member. I can be reached at carolyn@carolynmcmanus.com.

I would now like to introduce you to PMSIG member, Leslie Russek, PT, DPT, PhD, OCS. Leslie is an Associate Professor at Clarkson University in New York. She has published and presented in the areas of chronic pain and hypermobility spectrum disorder. As a practicing clinician, she has specialized in fibromyalgia and hypermobility for more than 20 years, and, more recently, expanded her practice to include patients with postural orthostatic tachycardia syndrome (POTS). I want to thank Leslie for contributing the following article examining fibromyalgia, mast cell activation, POTS, and hypermobility.

Is It Really Fibromyalgia? Recognizing Mast Cell Activation, Orthostatic Tachycardia, and Hypermobility

Leslie N Russek, PT, DPT, PhD, OCS
Associate Professor, Clarkson University &
Staff Physical Therapist, specializing in fibromyalgia, hypermobility, and chronic pain
Canton-Potsdam Hospital, Potsdam, NY

PATIENT SCENARIOS

Scenario 1: 38-year-old male presents with widespread severe pain not improved by anything other than Oxycontin, which "only takes the edge off." He also reports severe irritable bowel with frequent diarrhea, gluten intolerance, flushing, itching and hives, and chronic sinus congestion with frequent infections. He does not sleep well and is constantly fatigued. When he tries to exercise or participate in social activities, his hives will flare and he 'crashes' for several days due to flare of all symptoms. Pain is rated 8-9/10 most of the time. Using the 2016 diagnostic criteria for fibromyalgia (FM), his Widespread Pain Index (WPI)=19/19 and Symptom Severity Score (SSS) =10/12 (see Figure 1 for items in WPI and SSS).

Scenario 2: 14-year-old female presents with widespread pain, anxiety, and fatigue that prevents her from attending school. Symptoms began 2 years ago after forced bedrest due to a severe flu. Her primary complaint are the debilitating fatigue and anxiety attacks, but she also reports headaches, brain-fog, episodes of syncope, tachycardia, difficulty sleeping, activity/exercise intolerance, and cold hands and feet. Pain 4/10 most times, 8/10 during flares; FM WPI=5/19 and SSS=11/12.

Scenario 3: 42-year-old female presents with widespread, migrating pain, headaches, and fatigue that interferes with her ability to work as an administrative assistant. As a child, she was clumsy and frequently bumped into things or fell, twisting ankles or causing bruises. She has difficulty sleeping because it is difficult to get comfortable in bed. Previous physical therapy attempts to get her to exercise have increased pain. Pain is generally 6/10. Her WPI=14/19 and SSS=7/12.

INTRODUCTION

Fibromyalgia is a disorder characterized by chronic, widespread musculoskeletal pain and associated with severe fatigue, sleep disturbance, depression, gastrointestinal disorders, anxiety, paresthesias, headaches, and other signs and symptoms listed in Table 1.[1] Management of people with fibromyalgia is challenging, involves high utilization of heath care resources, and is not successful in reducing the huge costs in money, productivity, and quality of life.[1,2] People with FM still report poorer quality of life and are more likely to be disabled than people with other chronic widespread pain conditions.[2] Fibromyalgia affects 2% to 6% of the population in the United States; 10% of those patients access physical therapy in any given year[1] and 30% access some physical treatment (physical therapy, acupuncture, massage) in a 3-month period.[2] Though a number of interventions show some benefit, studies show that patients are often dissatisfied with their health care management.[3]

The pathophysiology of FM is not fully understood. For several decades, FM has been considered the prototypical 'central sensitization' condition, where the central nervous system increases sensitivity of many organ systems. Increased sensitivity results in hyperalgesia and allodynia of a variety of tissues, resulting in increased pain sensitivity (eg, headaches or migraines, pelvic pain, temporomandibular pain, myofascial trigger points, arthralgias, interstitial cystitis, etc) as well as nonpain complaints such as brain fog, irritable bowel, chronic fatigue, poor quality sleep, chemical sensitivity, anxiety, etc. See Fleming and Volcheck[4] for discussion of central sensitization.

More recently, research has hypothesized that the pathophysiology of FM is driven by neurogenic inflammation, where afferent nociceptive neurons are activated antidromically (towards the periphery), causing release of inflammatory mediators at the peripheral nerve endings. While neurogenic inflammation normally contributes to the healing response by initiating inflammation, excessive inflammation leads to peripheral and central sensitization, which creates a positive feedback loop of inflammation and nociception. Peripheral neurogenic inflammation contributes to the diffuse edema and neurogenic flare often seen in FM. Peripheral neurogenic inflammation involving the sympathetic nervous system could contribute to other organ system involvement, such as irritable bowel, migraine, or anxiety. Central neurogenic inflammation is also present in FM and may contribute to central sensitization and involvement of the hypothalamic pituitary adrenal axis, which would lead to sleep disturbance and reactivity to emotional stress. See Littlejohn et al,[5] and Chiu et al,[6] for detailed discussions of neurogenic inflammation in FM.

