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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

Walking the "Halls of the Hall"

Christopher Hughes, PT, PhD, OCS

On Saturday August 2, 2014, another 7 legends will be formally enshrined into the Pro Football Hall of Fame. I seem to gravitate to Hall of Fames. I grew up in Upstate New York minutes from the Baseball Hall of Fame and also attended Springfield College in Massachusetts where the Basketball Hall of Fame was right on campus. Recently I had another brush with "fame." On June 6, my son and I had the privilege to join the Pittsburgh Steelers rookies on their annual bus trip to the Pro Football Hall of Fame in Akron, Ohio. According to Ray Jackson, Director of Player Engagement for the Pittsburgh Steelers, the rationale for this annual trip is to provide the rookies with a sense of perspective about honoring the past, instilling excellence, and also getting a firsthand look at what it takes to succeed and to be considered one of the best in NFL history. With over 20 hall of famers enshrined from the Steelers organization, tradition about the past and setting the tone for the future is important. This has become known officially as "The Steeler Way."

On the bus ride, I could not help but think about whether there were any parallels to the Hall of Fame within our profession. How would a physical therapist become a hall of famer? Physical therapy is also based on a rich history and steeped in tradition. Awards with the names of Michels, Kendall, McMillan, and Blair carry the highest esteem within the profession. In physical therapy, we also "set a tone" of excellence through the pride we have in the school we attend and then our association with the employers we work for. Overall, our association (APTA) cultivates the profession and also recognizes excellence and promotes leadership. However, there is no hall of fame for physical therapists.

In his opening introduction prior to walking the "halls of the hall," Vice President of Communications, Mr. Joe Horrigan shared an interesting fact; this is among the many he has accumulated throughout his 38 years while employed at the Hall. I was somewhat surprised to find out that there are more undrafted than drafted players in the Football Hall of Fame. In other words, as an incoming rookie you have the possibility, whether drafted or undrafted, to gain entry in the Hall. Potential does not guarantee success. You can debate the facts and figures and review the criteria for entry, but one thing is for certain, you have to produce to become inducted. Mr. Horrigan also pointed out that "once a hall of famer" always a hall of famer. You cannot even die your way out of the Hall of Fame. You become attached to the honor forever and the body of work it represents.

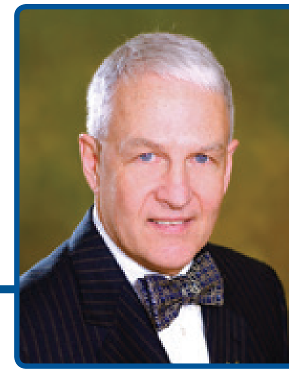
The PT profession does not formally have a Hall of Fame. But if we did, can you imagine what, and more importantly, who would be enshrined in such a place? Perhaps more of an issue is what would be the criteria for one to be considered Hall of Fame caliber? Would the benchmarks be total number of patients treated, patient satisfaction, patient outcome, years of experience, service, financial success, or mentoring? Also, who would nominate? Would it be patients, colleagues, or employers? Heaven forbid, we could end up with the same trials and tribulations of another famous hall…the Rock and Roll Hall of Fame! I guess this is what happens when a profession lacks clarity on its criteria for such an honor of performance. Not uncommon to what we sometimes hear from our patients who are befuddled by our own lack of standard. They often are confused on how they can attend different clinics and receive care that can sometimes be quite varied despite the same pathology. No home exercise program, no manual treatments, no justification for why we do what we do or worse yet, a lack of evidence for what we do!

Clarity comes from having a very succinct standard of performance. Steelers Coach, Mike Tomlin often cites the "standard is the standard." Other great teams and organizations will always have such focus on measuring performance. No doubt, it is a vital prerequisite for truly understanding the task at hand. I often wonder if we as a profession know what the standard is and also whether it can be reached with consistency among colleagues. Getting back to the Hall of Fame analogy, in the end, it is hard to measure success if we cannot measure performance. Who would be in your PT Hall of Fame?

President's Corner

Your Volunteer Leadership Benefits the Orthopaedic Section and You

Stephen McDavitt, PT, DPT, MS, FAAOMPT



When responding to surveys on volunteering, volunteers report that their activities have helped them with their interpersonal skills, such as understanding people better, motivating others, and dealing with difficult situations. They also report that gaining specific skills from their volunteer training and experience has translated into elevated job-related abilities as well as improving their job opportunities and outcomes.

Volunteering within the Orthopaedic Section creates meaningful and productive opportunities for you to have an impact on the profession, the American Physical Therapy Association (APTA), and the Orthopaedic Section. Members voice many reasons for volunteering. Their reasons include meeting new people, gaining leadership talents, and fulfilling their passion for enhancing their profession and their lives. Volunteering within the Orthopaedic Section enables members to connect with a large community of specialized professional colleagues. Whether serving as an officer, member of a special interest group or task force, or serving as an appointed committee chair, volunteering provides opportunities for being included in the Section in ways that have a direct impact on orthopaedic practice far beyond the usual daily professional environment. Seek out and talk to your colleagues who have experienced volunteering within the Section or elsewhere in the APTA. They will confirm this.

From my personal experience of being involved in various volunteer and leadership positions within APTA over the past 20 years, I agree with many of my colleagues who report that volunteering within APTA has provided them with opportunities for personal growth, acknowledgment, and a sense of professional accomplishment. Some have voiced their involvement as an extraordinary experience. Others describe and promote volunteering within APTA as an opportunity to:

- deploy their passion for the profession through service and stewardship (pay it forward),
- promote the growth and development of the profession through leadership,
- have an impact on mandates and policies for the profession, and
- ensure the success of the profession by helping society appreciate the benefits and quality of services that physical therapists provide.

To accomplish great things the Orthopaedic Section depends on a diverse pool of leader volunteers. Becoming a volunteer leader in the Orthopaedic Section is not something that requires a decade of previous experience. If you actually look at the core of great leadership, it is about leading with inclusion and employing empathy that motivates those who work with the leader to perform at their highest potential. There is nothing magical about being a leader beyond appreciating the talents of the people around you and providing them with meaningful volunteer opportunities. And it is not all that complicated for any member to step up to the plate and volunteer as a leader in order to experience the benefits personally and professionally.

The Nominating Committee is always looking for qualified officer candidates from the general membership to be slated for our annual Section elections. Our elected positions include President, Vice President, Treasurer, and two Directors that all have 3-year election cycles. The elected Board also needs talented recommendations for selecting volunteer leaders for appointed chairs of committees and members of task forces. The Nominating Committee is well-versed in the necessary qualifications for each elected and appointed position. Interested members are carefully evaluated to ensure the best candidates are selected. These decisions are based on the positions that are available and the assets that candidates can offer to fulfil the mission and vision of the Section. I hope all of you will consider nominating yourself or one of your colleagues as an officer candidate or for one of the many other appointed positions in the Orthopaedic Section. Considering and acting on this should be ongoing, regardless of the leadership positions that are currently vacant. So you can start right now!

I hope that after reading this *President's Corner* you will take the time to seriously seek an active leadership role with the Orthopaedic Section. Amazingly, all it takes to start the ball rolling is to recommend yourself or a respective colleague to the Nominating Committee. Do not forget, before you decide to nominate someone, please have a meaningful discussion with that person about why you believe he/she should consider becoming a leader in the Section. That collegial supportive action will make all the difference to them in stepping forward and being considered. Also, feel free to contact our Nominating Committee Chair with any questions you may have about leadership opportunities and qualifications with the Section. Our current Nominating Committee Chair is Cathy Arnot, PT, DPT, OCS. Cathy's contact information is listed in the Orthopaedic Section Directory in this issue of *Orthopaedic Practice*. Help us give Cathy and her committee the headache of having too many choices!

Quadriceps Strengthening for Anterior Knee Pain in a 16-year-old Male with Type 1 Osteogenesis Imperfecta: A Case Report

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ABSTRACT

Background and Purpose: Osteogenesis imperfecta (OI) is a heritable condition affecting type 1 collagen production. Of the 4 major types (1-4), type 1 OI is the mildest and most common. Currently, there is a void in the literature reporting sports injuries and the rehabilitation parameters for this population. This case report describes a quadriceps strengthening program for an adolescent male diagnosed with type 1 OI. **Case Description:** An active 16-year-old male presenting with left tibial tubercle pain was seen in an outpatient clinic. The patient underwent 5 weeks of physical therapy focusing on progressive quadriceps strengthening. **Outcomes:** The patient demonstrated a 27-point increase in his Focus on Therapeutic Outcomes (FOTO) functional status score, and a 3- and 4-point increase in his Patient Specific Functional Scores (PSFS). The patient returned to sport at discharge. **Discussion:** Patients with type 1 OI can return to recreational activity. Further research is needed to investigate appropriate exercise for the athletic type 1 OI population.