One of the challenges with FM is the lack of a definitive diagnostic test. In 1990, the American College of Rheumatology adopted criteria requiring at least 11 of 18 specified tender points to demonstrate widespread pain[7]; however, these criteria were neither reliable nor specific. In 2010, the diagnostic criteria were revised to reflect the belief that FM was due to central sensitization, and was often associated with other symptoms such as fatigue, poor sleep, cognitive complaints, headaches and depression; other diagnoses that could explain the signs and symptoms had to be ruled out.[8] In 2016, the diagnostic criteria were modified again, and are shown in Figure 1; they include a Widespread Pain Index (WPI) score that must include pain in 4/5 body regions, a SSS, and the presence of symptoms for at least 3 months. There is no longer a requirement to rule out other conditions that may explain the findings.[9]

Signs and symptoms of FM overlap with those of many other conditions that have widespread, multisystem involvement.[10] Three such conditions will be discussed here: Mast Cell Activation Syndrome (MCAS), Postural Orthostatic Tachycardia Syndrome (POTS), and Hypermobility Spectrum Disorder ([HSD], previously known as Joint Hypermobility Syndrome) which, constitute a common triad of comorbidities.[11] Table 1 shows the substantial overlap in signs and symptoms for these 3 conditions with FM.[8,12-15]

MAST CELL ACTIVATION SYNDROME

Mast cells are a part of the body's inflammatory and allergic response and are found in almost every tissue in the body. In MCAS, mast cells are overactive but not overabundant (as in mastocytosis, which is a rare condition).[16,17] The mediators released trigger inflammatory responses in various systems, leading to signs and symptoms that overlap extensively with FM (see Table 1).[18] Studies show that MCAS is common in conditions associated with central sensitization, such as FM, chronic fatigue, irritable bowel, pelvic pain, vulvodynia, and migraine.[18,19] Neurogenic inflammation may provide the link between central sensitization

2016 Fibromyalgia Diagnostic Criteria

Widespread pain index (WPI)

Where has the patient had pain *in the past week*,? (check all that apply)

Left upper region (1)	**Right upper region (2)**	**Axial region (5)**
☐ *L jaw*	☐ *R jaw*	☐ Neck
☐ L shoulder girdle	☐ R shoulder girdle	☐ Upper back
☐ L upper arm	☐ R upper arm	☐ Lower back
☐ L lower arm	☐ R lower arm	☐ *Chest*
Left lower region (3)	**Right lower region (4)**	☐ *Abdomen*
☐ L hip (buttock/trochanter)	☐ R hip (buttock/trochanter)	
☐ L upper leg	☐ R upper leg	
☐ L lower leg	☐ R lower leg	

Total: ______ WPI score (add up boxes checked, 0-19)

_______Number of regions checked (excluding items in italics); use this for criterion #2.

Symptoms Severity Score (SSS)

Rate the severity for each of the following symptoms *for the past week*:

	0=No problem	1=slight or mild problem, often mild or intermittent	2=moderate, considerable problem, often present	3=severe, pervasive, continuous, life-disturbing
Fatigue	☐	☐	☐	☐
Waking unrefreshed	☐	☐	☐	☐
Cognitive symptoms	☐	☐	☐	☐

Has the patient been bothered by any of the following *in the past 6 months*?

	0=No problem	1=Problem
Headaches	☐	☐
Pain or cramps in lower abdomen	☐	☐
Depression	☐	☐

Total SSS: _______(0-12)

Fibromyalgia Severity (FS) scale is the sum of WPI and SSS: ______

A patient satisfies the 2016 fibromyalgia diagnostic criteria if the following 3 criteria are all met, *independent of whether other diagnoses contribute to these symptoms.*

☐ **1. Criterion 1 is met if EITHER:** ☐WPI ≥ 7 and SSS ≥ 5 **OR** ☐ WPI 4-6 and SSS ≥ 9

☐ **2. Generalized pain: met if pain is in 4/5 regions (not including items in italics)**

☐ **3. Symptoms have been generally present ≥ 3 months**

Wolfe F, Clauw DJ, Fitzcharles MA, et al. 2016 Revisions to the 2010/2011 fibromyalgia diagnostic criteria. *Semin Arthritis Rheum.* 2016;46(3):319-329.

Figure 1. 2016 Diagnostic criteria for fibromyalgia.[9]

and mast cell activation, as the inflammatory mediators released peripherally by nociceptive neurons in neurogenic inflammation cause histamine release from mast cells, which leads to peripheral sensitization in a variety of tissues. Mast cell activation has also been reported in the central nervous system in FM, contributing to central sensitization.[19,20] Mast cells are prevalent in the gut and skin, explaining common complaints of MCAS. Mast cells are also very sensitive to activation of the hypothalamic pituitary-adrenal axis, hence are responsive to emotional stress, helping to explain why stress exacerbates so many symptoms.[21,22]

The current diagnostic criteria for MCAS are (1) typical clinical symptoms (see Table 1), (2) ≥ 20% increase in serum tryptase during or after a symptomatic period, and (3) response of clinical symptoms to histamine receptor blockers. Mast Cell Activation Syndrome is not yet well recognized in the United States and tryptase measurements are technically difficult, making definitive diagnosis challenging and frustrating for patients.[17]

Table 1. Comparison of common signs and symptoms in Fibromyalgia, Mast Cell Activation Syndrome, Postural Orthostatic Tachycardia Syndrome and Hypermobility Spectrum Disorder. Compiled from multiple references.[8,12-15]