Key Words: tibial tubercle, avulsion, adolescent, exercise

BACKGROUND

Osteogenesis imperfecta (OI) is a heritable condition affecting the structure and production of type 1 collagen, with an incidence as high as 1 in 15,000 live births.[1] In OI, the alignment and strength of the collagen fibers are compromised in all tissues containing type 1 collagen, namely bone, dentin, tendon, ligament, and sclera. Bone strength is particularly decreased in OI, which increases the risk for fracture throughout the lifespan.[2-5] There are 4 major subtypes of OI (1-4). Type 1 is the mildest and most common form, comprising almost 47% of the diagnoses.[4] Type 2 OI typically leads to fetal fatality, with type 3 and 4 presenting with a wide range of functional outcomes ranging from household ambulators to total independence.[4-6] The milder clinical manifestation allows those with type 1 OI to participate in higher levels of physical activity than those with type 3 or 4.[6,7]

Due to increased fracture risk, recommendations are made for children with type 1 OI to not participate in sports involving forceful player-to-player contact, such as football or hockey.[5,6] However, this population does participate in a variety of sports that have less frequent and less forceful player-to-player contact.[6,8] Some of these sports, such as volleyball and basketball, involve movements that require repetitive impact with the ground. Such movements (eg, jumping and sprinting) put high ground reaction forces through the lower extremity kinetic chain. While physical impact with other players may be infrequent, sports involving highly repetitive impact with the ground still require the long bones and joints of the lower extremities to repeatedly dissipate high-level forces.

Healthy adolescent athletes participating in repetitive impact sports have a reported higher incidence of knee injury compared to athletes in sports with less frequent ground impact.[9] Traditionally, conservative treatment for these athletes consists of a combination of lower extremity strengthening, jump training, and bracing options.[10] From a sports training and rehabilitation perspective, traditional strengthening for athletes with type 1 OI may not be appropriate given the decreased integrity of tendon and bone.

The incidence and management of fractures in type 1 OI have been discussed in the literature. However, soft tissue injuries have been given less attention and few cases describing soft tissue injury in adolescent athletes with type 1 OI exist. Specific to the knee, two cases describing tibial tubercle avulsion fractures[11] and 3 describing distal patellar avulsion[12] in OI have been documented. Still, the rehabilitation and functional outcomes of these injuries have not been described. The purpose of this case report is to describe the quadriceps strengthening program implemented for a 16-year-old male with type I OI presenting with subacute anterior knee pain.

CASE DESCRIPTION

Patient History

The patient was a 16-year-old Caucasian male (height 1.8 m, weight 79.8 kg, BMI 23.6) seen by his primary care physician with a chief complaint of left tibial tubercle knee pain of two months in duration. Pertinent medical history included type 1 OI and an extensive fracture history (Table 1), with a noted recent traumatic avulsion fracture of his right tibial tubercle. The patient was between his sophomore and junior year of high school. The patient lived at home with his mother, father, and younger brother. He enjoyed playing basketball, golfing, and participating in high school training programs. The patient's primary goal was to return to weight lifting and plyometrics, and to prepare for play in a recreational basketball league. He also was concerned about sustaining another tibial tubercle avulsion fracture like the one that occurred two years previously.

His current symptoms began during participation in a weight lifting and plyometric training program at the local high school and had worsened over the last two weeks. He reported the symptoms were similar in intensity and location to the right knee symptoms he experienced in the days preceding the contralateral tibial tubercle avulsion. Activities that required a component of powerful knee extension and controlled knee flexion (eg, sprinting and jumping) were the most provocative activities. Plain radiographs were taken and were negative for fracture. The patient was referred to an

Table 1. Patient Fracture History

Fracture site	Year	Mechanism of injury	Associated surgeries
Right tibia and fibula	1997	Fall	None
Right tibia and fibula	1999	Fall	None
Right tibia and fibula	2000	Fall	None
Lumbar stress fracture (unspecified)	2001	Soccer	None
Right ulnar (compound) and right radius	2002	Fall off of bicycle	ORIF
Right elbow fracture and dislocation	2007	Playing baseball (pitching)	ORIF
Right tibial tubercle avulsion	2010	Short arc quad exercise against resistance	Kevlar and screw

Abbreviation: ORIF, open reduction internal fixation

outpatient physical therapy clinic for evaluation and treatment with the medical diagnoses of left patellofemoral pain syndrome and left pes anserine bursitis.

Clinical Impression 1

Given the patient's report of similar symptoms accompanying the previous avulsion fracture, the physical therapist wanted to thoroughly investigate the integrity of the extensor mechanism of the left knee. It was important to first establish ligamentous integrity about the knee in order to rule out internal instability. Palpation of the left knee was an important aspect of examination and provided insight into possible pain generators and the presence of edema. Thigh muscle strength was measured using hand held dynamometry in order to assess musculotendinous integrity and strength about the knee. Soft tissue mobility and muscle length about the knee were assessed as hypermobility is commonly seen in osteogenesis imperfecta,[4] and because decreased length of the hamstrings or quadriceps can affect knee mechanics.[10,13] Patellofemoral pain syndrome has a varied clinical presentation, and can be unique among patients.[13] Therefore, the physical therapist wanted to create a more specific picture of the patient's symptoms. A provocative test of patellar mobility and retropatellar surface integrity was administered to further examine patellofemoral mechanics. A functional test of the knee was administered in order to investigate dynamic patellofemoral mechanics as well as functional hip abductor strength.

EXAMINATION

The patient was observed walking in the clinic; there were no remarkable findings for gait. A review of the neuromuscular system for the lower extremities included assessment of deep tendon reflexes and sensation to light touch. There were no remarkable findings. The medial and lateral collateral as well as the anterior and posterior cruciate ligaments were assessed for laxity and pain generation. All were found to be intact and not painful. The distal femur, patella, proximal tibia, and surrounding structures were palpated for areas of focal pain and edema. Range of motion and gross strength of the lower extremities were assessed with goniometry and manual muscle testing respectively. Hand held dynamometry was used to assess quadriceps strength in short-sitting. Several special tests were then performed at the knee to further differentiate implicated structures. The lateral step down was performed at the end of the exam in order to assess dynamic hip-knee mechanics and confirm other findings. A summary of the pertinent exam findings and rationale for chosen tests can be found in Table 2.

Clinical Impression 2

The patient's problem list and adjunct factors in accordance with the International Classification of Functioning, Disability, and Health model (ICF)[14] can be found in Figure 1. From the relevant exam findings, the patient's body structure and function deficits were decreased left knee extensor strength, decreased passive straight leg raise, and focal pain at the left tibial tubercle and left pes anserine. The Trendelenburg sign observed bilaterally during the lateral step down indicated possible functional hip abductor weakness.[15] The patient's diagnosis was categorized under Practice Pattern 4D of the *Guide to Physical Therapist Practice:* impaired joint mobility, motor function, muscle performance, and range of motion due to connective tissue dysfunction.[16] The physical therapy diagnoses were decreased quadriceps strength, decreased knee flexor mobility, and decreased knee extensor mechanism mechanics all secondary to repetitive knee motion and soft tissue integrity compromise. The patient's prognosis was good, but not excellent, for several reasons. His age, high motivation, and reports of positive experiences with physical therapy in the past were positive prognostic factors. The patient was likely to return to activities of daily living and school activities at preinjury functioning. However, the patient's goal was to return to high resistance weight lifting. When considering the high force demands of this activity on joints, his diagnosis of type 1 OI and extensive fracture history were negative prognostic factors for achieving the patient's desired level of functioning.

Given the patient's limitations found on exam, the patient was deemed appropriate for physical therapy intervention. The proposed plan of care included lower extremity stretching and strengthening, activity modification, iontophoresis, and cryotherapy. Patient pain ratings would serve as an indication of readiness to progress quadriceps strengthening exercises. The therapist assessed pain experienced during activities of daily living and during exercise at each session using the 11-point Numeric Pain Rating Scale (0 = no pain, 10 = worst possible pain). This pain scale has been found to be both valid and reliable.[17] An in-take Focus on Functional Outcomes (FOTO) survey and the Patient Specific Functional Scale (PSFS) were administered at evaluation. The electronic FOTO survey consisted of questions pertaining to the functional status of the body part or impairment for which the patient was seeking treatment. The survey produced a numeric score from 0 to 100, representing the patient's perceived level of functioning (0 = worst possible functioning, 100 = best possible functioning). The PSFS allowed the patient to identify two activity limitations related to his current condition and rate his ability to complete the activities (1 = unable to perform activity, 10 = able to perform activity at the same level as before injury). Both the FOTO survey and the PSFS were readministered after two weeks of therapy (at the fifth visit) and also at discharge.

The physical therapist chose a frequency of two visits per week for 6 weeks. Physical therapy goals focused on the patient's noted activity limitations in the PSFS that were hopping/jumping and power cleaning. Interventions targeted the body structure and function limitations that were decreasing the patient's activity and participation levels (Figure 1).

Table 2. Physical Therapy Examination Findings

Section of Exam	Findings	Rationale
Strength, mobility, and palpation	*ROM* R knee – 6-0-135 L knee – 4-0-139 *Passive straight leg raise* R moderately limited; less than 90° L moderately limited; less than 90° *Strength* R knee extension – 302.0 N[a] L knee extension – 254.9 N *Palpation* Moderate, localized pain at left tibial tubercle and left pes anserine; no pain at joint line or body of patellar tendon; pronounced left tibial tubercle	• Assess joint laxity • Assess hamstring length • Assess strength • Identify palpable structures generating pain, assess edema
Special Tests	*Patellar compression* Negative; no increase in symptoms, no crepitus *Thessaly Test* Negative; no increase in symptoms; no reported clicking *Ely's Test* Negative; mild limitation in knee flexion, no pelvic movement	• Increase friction between retropatellar surface and femur; pain indicative of patellofemoral dysfunction • Impinging the medial or lateral horn of the meniscus • Assess gross quadriceps and rectus femoris length
Functional Tests	*Single Leg Step Down* Painful; mild to moderate bilateral Trendelenburg sign, mild bilateral knee valgus	• Assess functional hip abductor strength and dynamic hip-knee mechanics

[a] Reference value for knee extension measured with hand held dynamometry for 16-year-old males is 396 ± 90N.[31]

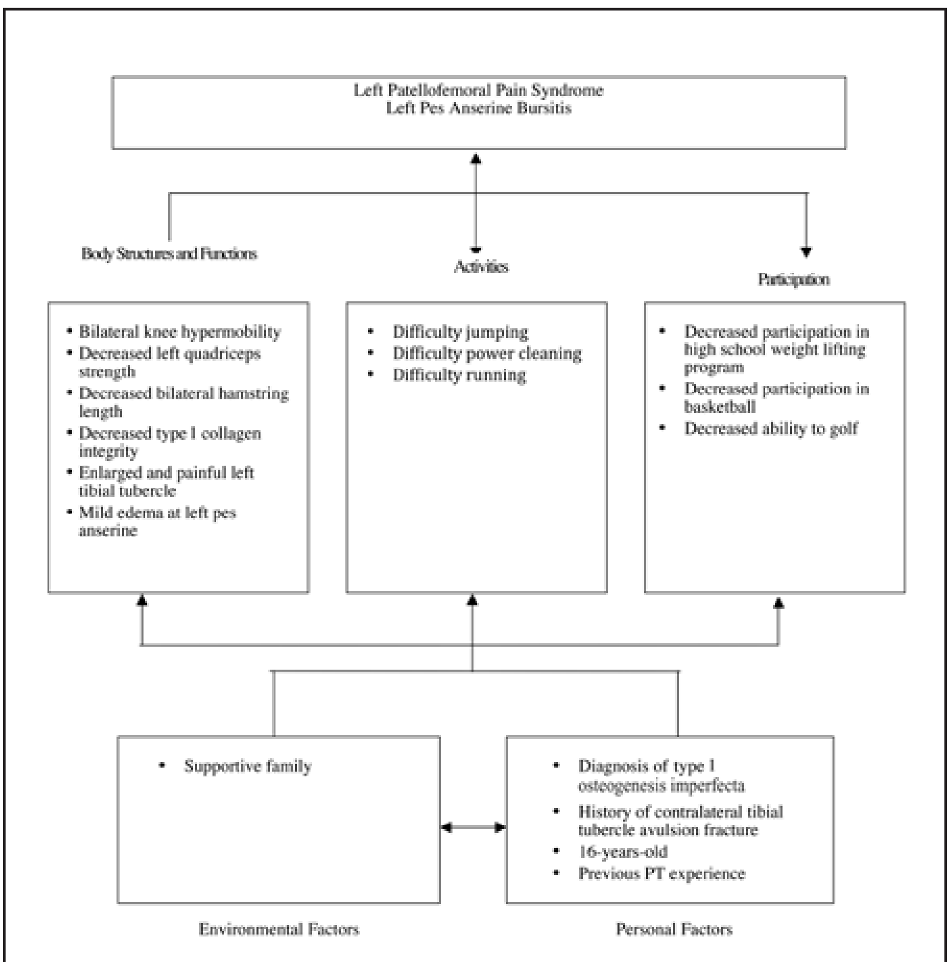

Figure 1.

INTERVENTION

The description, timeline, and rationale for interventions are provided in Table 3. Immediate rest from all sporting activities was recommended until acute symptoms subsided. It was recommended that the patient not to engage in activities that exceeded a 4/10 on the Numeric Pain Scale. This can be rationalized with the tissue stress/strain theory, in which a certain amount of stress is needed to simulate the tissue to prevent atrophy but not enough to inhibit the tissue healing process.[18] Self-limitation of physical activity due to pain was recommended because of the similarity of the patient's symptoms to those of Osgood-Schlatter disease.[19] Although the patient was not diagnosed with this condition, his symptom cluster of increased tibial tubercle size, pain with activity, and his age presented similarly. This, in combination with his inherently increased risk for fracture secondary to OI, focused intervention on prevention of tibial tubercle fracture.

Because of the deficit in knee extensor strength found on exam, isometric quadriceps strengthening began immediately. Isometric quadriceps strengthening was prescribed initially because isometric contraction provides enough activation to prevent quadriceps atrophy while transferring the lowest tensile load through the patellar

Table 3. Interventions and Parameters

Day in episode of care (visit)	Intervention	Frequency, intensity, and duration	Rationale
1 (1)	• Straight leg raise • Lateral step downs • Wall ball sits • Side-stepping with heavy resistance band at ankles	• 30 reps, 3x/day • 10.16 cm step; (painful to perform; withheld until visit 3) • 6 sec hold, 30 reps, 2x/day • 30ft x6 reps, 2x/day	• Isometric quadriceps and eccentric rectus femoris contraction • Withheld until able to complete isometric exercises without increasing symptoms • Isometric quadriceps and hip adductor contraction in partial weight bearing • Concentric hip abductor contraction, re-education of dynamic knee-hip mechanics in weight bearing
9 (3)	• Straight leg raise, Wall ball sits • Lateral step downs • Prone quad stretch with towel • Standing hamstring stretch	• (continued at same parameters from previous visit) • 10.16 cm box,15 reps, 2x/day; not painful • 30 sec x3 reps, 2x/day • 30 sec x3 reps, 2x/day	• Isometric hip abductor contraction in weight bearing to maintain neutral pelvis; concentric and eccentric quadriceps contraction in weight bearing • Increase quadriceps length and decrease tension through extensor mechanism • Increase hamstring length
14 (4)	• Prone quad stretch, standing hamstring stretch (continued) • Lateral step downs • Reverse planks • Hamstring curls on exercise ball	• (continued at same parameters from previous visit) • 15.25 cm box, 15 reps, 2x/day • 2 reps x30 sec, 2x/day • 15 reps, 2x/day	• Isometric gluteal, abdominal, posterior and anterior thigh muscle contractions • Hamstring curls target semitendinosus as well as semimembranosus
21 (6)	• Decline squats	• 30° decline, 20 reps, 2x/day	• Eccentric quadriceps contraction to affect patellar tendon remodeling
28 (8)	• Single leg squats • Jump squats • Lateral lunges	• 15 reps, 1x/day • 15 reps, 1x/day • 15 reps, 1x/day	• Concentric and eccentric quadriceps contraction; re-education of dynamic hip-knee mechanics • Powerful hip and knee extensor concentric contraction, controlled eccentric contraction; re-education of dynamic hip-knee mechanics • Concentric and eccentric quadriceps contraction; hip extensor and adductor concentric contraction
35 (9)	• Jump squat with 20.4 kg (45 lb) barbell • Begin return-to-run program	• 10 reps, x1/day	• Simulate explosive concentric quadriceps contraction of power cleaning • Aerobic training for basketball league

tendon and tibial tubercle.[20] As the patient's pain intensity rating decreased with exercises, concentric quadriceps exercise, and eventually eccentric exercise were gradually implemented.

When the patient was able to complete lateral step downs on a 10 cm step without an increase in pain, isometric quadriceps strengthening was stopped and exercises targeting the posterior thigh and gluteals were added (see Table 3, visit 4). Such exercises included reverse planks and lateral step down at varying step heights. The documented relationship between hip abductor strength and knee mechanics,[10,21] as well as the patient's goals to return to weight lifting and basketball justified the need for hip abductor strengthening. These exercises also aimed to reinforce proper patellofemoral mechanics.

Exercises requiring powerful hip and knee flexion and extension were added when the patient completed lateral step downs on a 15 cm step without demonstrating a

Trendelenburg sign (Table 3, visit 6). Jump squats simulated the demands of his weight lifting program and the weight of a 20 kg barbell was added when the patient was able to complete all other exercises painfree. A return-to-run program was added at the patient's final visit in order to transition back to aerobic training for basketball.

Quadriceps and hamstring stretches were added to the home program when the patient was able to perform them in a pain-free range (see Table 3, visit 3). Deficits in passive extensibility of both muscle groups were found on exam. Although daily stretching was eventually removed from his home exercise program, the patient was encouraged to continue with the stretches when he returned to weight lifting.

This case focused on interventions targeting symptoms at the tibial tubercle. However, it is important to note the treatment plan for the patient's symptoms at the left pes anserine. Ice massage and iontophoresis with Dexamethasone at 40 mA-minutes were applied to reduce pain and limit edema about the left pes anserine. A total of 4 iontophoresis treatments were administered at the second, third, fourth, and fifth visits respectively. There is little research discussing the effects of iontophoresis in pes anserine bursitis; however, the patient reported a significant decrease in symptoms after the first treatment and total resolution of pes anserine symptoms following the fourth treatment. The purpose of the wall-ball sits, reverse planks, and lateral lunges was twofold because, while intended to target the quadriceps and gluteals, they also involved the muscles inserting at the pes anserine.

In total, the patient was seen for 9 visits over 5 weeks, averaging two visits per week. The patient's home exercise program was comprised of the stretches and exercises outlined in Table 3. The patient reported 100% compliance with the home exercise program throughout the episode of care.