System	Health Issues	FM	MCAS	POTS	HSD
Neurological	• Central sensitization, hyperalgesia	X	X	X	X
	• Headaches, migraines, dizziness	X	X	X	X
	• Syncope or presyncope	X	X	X	X
	• Paresthesias and nerve compression disorders	X	X	X	X
	• Restless leg syndrome	X	X	X	X
	• Motor delay (in children)				X
	• Proprioceptive and motor control deficits, clumsiness, frequent falls, trips or bumping into things	X			
Cognitive	• Anxiety and panic disorder	X	X	X	X
	• Memory or concentration problems	X	X	X	X
	• Depression	X	X	X	X
Immune	• Excessive inflammatory response	X	X	X	X
	• Chemical and environmental sensitivities (including meds)	X	X	X	X
	• Frequent infections		X	X	
Autonomic	• Dysautonomia, palpitations, tachycardia	X	X	X	X
	• Sweats	X	X	X	
	• Raynaud syndrome	X	X	X	X
Cardiopulmonary	• Varicose veins		X	X	X
	• Diffuse or migratory edema	X	X	X	X
	• Deconditioning	X	X	X	X
	• Short of breath	X	X	X	X
Musculoskeletal	• Frequent sprains, subluxations and dislocations				X
	• Chronic joint pain	X	X	X	X
Soft tissues	• Tendinitis, bursitis, synovitis, tenosynovitis, fasciitis or tendon ruptures	X	X		X
	• Trigger points, muscle spasm	X		X	X
	• Muscle strain				X
Gastrointestinal	• Irritable bowel syndrome, diarrhea, food sensitivities	X	X	X	X
	• Abdominal pain, bloating	X	X		
	• Gastroparesis/constipation	X			X
	• Gastroesophageal reflux, chronic gastritis, heartburn	X	X		X
	• Hernias (all types) and organ prolapse				X
Dermatologic	• Hyperextensible and fragile skin				X
	• Slow healing or scarring, poor wound healing		X		X
	• Easy bruising	X	X		X
	• Dermatographia	X	X		
	• Flushing, pruritis, rashes	X	X	X	X
Urogenital	• Urinary incontinence	X	X		X
	• Prolapsed bladder or uterus			X	X
	• Urinary tract infections	X	X		X
	• Dysmenorrhea, endometriosis, vulvodynia, pelvic pain, painful intercourse	X	X		X
Nonsystem	• Female predominance	X	X		X
	• Insomnia, sleep disturbance	X	X	X	X
	• Chronic fatigue	X	X	X	X
	• Exercise intolerance	X	X	X	X
	• Symptoms worse in the morning	X		X	
	• Symptoms aggravated by stress	X	X	X	

Abbreviation: FM, Fibromyalgia; MCAS, Mast Cell Activation Syndrome; POTS, Postural Orthostatic Tachycardia Syndrome; HSD, Hypermobility Spectrum Disorder

Management of Mast Cell Activation Syndrome

Management of MCAS emphasizes patient education regarding triggers and trigger avoidance. Key triggers include rapid temperature changes (including during exercise), ultraviolet radiation, histamine-rich or histamine-releasing foods, mechanical irritation, ethanol, narcotics, some nonsteroidal anti-inflammatory drugs (NSAIDs), ACE inhibitors, and beta-blockers.[23] Stress is also a common trigger that should be decreased; interestingly, mindfulness meditation is shown to decrease neurogenic inflammation.[24] Although there is no research yet supporting low histamine diets for reducing inflammatory response in MCAS, some patients report that dietary control is helpful.[22] Pharmacological management emphasizes histamine blockers; medications that exacerbate mast cell activation should be avoided.[18,23]

Scenario 1

This patient presented with signs of widespread inflammation involving peripheral and central nervous systems, gut and skin typical of MCAS; because of the challenge in confirming a diagnosis of MCAS, his diagnosis is presumed. Neurogenic inflammation triggers peripheral and central sensitization and key signs and symptoms of FM. In this patient, mast cell activation may have exacerbated the systemic inflammatory response, and contributed to flares in response to exercise, stress, and certain foods. Furthermore, opiates and NSAIDs taken to reduce pain may, in fact, have aggravated his inflammatory response.

Because his gastrointestinal symptoms were so intense, the patient chose to start by trying a ‘low histamine’ diet, and when he returned in 2 weeks, reported feeling “90% better” with minimal pain, improved energy, and tolerance to activity. He had voluntarily discontinued all opiate medications. Fibromyalgia SSS 4/12; WPI 5/19. His physical therapy program continued with pain neuroscience education emphasizing self-management with cognitive behavioral approaches, and a gradually progressed aerobic exercise program to address deconditioning, enhance descending inhibition pathways,[25] and potentially stabilize mast cell activity in muscles.[26]

POSTURAL ORTHOSTATIC TACHYCARDIA SYNDROME

Postural orthostatic tachycardia syndrome is a type of dysautonomia in which inadequate venous return to the heart evokes a strong sympathetic tachycardia response. Prevalence of POTS is reported to be up to 1%, but it is likely underdiagnosed.[27] Postural orthostatic tachycardia syndrome affects women 5 times more often than men and most often affects women during adolescence and childbearing age. Although there is little research, experts suggest that it may be common in FM.[28] Postural orthostatic tachycardia syndrome is formally diagnosed using a tilt-table test monitoring both heart rate and blood pressure during 5 minutes of resting supine and for 10 minutes after the patient transitions to upright; a Stand Test can be performed by having the patient stand quickly and keep still, without fidgeting.[27,29] Sustained heart rate increases ≥ 30 bpm (≥40 bpm in children) within 10 minutes of moving from supine to standing, without BP drop of 20/10 mmHg indicate POTS. Other signs and symptoms of POTS overlap substantially with FM (see Table 1). Multiple pathophysiological processes lead to the presentation: decreased venous return causes tachycardia, which leads to anxiety; decreased circulation to the brain results in lightheadedness, anxiety, brain fog, and syncope; frequent sympathetic response causes fatigue.[27,30] Inappropriate autonomic response to exercise leads to exercise intolerance, or severe fatigue as a result of low levels of exercise.[31] Symptoms are often initially triggered by a physical stressor that results in forced rest, such as surgery, pregnancy, illness, or injury. See Arnold et al,[27] for more detail about POTS diagnosis and pathophysiology.