OUTCOMES

The outcomes are summarized in Table 4. All outcomes were clinically meaningful and the patient made strong progress toward all of his personal and therapy goals. There was a 27-point increase in the patient's FOTO functional status score (MCID 9 points).[22] There was a 3-point and 4-point increase in the patient's PSFS scores for jumping/hopping and power cleaning respectively (MCID 2.5 points).[23] The patient hopped near equal distances for the single leg hop test at discharge, with his involved lower extremity hopping further than the uninvolved lower extremity. Almost no change was seen in quadriceps strength bilaterally as measured using hand held dynamometry.

The FOTO functional status scores represented the patient's perceived participation restrictions throughout the episode of care. This measure has provided valid and reliable functional status reports of patients with hip, knee, and foot and ankle pathologies.[24] The PSFS served as an assessment of the activity limitations and his ability to return to activity levels at preinjury status. The PSFS was validated and shown to be reliable for patients with knee dysfunctions.[23] At the body structure and function level, quadriceps strength was measured with hand held dynamometry, which has been validated and shown to have strong interrater reliability for lower extremity strength measurement.[25] A strength deficit of more than 15% side-to-side is considered significant, and in this case, a 16.6% percent difference was found at discharge.[10] However, a 15.6% difference was found at initial evaluation as well, and the exercise program designed for this patient did not parallel the high resistance demands of the patient's previous training program. The single leg hop for distance has been shown to be a valid test to predict ability to return-to-sport after injury, which was an important goal for this patient. When comparing hop distances between the involved and uninvolved lower extremities, a ratio of less than 85% is considered significant for a poor outcome.[26]

DISCUSSION

This case report described the quadriceps strengthening program for a 16-year-old male with type 1 OI presenting with subacute tibial tubercle pain. Outcomes were clinically meaningful as the patient increased his FOTO functional status score and his PSFS scores. Despite showing no increase in quadriceps strength with hand held dynamometry, he demonstrated the ability to single leg hop nearly equal distances at discharge and was able to return to weight lifting.

The rehabilitation sequence for this patient was similar to reports of patients with traumatic tibial tubercle avulsions fractures. Postoperatively, isometric quadriceps strengthening is recommended for these patients to prevent quadriceps atrophy and to begin re-education of the extensor mechanism.[20] Although the patient had not sustained a fracture of the tibial tubercle, the acute nature of his symptoms paired with his medical history placed him at a higher risk for fracture. Therefore, his exercise progression was approached with caution as if he had undergone a surgical procedure of the extensor mechanism. During the acute phase of a joint injury in a patient with OI, it is important to recognize the immediate threat to bone integrity about the joint. Although strength assessment can provide insight into tendon integrity, it is difficult to assess bone integrity upon clinical exam. Therefore, as in this case report, subjective patient feedback regarding symptoms may be the most accessible and most accurate guiding factor for exercise selection and progression.

The decrease in our patient's symptoms could be attributed to factors other than quadriceps strengthening alone. First, the patient was not engaging in provocative activities throughout his episode of care in lieu of the suggested activity modification. He presented similarly to an acute case of Osgood-Schlatter disease, a condition in which resolution is typically insidious with aging regardless of treatment.[19,27] Secondly, hip abductor strengthening has decreased symptoms in patients with patellofemoral pain syndrome more effectively than quadriceps strengthening alone.[21] Therefore, the exercises requiring hip abductor activation may have attributed to the patient's decrease in symptoms.

This is the first case report describing the exercise parameters for an adolescent athlete with type 1 OI. Van Brussel et al[28] conducted a randomized controlled trial in which 34 children with type 1 OI or 4 OI participated in a 12-week strengthening program. The program consisted of low-intensity cardiovascular training and resistance training using no more than 1 kg. The authors concluded that children with type 1 OI could engage in regular strengthening programs; however, heavy resistance training was not considered. The patient in this report had regularly engaged in resistance training for several years with weights exceeding 25 kg. Yochum et al[8] reported on an adult male with type 1 OI who was a competitive power lifter. The patient in this study had endured over 30 fractures in his lifetime, yet the authors did not comment on the effects of the lifting on his bones and joints. Future research should investigate the effects of heavy resistance and high intensity anaerobic training on the bone and ligamentous integrity of the type 1 OI population.

Evidence is also lacking regarding the effects of eccentric training in patients with osteogenesis imperfecta. In the chronic

Table 4. Summary of Outcomes

Outcome Measure	Variable	Day 1	Day 16 (visit 5)	Day 35 (visit 9)
Numeric Pain Scale	Pain with daily activities	5/10	5/10	0/10
	Pain with exercise	5/10	3/10	1/10
PSFS	Hopping/jumping	7/10	5/10	10/10
	Power cleaning	6/10	4/10	10/10
FOTO	Functional Status Primary Measure	72/100	75/100	99/100
Quadriceps strength (HHD)	Right LE	67.9 lbs	NT	66.3 lbs
	Left LE	57.3 lbs		55.3 lbs
Single Leg Hop	Right LE	NT	NT	81.0 cm
	Left LE			82.0 cm

Abbreviations: PSFS, Patient Specific Functional Score; FOTO, Focus on Functional Outcomes; HHD, hand held dynamometer; LE, lower extremity; NT, not tested

phase of a tendinopathy, eccentric strengthening is intended to induce collagen remodeling.[29,30] Although the patient did not have the signs and symptoms of a chronic tendinopathy, attempting to strengthen the structural integrity of the patellar tendon could in theory decrease loads transmitted through the tibial tubercle. Langberg et al[30] investigated the collagen synthesis and degradation of the Achilles tendon in elite soccer players with Achilles tendinopathy during a 12-week eccentric strengthening program. When compared to baseline, they found significantly increased levels of peptides that serve as biomarkers for type 1 collagen synthesis. Because the genetic coding for collagen is altered in OI, tendons may not have a similar response to eccentric strengthening in this population. The patient in this case report was able to complete daily eccentric strengthening for two weeks without significant change in symptoms; however, long-term effects of eccentric training could not be determined.

There were several limitations to this case report. Because of the unique nature of a case report, cause and effect relationships cannot be established based on this patient's outcomes. Also, the outcomes reported in this paper cannot be generalized to a larger population of adolescents with type 1 OI. Hip abductor and external rotator strength were not objectively measured with hand held dynamometry at evaluation or throughout the episode of care. Results from these tests would have further confirmed or negated the rationale for the plan of care. Although the lateral step down test was used to objectify functional hip abductor weakness, it is difficult to determine whether a positive step down test signified impaired muscle strength rather than impaired motor control (ie, poor dynamic hip-knee mechanics). Also, the exercise program put forth in this report was progressed chiefly on subjective pain reports from the patient. Because pain is interpreted differently among individual patients as well as different populations, such as athletes, it may be difficult to objectively progress other patients in a similar fashion. Finally, there was no short-term or long-term follow-up with this patient. The patient returned to his weight lifting program within days after discharge; however, it is not known if he was able to perform at his preinjury level or if his symptoms returned.

While fractures in OI are well documented, soft tissue injury has been given less attention. In this case report, we highlighted the slow progression of a strengthening program beginning with isometric exercise and finishing with a return to supervised plyometric training for a patient with type 1 OI experiencing tibial tubercle pain. This case is unique due to the patient's unconventional participation in heavy resistance weight training in the setting of OI and his goals to return to this high demand activity. The report provides insight into the activity levels as well as a framework for exercise rehabilitation programs for patients with type 1 OI. Although we did not complete long-term follow-up with this patient, long-term follow-up would provide insight into the effects of high resistance exercise on tendon and bone integrity in this population. Given the increasing participation of adolescents with type 1 OI in sports, future research should focus on the effects of high intensity plyometric training and eccentric strengthening on soft tissue and bone integrity in this population.

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Within-day Test-retest Reliability of Transcranial Magnetic Stimulation Measurements of Corticomotor Excitability for Gastrocnemius and Tibialis Anterior Muscles

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ABSTRACT

Background: Manual therapy interventions targeting the talocrural joint can improve gait and balance functions in individuals following ankle sprains. Less is known about the underlying mechanisms of functional improvements after manual therapy. One hypothesis involves change in corticomotor excitability (CE) following manual therapy procedures. Transcranial magnetic stimulation (TMS) is a brain imaging method that could provide important information regarding potential changes in CE associated with manual therapy techniques applied to the talocrural joint. However, within-day reliability of TMS to measure CE must first be established in order to measure CE changes associated with manual therapy procedures. **Objective:** To determine the within-day test-retest reliability of TMS CE measures for gastrocnemius (GAS) and tibialis anterior (TA) for use in test-retest designs assessing corticomotor excitability in manual therapy and exercise studies. **Method:** TMS measures, including motor evoked potential (MEP) amplitude and cortical silent period (CSP), were completed twice on the same day under resting and active conditions in n = 6 nondisabled participants. The absolute reliability (coefficient of variation), relative reliability (intraclass correlation coefficient), standard error of measures, and minimal detectable change outside the 95% confidence interval were calculated for both GAS and TA muscles in each experimental condition. **Results:** There were no statistically significant differences between the first and second TMS measurements. TMS measurements for GAS and TA demonstrated good absolute and relative test-retest reliability under the active condition, but not the resting condition. **Discussion:** TMS under the active condition can be reliably used to assess CE even in postural muscles with a small cortical representation area, such as GAS.