Management of Postural Orthostatic Tachycardia Syndrome

Physical therapy plays a key role in management of POTS. Education about POTS self-management should address fatigue, sleep disturbance, exercise intolerance, anxiety, and other symptoms. Patients with POTS may benefit from increasing fluid and electrolyte consumption, compression stockings, strategies such as ankle pumps to improve venous return, and may need to lie supine with feet elevated to manage symptoms of syncope or anxiety. Individuals with low exercise tolerance may need to begin exercising with recumbent lower extremity strengthening exercises to facilitate venous return and gradual progression to aerobic exercise in a recumbent position with gradual progression to upright. Psychological and behavioral approaches such as stress management, pacing, and cognitive behavioral therapy are often also beneficial.[32-34] Although no medications have been approved for POTS, some are recommended off-label; medications that aggravate symptoms should be avoided. See Strassheim et al,[32] and Raj,[35] for excellent overviews of POTS management.

Scenario 2

This is a patient with POTS, which often presents initially in adolescent females, especially after forced bedrest as with this patient whose symptoms began after an illness. The stand test showed heart rate change from 72 bpm to 125 bmp with standing, and provoked symptoms of anxiety, pre-syncope, and headache. Fatigue results from inappropriate autonomic responses aggravated by deconditioning and sleep disturbance. Activity and exercise intolerance is common, especially in response to exercise in the upright position, which places additional stress on venous return.

This patient’s program emphasized education regarding POTS, the effect of position on venous return and how this can contribute to syncope and anxiety, the importance of hydration, and salt intake to maintain blood volume. She was advised to lie supine with the feet elevated when she experienced pre-syncope or anxiety. She was put on a graded exercise program starting with supine lower extremity strengthening (to improve venous return) and very low-level aerobic exercise using the recumbent bike. After 6 months, she had returned to full days at school, was participating in gym, and had no episodes of syncope or anxiety. She continued to have episodes of severe fatigue after increased activity or emotional stress. She no longer met the diagnostic criteria for FM. She reported pain typically 0/10 except for intermittent headaches, WPI = 0/19 and SSS = 4/12. She was discharged to an ongoing graded exercise program.

HYPERMOBILITY SPECTRUM DISORDER

Research suggests that HSD is a common comorbidity of FM, with 47%[36] to 65%[37] of patients with FM demonstrating HSD; some have proposed that HSD may often be incorrectly diagnosed as FM.[10,38] Recently, HSD has been recognized as the most common heritable connective tissue disorder, possibly affecting up to 10% of the United States population, affecting children equally but women past puberty 2 to 8 times more often than men.[39] The primary signs and symptoms of HSD, beyond widespread hypermobility, are listed in Table 1, and clearly overlap extensively with FM. See Tinkle et al[39] for a detailed discussion of HSD. Multisystem involvement reflects the fact that most connective tissues can be affected and not just joints. Symptoms may be triggered by musculoskeletal trauma or overuse, often by minor stressors. Symptoms may flare after forced rest due to surgery, illness, pregnancy, or injury; a possible mechanism is through decreased muscle tone increasing joint instability.[38,40] The pathophysiology is not yet understood; unlike other forms of Ehlers Danlos Syndrome (EDS), no genetic marker has yet been identified[41] and some suggest that connective tissue integrity is compromised by excessive mast cell activity.[11,12]

The diagnostic criteria of HSD have also evolved in the past few years. In an effort to identify a genetic marker, diagnostic criteria for hypermobile EDS (hEDS, available at https://ehlers-danlos.com/wp-content/uploads/hEDS-Dx-Criteria-checklist-1.pdf)[42] were made deliberately restrictive and exclude many patients who were previously diagnosed with Joint Hypermobility Syndrome. Consequently, HSD has been defined as generalized joint laxity associated with some of the other diagnostic criteria for hEDS, but not enough to meet the new, stricter criteria for hEDs.[42] Joint hypermobility is assessed using the 9-point Beighton score: hyperextension of elbows or knees ≥ 10º, touching the thumb to forearm, hyperextension of 5th MCP ≥ 90º, and trunk flexion placing palms on the floor with knees extended. Prepubescent children must score ≥ 6/9, puberty to 50 years must score ≥ 5/9, and people over 50 years must score ≥ 4/9. Because injuries my compromise mobility in some joints, people who score 1 point below the cutoff can add 1 point if they answer Yes to ≥ 2 items on the 5-item questionnaire about historical hypermobility.[41-42]