Key Words: motor evoked potential, cortical silent period, intraclass correlation coefficient

INTRODUCTION

Although the use of manual therapy procedures by physical therapists has been widely documented to improve function and decrease symptoms related to musculoskeletal pathology, studies to document the mechanisms underlying manual therapy interventions are less common. Understanding the potential mechanisms of manual therapy can help physical therapists select and create optimal treatment protocols by showing how manual therapy procedures modulate changes in symptoms and motor behavior. Historically, mobilization and manipulation were thought to reduce a cycle of maladaptive fibrosis.[1,2] However, the relatively rapid improvements in symptoms and disability observed following manual therapy procedures have led some authors to hypothesize and investigate potential neural mechanisms associated with improvements in symptoms and motor behavior after manual therapy procedures. Similarly, recent ultrasonographic findings have indicated short-term changes in abdominal and multifidus muscle thickness in individuals with low back pain following lumbopelvic manipulation.[3,4] These short-term changes in morphology were thought to be mediated by improved trunk muscle recruitment, perhaps by way of a neural mechanism.

Transcranial magnetic stimulation (TMS) has become a commonly used method to investigate experience-dependent neuroplasticity in response to exercise training or skill acquisition.[5-7] Recent studies have suggested the feasibility of using TMS to measure changes in corticomotor excitability after manual therapy. Dishman and colleagues[8,9] identified a significant increase in the lumbar paraspinal and gastrocnemius motor evoked potentials (MEP) following lumbar manipulation in healthy volunteers. Muscle-dependent effects of cervical spine manipulation on sensory and motor TMS measurements also have been identified.[10,11] Although these initial TMS studies are promising, use of the spine as the experimental paradigm may be limited because the relationship between symptoms and their location is unclear, and the lack of localization of treatment procedures.

Our group recently recommended the talocrural joint as a novel region to investigate potential changes in TMS measurements associated with manual therapy procedures.[12] This recommendation was based on the size of the joint, relative localization of pathology and treatment procedures to the region, and high prevalence of injury to this joint. However, the reliability and sensitivity to change of TMS measurements following manual therapy interventions has yet to be established for muscles crossing the talocrural joint. Many factors can contribute to the inherent noise of TMS measurements, including artifact and interference of electromyographic (EMG) signal when stimulating over primary motor cortex (M1). Additionally, variability in TMS measurements can be introduced by variable coil positioning during stimulation, electrode placement on the muscle between stimulation time points, and a subject's level of attention, age, muscle fatigue, or hormonal fluctuations.[13-16] The relatively deep location of ankle and foot muscle motor representation in the central sulcus further complicates potential problems related to coil placement.

The purpose of this study was to determine the within-day test-retest reliability of TMS measurements of musculature crossing the talocrural joint. Gastrocnemius (GAS) and tibialis anterior (TA) were selected for analysis on the basis of their relatively large size and importance to activities of daily living. In this study, TMS measurements were obtained during two common experimental conditions, rest and during submaximal active contraction of the target muscle. All subjects were tested on the same day with approximately a one-hour interval between two test sessions. This pre- and post-timing interval (1 hour) is consistent with the common time period for manual therapy applied in the clinic, which includes the time window of pre-treatment assessment, manual therapy and treatment, and post-treatment observation of functional improvement. We hypothesized that TMS measurements would demonstrate adequate test-retest reliability and sensitivity to change.

METHOD

Participants

Six nondisabled young adults with mean age 24.17 ± 0.98 years old (5 female and one male) participated in this study. Participants were excluded if they had lower extremity injury in the past 12 months, a history of lower extremity or low back surgery, lower extremity neuropathy, vestibular dysfunction, diabetes, or active arthritis. Based on the TMS safety guidelines,[17] other exclusion criteria include neurological disorders; psychological problems; history of significant head trauma; any electrical, magnetic, or metal device implanted in the body (ie, cardiac pacemakers or intracerebral vascular clip); pregnancy; history of seizures or unexplained loss of consciousness; immediate family member with epilepsy; use of seizure threshold lowering medication; current use of alcohol or drugs; history of schizophrenia; or history of hallucinations.

Procedure

After informed consent was obtained, all participants completed a TMS safety questionnaire before participating in the study. Two TMS assessments of TA and GAS were conducted with one hour between the conclusion of the first test and initiation of the second test. The entire study protocol was completed within 4 hours for each participant. All TMS testing was conducted over the TA and GAS representational areas of left M1. This study was approved by the University of Southern California's Health Sciences Institutional Review Board.

TMS measurement

All the TMS assessments were carried out with a single-pulse magnetic stimulator (Magstim 200^2). A Double Cone 110 mm coil was used to generate the TMS pulse because it can provide stimuli with sufficient depth of penetration to activate the cortical representational areas of lower extremity muscles. The skin over the designated muscles of the right lower extremity was prepared with cleansing gel and alcohol to decrease impedance for applying surface EMG electrodes. Surface EMG electrodes (Ag-AgCl, 12 mm diameter, inter-electrode distance: 17 mm) were attached over the muscle belly of TA and GAS, and the ground electrodes were placed over the medial and lateral femoral epicondyle, respectively for each muscle. The electrodes remained in place between the two TMS test sessions. The EMG signals were filtered with 1-1000 Hz bandwidth filter, amplified, and digitized at 2000 Hz. The data were displayed and stored with customized MATLAB module (dwaq; dataWizard acquisition, ADW) in 600-ms samples beginning 100 ms before TMS stimulus.

To determine the optimal TMS stimulus point ('hotspot'), the participants were required to wear a swim cap with 1 cm × 1 cm grid. The coil was initially placed on a potential spot for the target muscle, and then systematically moved in 1 cm increments in each direction to find the point that induced the most consistent and prominent MEPs with the shortest latency.[18] After the hotspot was determined, the stimulation intensity was gradually adjusted until MEP amplitude was minimum 50μV evoked 5 out of 10 trials (50%).[18,19] This stimulation intensity was established as the resting motor threshold (RMT). For testing purposes, stimulation intensity is set as a percentage of each individual subject's motor threshold, enabling comparison among subjects. Since the biological response to stimulation varies greatly across subjects depending on unique, individual characteristics, normalizing stimulation intensity can greatly decrease variability between subjects.[17] To control TMS coil positioning variability, a stereotactic image guidance system (Brainsight Frameless, Rogue Research Inc, Montreal, Canada) was used. The hotspot of each muscle was marked on a 3D reconstruction of a standard magnetic resonance image of the brain in the first test session, and the same point of stimulation was used for the second test session.

For both TA and GAS, TMS stimuli were applied under two conditions: with the subject at rest (resting condition) and during voluntary contraction of the muscle (active condition). We used the active contraction condition in order to obtain measurement of cortical silent period (CSP), which would provide a method by which to differentiate between peripheral and central responses. During the resting condition, participants were asked to completely relax their legs while 10 TMS pulses were applied over the hotspot at 120% of motor threshold. For the active contraction condition, the TMS pulse was delivered as participants actively contracted TA and GAS by performing ankle dorsiflexion and plantar flexion respectively through a small amount of range. The dorsiflexion and plantar flexion ranges were controlled at 50% of the participant's maximal active range of motion. The movement range was controlled by placing a ruler in front of the ankle. Participants were instructed to consistently dorsiflex (for TA) to touch the ruler with the toe or plantarflex (for GAS) to touch the ruler with the instep (Figure 1). Ten TMS pulses at 100% of RMT were delivered with an interstimulus interval of approximately 5 to 10 seconds.

Figure 1. Experimental setup. A double cone coil was used to evaluate corticomotor excitability of tibialis anterior (TA) and gastrocnemius (GAS). In the resting condition, TMS data were collected while the subject was relaxed. In the active contraction condition, TMS stimuli were applied while the subject voluntarily dorsiflexed (for TA) to touch the ruler with the toe or plantarflexed (for GAS) to touch the ruler with the instep.

Data analysis

Data were analyzed off-line with a customized MATLAB (Mathworks, Natick, MA) software, dataWizard (version 08.11, A.D.W., USC) by the same rater.[20] The MEP amplitude for both resting and active conditions was determined as the difference between peak-to-peak envelope of the EMG signal output (Figure 2). The cortical silent period, the period of EMG silence following an MEP[21] generated with pre-contraction of the target muscle, was also analyzed. To calculate CSP, the period from the TMS pulse to the sustained return of rectified, integrated EMG signals of at least two standard deviations of background EMG amplitude following EMG silence was measured (Figure 3).[21] The average of 10 trials for each testing condition was calculated and used for data analysis. Distribution of the data was screened resulting in the application of nonparametric Wilcoxon signed rank test to compare the means between the two TMS assessments.