Management of Hypermobility Spectrum Disorder

Physical therapy is key to management of HSD. Patient education should emphasize injury prevention through proper body mechanics, joint protection, posture, and ergonomics. Identification of aggravating activities, positions, or muscle length-strength imbalance is critical; gravity, alone, may cause joint subluxation. Migrating pain is due to overload of fragile connective tissue, tight muscles pulling on loose joints, trigger points, poor body mechanics, and motor control. Exercise should include proprioceptive and motor control training, followed by strengthening of stabilization muscles and graded aerobic exercise. Exercises need to be progressed more gradually in patients with HSD due to connective tissue weakness and increased time to gain strength.[39] Orthotics are often helpful for improving alignment of the lower extremities, but evidence for bracing is weak and experts recommend bracing only during flares.[40] Sleep hygiene can help manage sleep disruption; patients may be hypersensitive to pressure from the bed and may benefit from experimenting with bed surfaces. Cognitive behavioral approaches and pain self-management are also helpful.[34] There are no medications, currently, that address the pathophysiology of HSD; medications can be used to address symptoms of pain and inflammation.[38]

Scenario 3

This is a patient with HSD. Clumsiness and frequent injury reflect the proprioceptive and motor control deficits common with HSD. Headaches are typical of cervical instability and secondary trigger points in muscles overworked trying to stabilize hypermobile joints. Fatigue and brain fog are likely due to sleep disturbance, which is commonly due to discomfort from whatever body part contacts the bed. Her poor response to exercise in the past reflects fragile tissues that are unable to tolerate standard exercise programs and progressions.

Her program emphasized patient education regarding HSD, posture, body mechanics, self-management of trigger points, and the fact that minor physical stressors could cause pain. She began gentle proprioception and motor control exercises to improve stabilization of her cervical spine. She also began sleeping on a featherbed to distribute body weight while sleeping. After 3 months, her headaches were gone. She was sleeping better, but still not waking refreshed. She had intermittent migrating pain that she was typically able to attribute to specific postures or activities. Pain was generally 2/10 with occasional flares up to 5/10. She no longer met the diagnostic criteria for FM: WPI=3/19 and SSS=3/12. She was discharged with an ongoing exercise and pain self-management program.

CONCLUSION

These patient scenarios demonstrate research that shows HSD co-exists with FM or is misdiagnosed as FM[36,37] and that MCAS presents with FM-type symptoms.[12] Little research has been done to measure the co-morbidity of POTS with FM. Mast cell activation syndrome, POTS, and HSD often present as a triad and have many overlapping signs and symptoms.[11] However, MCAS has a dominant inflammatory presentation, POTS has primarily autonomic signs and symptoms, and HSD leads to mechanical stresses on fragile tissues. While the additional diagnoses do not cure FM, patients are often reassured to understand factors underlying what can seem like random and unrelated symptoms. Patients with HSD are often relieved to learn that there is a reason for their hypersensitivity and frequent injuries.[43] Patients with POTS are often relieved to have an explanation for anxiety attacks, syncope, and extreme intolerance to (upright) exercise and activity (personal observation). Patients with MCAS are often relieved to make sense of all of their various symptoms affecting multiple tissues and organs (personal observation).

Physical therapy is key to managing HSD[34,38,40] and POTS,[44] recognition and management of these conditions is critical. Looking for and managing MCAS, POTS, and HSD is not a magical solution for treating patients with FM. However, addressing these other conditions can help to decrease the overall symptom load, inflammatory state, and neural sensitization that contribute to high levels of morbidity in FM.

PATIENT AND CLINICIAN RESOURCES

- The National Fibromyalgia & Chronic Pain Association, at https://www.fmcpaware.org/
- The American Fibromyalgia Syndrome Association, Inc, at http://www.afsafund.org/
- Mast Cell Action, at https://www.mastcellaction.org/about-mcas
- The Mastocytosis Society, at https://tmsforacure.org/
- PoTS UK, at www.potsuk.com
- Standing Up To POTS, at http://standinguptopots.org
- The Ehlers-Danlos Society, at www.ehlersdanlos.com
- HMSA: Hypermobility Syndrome Association, at www.hypermobility.org

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US WEBINARS

As you may be aware from past announcements and correspondence, we have been working with the American Institute for Ultrasound in Medicine recently. As a result, we have had two webinars presented by physical therapists in 2018 with 2 more scheduled. The first was on April 19 is by Mohini Rawat, DPT, ECS, OCS, RMSK, presenting "Neuromuscular Ultrasound for Peripheral Nerve Entrapment and Nerve Injuries." Then, Gregory E. Fritz, PT, RMSK, and Colin Rigney, PT, DPT, OCS, RMSK, presented "Musculoskeletal Ultrasound Assessment of Tendinopathy" on June 11. Past webinars are archived on AIUM's website and on their YouTube channel, both of which can be easily located with a simple search. To emphasize, these are free to view.

The next scheduled event is "Ultrasound-Guided Dry Needling" by Scott Epsley on July 23rd. Please go to aium.org to register for these webinars or view those from the past. Later in the year, Chuck Thigpen will present on the use of ultrasound to enhance shoulder examination and assessment.

IMAGING SIG ELECTIONS

This fall, SIG elections will again be conducted. The Nominating Committee will soon be active in soliciting potential candidates. The positions available this year are President and Nominating Committee member. Each is for a 3-year term. If you are interested or would like to nominate someone else, please contact the Nominating Committee members: Paul Beattie (Chair) at *pbeattie@mailbox.sc.edu*, Megan Poll at meganpoll@gmail.com, or Mohini Rawat at mohinirawat@gmail.com.

IMAGING SIG SCHOLARSHIP

By the time this column appears, notices for acceptance for programming at CSM 2019 will have been sent. Please remember the availability of the Imaging SIG scholarship for CSM and spread the word to interested parties. We began this last year and plan to continue this as an on-going effort to support those doing research related to imaging in physical therapist practice as well as promoting the SIG overall. The application process and selection criteria are explained on the Imaging SIG's webpage on the Orthopaedic Section's website at www.orthopt.org.

The Scholarship Committee is comprised of Lena Volland (Chair), Murray Maitland, Bryon Smith, Becky Rodda, Meg Sions, and Andrew Smith. If you have any questions about the scholarship, please contact Lena Volland at lvolland@usa.edu.

STRATEGIC PLAN

Several teams have begun work on the SIG's strategic plan. We have 3 main domains of focus: research, education, and practice. Special thanks goes to all those volunteering in this effort, including Jen Reft, Lisa Hoglund, Katie O'Bright, Bryon Smith, Kimiko Yamada, Lena Volland, Murray Maitland, Matthew Wyland, Greg Dedrick, Meg Sions, Steve Kareha, Marie Corkery, Dale Gerke, Christa Nelson, and Todd Telemeco. Those efforts under the Research heading are being coordinated by George Beneck. Jim Elliott is working with those in Education, and Chuck Hazle is managing those under Practice. We plan to have some accomplishments to report by year's end.

TELEPHONE/WEB-BASED MEMBER MEETING

As we have done in the past, a member meeting will be held on a date to be determined during October-November. We typically poll for a time slot for greatest attendance. The specific time is then announced and the meeting is managed by the Section office. Recordings of past meetings are accessible on the Orthopaedic Section's website for those unable to attend live.

President's Message

Kirk Peck, PT, PhD, CSCS, CCRT, CERP

NEW BEGINNINGS

I hope all of you are now enjoying the transition from spring to summer activities. In my home state of Nebraska, the unpredictability of weather forecasting is what people find most perplexing this time of year. On any typical day in April or early May our inhabitants may enjoy a lovely afternoon basking in the hot sun while the next day might turn into a 6-inch snow fall. In less than 24-hours, temperatures may soar to 80° again without any rhyme or reason. It is all part of daily life living in the Midwest and comes without pomp and circumstance to those who were born and raised in "middle earth." But again, I emphasize the importance of transition. Winter gives way to flowers in the spring, which ultimately leaves blame to weeks of drought in the hot summer months when rain is nowhere to be found. Life transitions can be both fruitful and productive or tainted with negative outcomes, but either way, change is an inevitable part of progress.

So, why drone on about the change in seasons you might ask? Simple truth, this is my final year serving as ARSIG President as I will have completed two full terms at the end of CSM 2019. Therefore, the time has come for a fresh beginning with new leadership at the helm. Luckily, transitioning a new officer into SIG functions will be much easier with a recently developed comprehensive strategic plan to pave the way for current and future activities. All that remains now is for individuals to step-up to the plate and be nominated for ARSIG President. To help sway potential candidates, I urge you to review all the new and exciting initiatives planned for future growth in animal rehabilitation. The complete ARSIG Strategic Plan is publically accessible at https://www.orthopt.org/content/special-interest-groups/animal-rehabilitation

APTA POSITION STATEMENT

During the 2018 APTA House of Delegates (HOD) held in Orlando, Florida, this past June an RC motion to revise the position statement related to collaborations between physical therapists and veterinarians was introduced. The APTA currently has position statements related to Veterinarian/Physical Therapist relationships, but updated language was needed to better reflect current state of practice for physical therapists treating animals. Although I was not present during the HOD this year, I was involved in reviewing the draft language for the proposed motion. Final language for the new Position Statement should be available shortly.

SILENTLY THEY SPEAK

There is an echo of unfortunate criticism often directed at physical therapists who treat animals that needs to be respectfully dispelled. The argument implies that physical therapists are out of their educational boundaries when it comes to treating animals since "real" animals are unlike those portrayed in *Charlotte's Web*.

For Pete's sake the argument continues…animals are incapable of articulating past medical history, explaining mechanisms of injury, or vocalizing levels of pain on a scale of 1 to 10 using human dialect. So how can physical therapists competently and effectively treat critters of non-human origin? After all, academic degrees in physical therapy do not include courses on how to "read" the ears of a horse signifying either relaxation or aggression while mobilizing a thoracic rib, or recognize the need to restrain a dog, even those with Snoopy-like personas, prior to physically palpating a strained iliopsoas muscle. So until the day comes to pass when animal rehabilitation becomes a standard elective in physical therapy programs, or possibly its own academic degree, reading clinical signs of pain, anxiety, and depression in dogs, horses, Mongolian rodents, or whatever animal you prefer, seems to be an elusive competency that no physical therapist can acquire…or so the argument goes. To that assumption I reply, "Really…Is that honestly a proven fact withstanding the rigor of a double-blinded controlled study?"