The intraclass correlation coefficient ($ICC_{(3,k)}$) of each muscle under each condition was analyzed with SPSS (Version 16, SPSS Inc., Chicago, IL) to determine the consistency of the TMS data obtained.[22] In this study, ICC values above 0.90 were considered excellent reliability, between 0.75 and 0.90 were indicative of good reliability, while values below 0.75 were considered moderate to poor reliability.[22] Standard error of measurement (SEM) was calculated from the ICC results to determine the standard deviation of systematic measurement error. The SEM is the product of the standard deviation (SD) and the square root of one minus the correlation coefficient [$SEM = SD*\sqrt{(1-ICC)}$].[22] In addition to SEM, the coefficient of variance of typical error (CV_{TE}) was calculated (CV_{TE} = 100%* SD of the difference ÷ $\sqrt{2}$ ÷ mean of all trials). The CV_{TE} assesses the standard deviation in proportion to the mean, and it enables the comparison of the response stability across different TMS measurements.[22] The minimum detectable change (MDC) outside the 95% confidence interval was also calculated in order to provide a reference for future studies to determine whether the amount of observed change is due to actual experimental manipulation or due to measurement error. The MDC_{95} was calculated as $1.96*\sqrt{2}*SEM$, while 1.96 represents the 95% confidence interval of SEM from the normal distribution, and $\sqrt{2}$ is used to account for the additional uncertainties introduced by repeated measurement errors between two time points.[23]

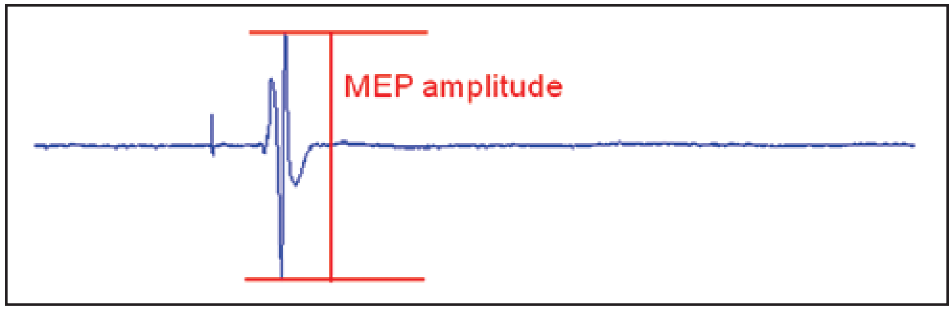

Figure 2. Motor evoked potential amplitude determination at resting condition.

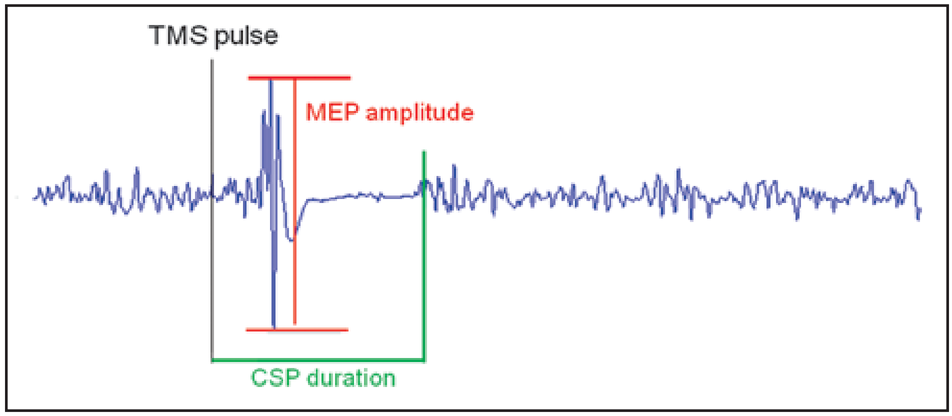

Figure 3. Motor evoked potential amplitude and cortical silent period determination at active condition.

RESULTS

There were no statistically significant differences between the first and second test sessions in any of the TMS measurements (Table 1). The relative and absolute reliability for all the TMS measurements are presented in Table 2. The $ICC_{3,k}$ values of both muscles were good to excellent for MEP amplitude and CSP measured during the active contraction condition (r = 0.84 – 0.99). However, the $ICC_{3,k}$ values for MEP amplitude during the resting condition were poor to moderate (r = 0.27 – 0.46). Similarly, absolute reliability (CV_{TE}) demonstrated lower percentage errors in MEP amplitude and CSP during the active contraction condition (5.28 – 26.19%) compared to the resting condition (32.23 – 38.35%). The SEM and MDC_{95} values are also provided in Table 2. Changes within ± 2 SEM were considered within systematic measurement error and further calculation of MDC_{95} provided a reference value for detecting 'true changes' that were independent of the variations associated with repeated measurements.[23]

DISCUSSION

This study established the within-day reliability of TMS measurements for GAS and TA, thus providing data for future investigation of potential corticomotor changes after a single session of manual therapy. Test-retest reliability of TMS measurements previously had been well-established for upper extremity muscles,[13,24-26] with only a few studies investigating corticomotor excitability (CE) of lower extremity muscles. However, until this study, reliability of TMS measurements for GAS had not been established. Commonly, TMS reliability studies were conducted across several days[27,28] with less known about within-day variability. This study was the first to establish high within-day test-retest reliability of MEP amplitude and CSP duration measurements in both TA and GAS.

Interestingly, MEP amplitude and CSP duration during active contraction for both GAS and TA showed good to excellent reliability compared to the resting condition. These findings are consistent with previous research involving TMS measurements obtained during TA active contraction.[27-29] There are two possible explanations for this

Table 1. Mean (SD) Values of Each TMS Measurements in Two Test Sessions

TMS variables	First test	Second test	P value
TA rest MEP (µV)	231.40 (68.73)	288.63 (109.37)	0.249
TA active MEP (µV)	1286.14 (487.50)	1349.30 (483.11)	0.600
TA CSP (ms)	136.41 (44.17)	127.22 (43.80)	0.075
GAS rest MEP (µV)	186.32 (93.51)	168.92 (66.35)	0.917
GAS active MEP (µV)	613.20 (246.33)	676.37 (376.20)	0.917
GAS CSP (ms)	136.60 (36.26)	141.04 (46.52)	0.753

Abbreviations: TA, tibialis anterior; GAS, gastrocnemius; MEP, motor evoked potentials; CSP, cortical silent period

Table 2. Relative and Absolute Reliability Results of TMS Measurements

	ICC	SEM (units)	CV_{TE} (%)	MDC_{95} (units)
TA rest MEP (µV)	0.27	77.88	32.23	215.87
TA active MEP (µV)	0.94	114.85	12.03	318.34
TA CSP (ms)	0.99	5.02	5.28	13.90
GAS rest MEP (µV)	0.46	59.85	38.35	165.90
GAS active MEP (µV)	0.84	128.77	26.19	356.92
GAS CSP (ms)	0.98	6.04	6.05	16.75

Abbreviations: TA, tibialis anterior; GAS, gastrocnemius; MEP, motor evoked potentials; CSP, cortical silent period

result. First, volitional muscle contraction may preactivate corticomotor excitability to a more consistent level across trials. Second, the requirement of performing an active contraction may increase the focus of the subjects' attention throughout testing.[24] We suggest that changes in TMS measurements for TA and GAS under the active contraction condition may more reliably reflect treatment effects than resting condition.

There are two potential limitations of this study. First, the muscle contraction level during the active condition was controlled by movement range of motion instead of muscle contraction force. The muscle contraction level was controlled by actively dorsiflexing or plantar flexing through 50% of each subject's available active range. By controlling ankle movement range instead of contraction force, participants can maintain a relatively easy movement throughout testing. Moving the ankle through 50% of active range of motion requires less than 20% of maximal voluntary contraction;[30] hence, muscle fatigue throughout testing would not be a major concern in this study. In this study, good to excellent reliability was found during the active contraction condition in the present study, which suggests that controlling muscle contraction level by movement range is both feasible and reliable. A second limitation of this study is that only nondisabled young adults were recruited into this study. Thus, the reliability results may not generalize to other age groups or individuals with pathology. However, in clinical settings, young adults with sport-induced ankle injuries often require re-training for gait and balance. The reliability of TMS procedures with healthy young adults in this study will inform future studies examining changes in corticomotor excitability after one session of treatment in young adults with acute ankle sprain.

In summary, for both GAS and TA muscles, testing under an active contraction condition induced more consistent and reliable results than testing under resting conditions. Tibialis anterior and gastrocnemius muscles are the major muscles that may be directly affected by ankle manual therapy. The mechanisms underlying why manual therapy can effectively improve gait and posture are not well understood. This study provided a feasible and reliable method for future investigations into the possible corticomotor changes after a single-session treatment. In addition, the SEM, MDC_{95}, and CV_{TE} values provided in this study can assist researchers in future studies to determine true change in corticomotor excitability due to training or intervention.

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Differentiating Hip Versus Back Pathology with a Patient Status Post Lumbar Laminectomy and Fusion: A Case Study

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ABSTRACT

Background: In older adults with normal degenerative changes, it can be difficult to differentiate low back pain from hip pain. The purpose of this report is to describe the role of differential diagnosis of hip from back pathology in a patient post lumbar laminectomy and fusion. **Case Description:** The patient was a 56-year-old female seen in physical therapy two months postoperatively. A thorough examination led to a differential diagnosis of intraarticular hip pathology and the patient was referred to an orthopaedic specialist. **Outcomes:** The patient was diagnosed with severe right hip osteoarthritis and scheduled for a right hip arthroplasty. Three months after surgery the patient had complete resolution of pain and return of function. **Discussion:** Physical therapists should always complete differential diagnosis and screen for additional pathologies. Groin pain, decreased hip internal rotation, decreased hip strength, and gait dysfunction are key findings to differentiate between back and hip pathology.