I imagine that most physical therapists who expand their professional horizons into treating animals are most likely the same people who grew up with pets of all sizes, shapes, and species, and learned to recognize a thing or two regarding certain animal behaviors as a natural part of life. No, I am not suggesting that pet owners are automatic "experts" in learning to detect key signals of animal language, especially when giving a physical examination to specifically localize pain. However, people who spend a good deal of time around animals for any given reason certainly do learn a trick or two. These tricks include passive observation and general experience in the language of animals through use of body language, vocalizations, and change in personal behaviors.

The illogical argument against physical therapists treating animals leads into a baseless assumption that possession of an innate ability to understand the language of animals is germane to only the veterinary profession. However, this argument fails the test of reality. Understanding and communicating with animals on a non-verbal level is not specific to any one profession. For the most part, it is a skill that cannot be effectively taught in formal education aside from recognizing positive and negative signs to look for during a physical examination. Physical therapists are certainly capable of learning to read various animal postures and body language indicating potential areas of pain and discomfort, much like they do with human clientele. In addition, physical therapists are well-versed in how to communicate with humans as part of practice, and therefore, should have little difficulty asking appropriate questions of animal owners to facilitate knowledge acquisition.

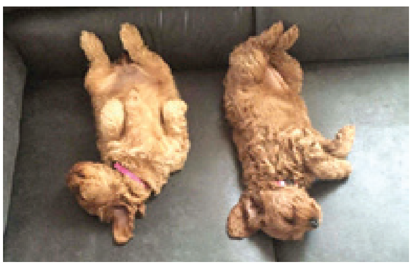
It should also be noted that the more experience one gains handling animals, the more natural it becomes from a standpoint of recognizing questionable signs and behaviors. Developing personal abilities to detect animal expressions of pain, reading body language, palpating irritable tissues, and observing clear indicators of discomfort, fatigue, and malaise, are all obtainable skills that develop over time. The reader should keep in mind, however, that like any new skill to be learned or acquired, variability in individual competency will exist.

Finally, we have all learned since we were children that animals speak their own language using mechanisms that do not incorporate the human equivalent of Broca's area of speech production. If animals could actually speak, then *Planet of the Apes* just moved beyond fantasy entertainment, and life just took on a whole new meaning for many of us. The fact is physical therapists are perfectly capable of delivering the same level of skill used in human rehabilitation to effectively treat language deficit organisms. So if you ever become the recipient of someone claiming that physical therapists should not be treating animals simply because they cannot speak using common human vocalizations…well, let's just say, I now hope you get the picture!

Contributory Acknowledgment

In this edition of *OPTP*, Thomas Maybury and Kirk Peck offer a brief review of medial shoulder instability followed by a personal case study of Tucker. This case is a great example of how the incorporation of using a model of conservative care for a canine with mild shoulder instability can have very positive results.

"Yep, The World Still Looks The Same Upside Down, & No Change In Blood Pressure"



Rizzo & Frenchy enjoying the day from a different perspective!

Photo Courtesy of Kirk Peck

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A Conservative Approach to Treating Medial Shoulder Instability

Kirk Peck PT, PhD, CSCS, CCRT, CERP
Tom Maybury, PT, DPT

Medial shoulder instability (MSI) in the canine client is a relatively common condition, especially in sporting dogs where the integrity of anatomic structures that restrict end range shoulder abduction are repetitively stressed or acutely traumatized.[1] For example, tensile stress applied to the shoulder joint capsule, medial glenohumeral ligaments, and tendons of the subscapularis and supraspinatus can become problematic as a dog maneuvers between agility weave poles.

Without the benefit of possessing an anatomic fibrocartilaginous labrum to deepen the glenoid fossa and add stability to the glenohumeral joint, the canine client must rely on soft tissue and ligamentous structures to retain functional joint integrity of the shoulder complex.[2] Medial dynamic stability of the shoulder is particularly reliant on muscle and tendon strength of the subscapularis, supraspinatus, biceps brachii, latissimus dorsi, and superficial and deep pectoral muscles.[3-5] Therefore, a key component to preventing MSI is proper conditioning of contractile tissues through strengthening, core stabilization, and muscle endurance activities to prevent fatigue during both training and competition.

The most accurate method of diagnosing canine MSI is arthroscopic exploration performed by a veterinarian.[4] Radiographic and magnetic resonance imaging may confirm injury to various anatomic structures of the shoulder complex, but hold minimal value in specifically diagnosing MSI. The most validated clinical examination for MSI is to lie the client in a laterally recumbent position, stabilize the scapula, extend the shoulder, and then abduct the glenohumeral joint in isolation of scapular movement. Experts generally agree that abduction of the glenohumeral joint beyond 40° while performing the examination indicates a potential MSI with the severity of injury increasing as abduction moves beyond 65° to 80°.[6] The evaluator must compare both shoulder joints for asymmetries to confirm the clinical diagnosis.

Treatment for MSI may require surgery in severe cases to stabilize the glenohumeral joint to more conservative care to manage mild to moderate instability.[7] If surgery is used for anatomic stabilization, then a comprehensive postoperative rehabilitation program will be needed to maximize successful client outcomes. Duration for return to sport may range from 6 to 9 months depending on the case. Nonsurgical treatment for MSI will also require a well-structured plan of care that adheres to the rules of specific tissue healing rates, and physical abilities attributed to individual dog breeds, home/life situations, and client/owner functional goals.[8-9]

Below is a case example of a dog that was diagnosed with MSI through clinical signs and symptoms, and treated conservatively primarily by the owner after instruction from a physical therapist certified in canine rehabilitation.