Key Words: differential diagnosis, hip osteoarthritis, hip pain, physical therapy

INTRODUCTION

Differentiating low back from hip pathology can be difficult due to overlapping pain referral patterns.[1] Intraarticular hip pathology can commonly refer pain to the groin, anterior thigh, buttock, anterior knee, and lateral thigh regions.[2] Similarly, with lumbar pathology, pain can be referred into the proximal, middle, and distal anterior thigh regions from the L1, L2, and L3 nerve roots respectively[1] and buttock pain can originate from the L4 and L5 nerve roots. A thorough history and physical exam of the low back and hip areas can guide the practitioner in establishing the correct diagnosis in a timely and efficient manner, while helping to avoid the costly care and management of misdiagnosis. In older adults with normal lumbar degenerative changes, it can be especially difficult to differentiate pain originating from the low back from pain originating in the hip. A common example is differentiating degenerative back pathologies from intraarticular hip pathologies, such as hip osteoarthritis (OA).

Low back pain (LBP) is the second most common cause of disability in adults in the United States.[3] More than 80% of the United States population will experience an episode of LBP sometime during their lives,[4] making LBP a diagnosis very commonly seen by primary care clinicians and physical therapists. Over the past few decades, there has been an increase in the number of medical procedures for the low back, including spinal injections and surgery. Among elderly Americans, the increase in procedures is closely related to an increase in diagnostic imaging.[5] Although magnetic resonance imaging (MRI) is highly sensitive, studies have questioned the relevance of MRI findings in terms of specificity and correlation with clinical findings.[6-8] In one such study, MRI was performed on 67 individuals who had never had an episode of LBP or sciatica. In the group that was younger than 60 years of age, 20% were found to have a herniated nucleus pulposus. In the group that was 60 years of age or older, all but one person demonstrated degeneration or bulging of a disc in at least one lumbar level.[6] In another study, 200 subjects without a history of LBP were given an initial exam and MRI of the low back and were followed over a 5-year period. Fifty-one subjects developed a new onset of LBP and had a new MRI taken within 6 to 12 weeks of the pain onset. Only 4% of the subjects showed MRI changes with probable clinical significance.[7] These studies demonstrate the importance of correlating normal lumbar degenerative changes, such as joint space narrowing, disc degeneration, stenosis, osteophyte formation, and lumbar spondylolisthesis, with a thorough history and clinical exam, especially in older adults who would be expected to have age-related degenerative changes.

Hip arthritis is a much less common condition compared to LBP, with estimates being 3.2% of the population older than 55 years of age.[9] Despite the fact that hip OA is less common than LBP, the two conditions often coexist. Hip OA can cause abnormal gait and spinal sagittal plane alignment and is associated with LBP.[10] Hip and spine arthritis are also part of the same age-related degenerative process and therefore often coexist.[11] In a prospective study looking at 344 patients waiting to receive hip arthroplasties, 49% reported LBP. Of these patients, 66% had resolution of back symptoms following their hip surgeries.[11] In a study by Hsieh et al,[2] LBP was found in 21% of patients who were scheduled to receive a hip arthroplasty, and the presence of LBP was statistically more common in those with a longer duration of hip symptoms. In their study of patients with coexisting lumbar spine and hip pathologies described as hip-spine syndrome, Ben Galim et al[10] followed 25 patients with severe hip OA and at least moderate LBP. They found that in the spine and hip regions, both pain and function improved significantly following hip arthroplasties. A key point recognized by the authors after the study was that in patients with both hip OA and LBP, the hip should be treated first.[10]

Whether a patient is seen by direct access or is referred for any type of low back or hip pain, the physical therapist should be cognizant of the potential structures that could be causing the patient's symptoms. As a practicing autonomous provider, it is the therapist's responsibility to perform a medical screen, assess regions above and below the involved area, and to rule in or rule out other potential conditions. Figure 1 provides an algorithm for evaluation of low back versus hip pain with differential diagnosis based on the location of pain.[1] There are other examples in the literature of using an algorithmic approach to help guide the practitioner in developing a hip differential diagnosis based on location of pain and information from

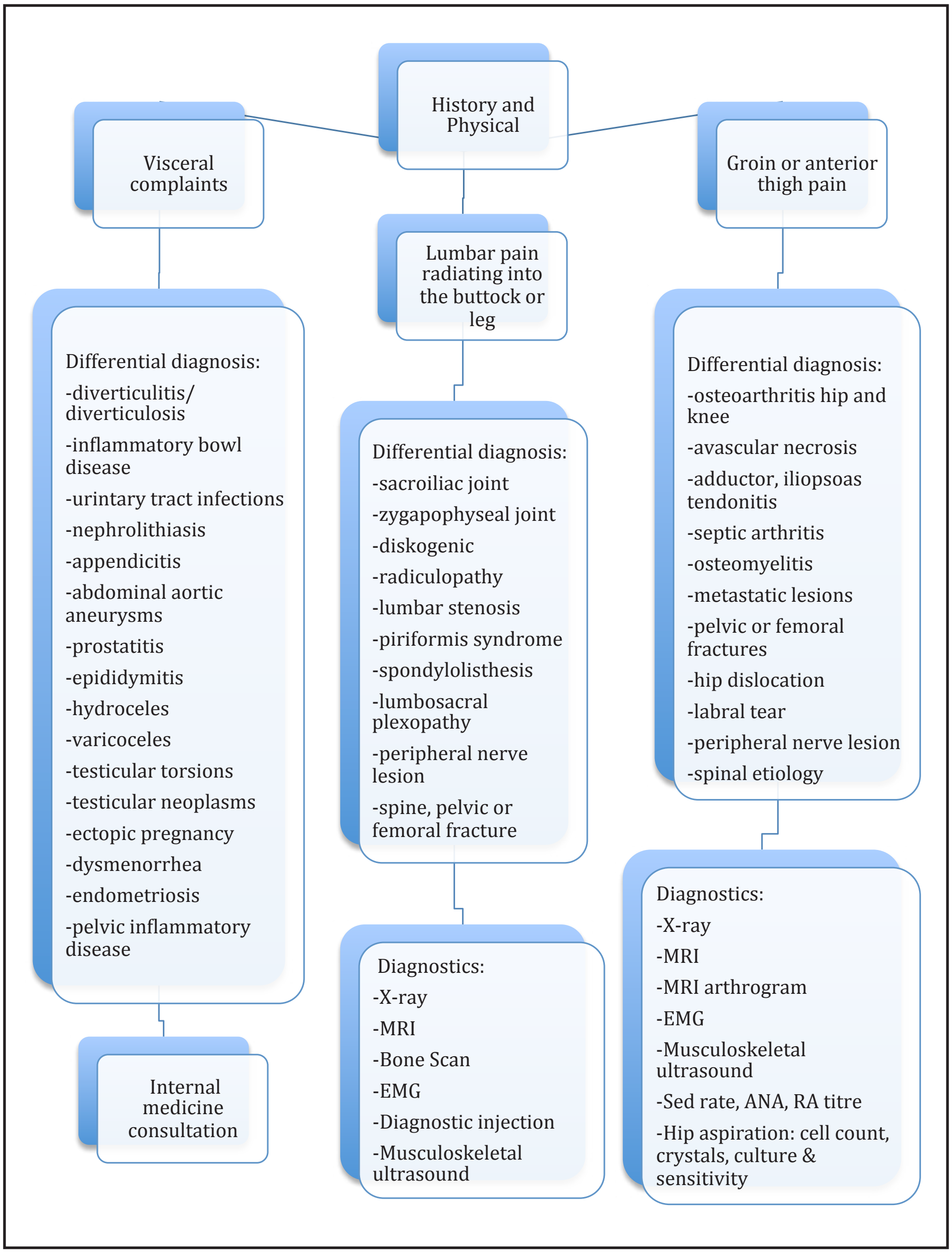

Figure 1. Algorithm for evaluation of low back and hip pain. Reprinted with permission from *Pract Neurol.*[1] Copyright 2008, BMJ Publishing Group.

the clinical exam, such as range of motion (ROM) and special tests.[12]

The purpose of this case report is to describe the role of the physical therapist in differentiating hip pathology from back pathology in a patient post lumbar laminectomy and fusion. After the patient's surgery, the key signs and symptoms of groin pain, decreased hip internal rotation ROM, decreased hip strength, and gait deficits led to a differential diagnosis of intraarticular hip pathology with a referral to an orthopaedic hip specialist.

CASE DESCRIPTION

The patient was a 56-year-old female who was referred to outpatient physical therapy two months after a lumbar laminectomy and fusion of L4-5 due to a lack of any improvement in both pain and function following the surgery. Her occupation as a materials engineer primarily consisted of desk work; however, she also needed to periodically climb ladders in tight spaces. A presurgery MRI indicated degenerative changes throughout the lumbar spine with a 4 mm anterolisthesis of L4 on L5. According to Watters et al,[13] a degenerative lumbar spondylolisthesis can be defined as a forward or backward slip by at least 3 mm. Presurgery, the patient completed approximately one month of physical therapy treatment with a different physical therapist and also had corticosteroid injections with minimal relief. The patient completed a 6-week course of physical therapy following her back surgery. During that postsurgery time, her main complaints included overall right lower extremity weakness, hip stiffness, difficulty with stairs walking more than one-quarter mile, and pain with sitting or standing for longer than 30 minutes. The patient's pain was reported mainly in the right groin area as well as the right lateral thigh and the lateral and anterior aspects of the right knee region.