CASE STUDY

Tucker is a 6-year-old Vizsla/Bulldog Mix. Between the ages of 12 and 24 months, he sustained an undisclosed injury to the right shoulder. The primary veterinarian caring for Tucker at the time of injury was unable to determine the exact pathology resulting in right forelimb lameness. The injury remained untreated for approximately 6 months secondary to a lack of direction for an undiagnosed condition.

In the spring of 2016, Tucker was evaluated by a physical therapist certified in canine rehabilitation. Evaluation revealed the following: notable lameness on the right forelimb with excessive internal rotation of the glenohumeral joint during stance phase, general muscle atrophy surrounding the right shoulder complex, loss of muscle mass and tone of the pectoralis muscles, and a positive sign of increased range of motion (~ 50°) with shoulder abduction from an extended position with manual stabilization of the scapula. The MSI abduction test on the left forelimb was ~ 35°. Tucker expressed no signs of pain during gait or with any physical assessment of forelimb mobility on the right.

A home-based individualized plan of care (POC) was developed for Tucker and his owner using an 8-week rehabilitation protocol. See MSI Table on the following page. Tucker's POC was particularly unique in that his owner happened to be a student enrolled in a doctor of physical therapy program during the time of rehabilitation so he was capable of performing higher level treatment techniques, including joint mobilization. In addition, Figures 1-3 are 3 examples of strengthening and balance exercises Tucker completed with assistance from his owner.

Table. Medial Shoulder Instability: Conservative Rehabilitation Program

Medial Shoulder Instability Conservative Rehabilitation Plan of Care			
Time Frame	**Daily Exercise (2x/day)**	**Therapeutic Exercise (2x/day)**	**Restrictions**
0-7 days	- ¼ mile walk	- Weight bearing on single leg (3x30 sec) - Walking in clockwise/counter-clockwise circles (x10 each direction) - Physiological passive ROM of R anterior leg (20 min) - Joint mobilizations of anterior R shoulder – grade 2 (5 min) - Sit to lie (2x10)	- No agility - No sprinting - No lateral movements - No toys - No roughhousing with other dogs
7-14 days	- ½ mile walk - Slow jog in straight line (5x 300 ft)	- Same as above (increase reps as tolerated) - Horizontal adduction in weight bearing (2x10) - Physical therapist assisted manual weight shift front to back/side to side (3x30 sec) - Static anterior legs weight bearing (3x30 sec) - Physiological passive ROM of R anterior leg (20 min) - Joint mobilizations of anterior R shoulder – grade 3 (5 min)	- No agility - No sprinting - No lateral movements - No toys - No roughhousing with other dogs
14-28 days	- 1-2 mile walk	- Same as above (increase reps as tolerated) - Moderated jog (50%) in straight line (10x300 ft) - Dynamic anterior legs weight bearing (wheel-barrel) (5x25 ft) - Push-ups (army crawl) (2x10) - Mild agility with toys (limit lateral movement) - Ascend/descend stairs (3x1 flight) - Joint mobilizations of anterior R shoulder – grade 4 (5-10 min)	- No sprinting - No lateral movements - No roughhousing with other dogs
28-42 days	- 2-4 mile walk/jog - Fetch with toys (5-10 min)	- Same as above (increase reps as tolerated) - agility with toys (slowly progress lateral movement) - controlled interaction with other dogs (5-10 min bouts)	- Watch for signs of fatigue
42-60 days	- 3-5 mile walk/jog - Resume regular fetch activities	- Same as above (increase reps as tolerated) - Resume normal play with dogs as tolerated by fatigue	
Abbreviations: ROM, range of motion; R, right			

Sample Strengthening and Stabilization Exercise (Figures 1-3)

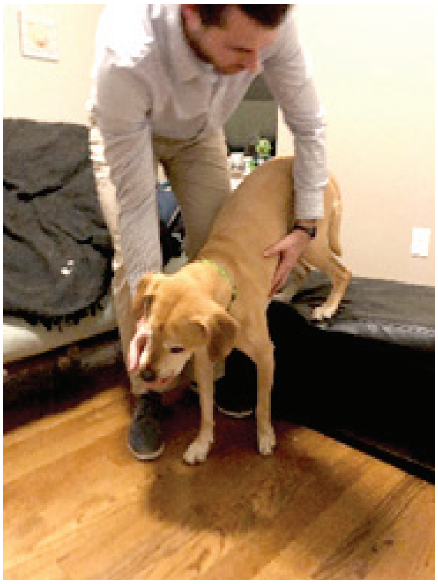

Figure 1. Progressive weight bearing.

Figure 2. Dynamic shoulder adduction strengthening.

Figure 3. Single leg stance for stabilization.

OUTCOMES

Following 8 weeks of structured rehabilitation, Tucker successfully returned to long-distance running with his owner and playing with age-related levels of canine enthusiasm. His owner was unequivocally pleased witnessing his dog return to a high level of function with improved quality of life.

Medial shoulder instability is a medical condition that can occur with any dog, but is most prevalent in the sporting populations. The pathology involves some degree of disruption of anatomic structures on the medial aspect of the glenohumeral joint. The result of injury often leads to shoulder instability causing various levels of lameness during gait, and loss of physical function with daily activities or specific to sport play. However, with carefully structured rehabilitation, either postoperatively or conservative care, most dogs can restore shoulder joint stability and return to desired levels of function.

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