Tests and Measures

At the initial evaluation, the patient's resting pain score was 3/10 on the visual analog scale. Her Oswestry Disability Questionnaire score was 34% and her Roland Morris Questionnaire score was 10 out of 24. Both of these questionnaires are widely used to assess pain-related disability in persons with LBP, and both have demonstrated valid and reliable measures that are responsive to change.[14] The patient's lower extremity neural screen was negative, demonstrating normal deep tendon reflexes, normal sensation, no abnormal strength findings in the L2-S1 myotomes, and negative neural tension in the sciatic and femoral nerves. Although her lumbar ROM was globally limited, it was painfree. Her single leg static balance was decreased for the right lower extremity as she was able to maintain balance for about 5 seconds. Her initial strength measurements assessed by standard manual muscle testing (MMT) are listed in Table 1. Her hip goniometric passive ROM measurements, which were taken in supine, are listed in Table 2. Most notable were the strength deficits in the musculature of the right hip and right hip ROM deficits in several planes. Significant flexibility deficits were noted bilaterally in the piriformis, gluteus maximus, and hip adductor muscles, with the right being more restricted than the left. The patient's gait lacked hip extension on the right, with a short right antalgic stride, and a notable Trendelenburg pattern. After her initial evaluation and throughout treatment, the patient complained of significant right groin pain, especially with hip internal rotation, and pain at both the anterior and lateral aspects of the right knee with passive hip flexion, internal rotation, and external rotation.

Table 1. Manual Muscle Testing Measurements

Hip movement	Initial MMT right	Initial MMT left	Re-evaluation MMT right	Re-evaluation MMT left
Flexion	4-/5	5/5	4-/5	4+/5
Extension	4/5	5/5	5/5	5/5
Abduction	4-/5	4/5	4/5	4/5
Adduction	4-/5	4+/5	4-/5	4/5
Internal rotation	4/5	5/5	4/5	5/5
External rotation	4-/5	5/5	4-/5	5/5

Abbreviation: MMT, manual muscle testing

Table 2. Goniometric Measurements

Hip movement	PROM right	PROM left	Re-evaluation PROM right	Re-evaluation PROM left
Flexion	100°	115°	110°	125°
Extension	NT	NT	NT	NT
Abduction	NT	NT	30°	55°
Adduction	NT	NT	NT	NT
Internal Rotation	25°	45°	20°	50°
External Rotation	25°	55°	40°	52°

Abbreviations: PROM, passive range of motion; NT, not tested

Re-evaluation measurements were taken 4 to 6 weeks after the initial evaluation. The patient's resting pain level at re-evaluation was 2/10, Oswestry Disability score was 20%, and Roland Morris score was 8 out of 24. She continued to have significant groin pain and only mild improvements in functional deficits. Table 2 lists changes in passive ROM measurements after 4 to 6 weeks of treatment. Hip passive ROM measurements remained limited in several planes, with an actual decrease in hip internal rotation. Changes in hip strength, as seen in Table 1, were minimal, with no changes in hip flexion, internal rotation, external rotation, or adduction. Her gait deficits remained unchanged.

Diagnosis and Prognosis

According to the *Guide to Physical Therapist Practice*,[15] the physical therapist diagnosis for this patient was within Pattern 4E and included impaired joint mobility, motor function, muscle performance, and range of motion associated with localized inflammation. At the time of initial evaluation, the patient's prognosis was good for making significant functional gains in a reasonable length of time with skilled physical therapy intervention. Her goals were to use stairs without a handrail, ambulate community distances, put on shoes without difficulty, transfer from a low chair without difficulty, and sit for at least 60 minutes without discomfort. Over the 6-week treatment period, as objective and subjective measures improved minimally and the patient was unable to progress with exercises, it was clear that the prognosis with skilled physical therapy was no longer favorable and the patient required an additional work-up by a specialist before continuing care.

Intervention

Following the patient's lumbar laminectomy and fusion, her treatment consisted of lumbo-pelvic core stabilization exercises, soft tissue mobilization of the pelvic girdle musculature, lower extremity stretching, lower extremity strengthening with focus on hip musculature, postural education and awareness training, instruction in body mechanics, gait training, and range of motion exercises for the spine and hip. There was minimal exercise progression over the 6-week period due to the patient's pain level and tolerance.

Outcomes

Based on the patient's symptoms and clinical examination, a differential diagnosis of hip intraarticular pathology was made by the physical therapist. The patient was referred to an orthopaedic hip specialist and was diagnosed with severe osteoarthritis of the right hip and scheduled to receive a hip arthroplasty with a lateral approach. The patient initiated physical therapy about 4 weeks after her hip replacement for rehabilitation according to a standard hip replacement protocol. At the initial physical therapy exam status post hip arthroplasty, the patient reported almost complete resolution of groin, thigh, and knee pain. Her initial Hip Condition Questionnaire score was 19 out of 50. This is a questionnaire used in some physical therapy settings to assess pain-related disability due to hip pain, and it has been found to have moderate to sufficient psychometric properties.[16] The patient was discharged from physical therapy after two months of care. At that time, she had returned to work full time without limitations, was using stairs without compensations, and demonstrated a normal gait pattern without an assistive device. She continued to have some hip ROM and strength limitations post-hip arthroplasty but overall was making significant improvements. The patient reported a return to 95% of her prior function without pain and scored 3 out of 50 on the Hip Condition Questionnaire, indicating a significant improvement in overall function. Her home exercise program included continuation of her ROM exercises, gait and functional training, and strengthening exercises.

DISCUSSION

This case demonstrates how findings of groin pain, decreased hip internal ROM, decreased hip strength, and gait deficits, which were present after a lumbar laminectomy and fusion, led to a diagnosis of intraarticular hip pathology and referral to a hip orthopaedic specialist. The groin region, a common pain referral area from intraarticular hip pathology, has been shown in various studies to be a key symptom of hip pathology.[2,17,18] A retrospective analysis completed by Brown et al[17] on 97 patients with lower extremity pain revealed which signs and symptoms were the best predictors for primary sources of pain in the hip or spine. They found that patients with groin pain were 7 times more likely to have a hip disorder, or hip and spine disorder, rather than a spine disorder only.[17] In another study, 113 patients with end-stage hip disease were evaluated for pain patterns prior to hip arthroplasty. The most common areas of pain before surgery included the groin, anterior thigh, buttock, anterior knee, and greater trochanter.[2] In the clinical guidelines for hip pain and mobility deficits for hip osteoarthritis, the Orthopaedic Section of the American Physical Therapy Association (APTA) recommended that key symptoms be present for diagnosis and classification of unilateral coxarthrosis or to identify the impairment based category of hip pain and mobility deficits. One key symptom that should be present includes "moderate lateral or anterior hip pain during weight bearing."[19] The patient presented in this case report fit this criterion as she experienced anterior pain in the groin region throughout her treatment.

Cibulka et al,[19] in their review of guidelines for hip pain and mobility, stated that limited hip internal rotation by more than 15° when compared to the nonpainful side is a useful clinical finding that fits the unilateral coxarthrosis criterion. In the criteria for the classification of OA of the hip, the American College of Rheumatology also recognized decreased hip internal rotation as a key sign.[20] Many studies have demonstrated that decreased hip internal rotation and painful internal rotation are key signs or clinical predictors in patients with hip OA or other hip intraarticular pathologies.[17,21-25] Brown et al[17] reported that patients with limited hip internal rotation were 14 times more likely to have a hip, or hip and spine disorder, rather than a spine disorder only. In an additional study, 195 patients over the age of 40 presenting with a new episode of hip pain were tested for radiological evidence of hip OA. Hip flexion, internal rotation, and external rotation were tested to identify which were most discriminatory of hip OA. Internal rotation limitations were found to be the most predictive of hip OA.[21] The patient presented in this case study clearly had a significant decrease in hip internal rotation compared with the uninvolved side, and hip internal rotation was painful, reproducing her groin pain.

Another key finding that suggested intraarticular hip pathology in this patient was significant hip weakness in a non-myotomal pattern that did not significantly improve over the 6-week period of physical therapy. In addition, she had a painful gait with significant deficits, including a Trendelenburg pattern, which can indicate hip weakness. In a study by Rasch et al,[26] 22 patients with known hip osteoarthritis who were scheduled for hip arthroplasty were tested for hip and knee strength. Hip extension, flexion, adduction, abduction, and knee extension strength of the involved limbs were reduced by 11% to 29% when compared to the uninvolved limbs. These scores were significant and confirmed muscular impairment, which likely led to functional losses such as decreased ambulatory capacity.[26] In the study by Brown et al,[17] patients with a limp were 7 times more likely to have hip, or hip or spine disorder, rather than spine disorder only. In Cibulka and Threlkeld's case study,[22] key findings in a patient with hip OA included significant hip weakness and gait deficits. Pain, as well as weakness, can lead to gait disturbances. The Orthopaedic Section, APTA, recognized pain with weight bearing in adults over the age of 50 as an important clinical indicator in the diagnosis and classification of unilateral coxarthrosis and identification of the impairment based category of hip pain and mobility deficits.[19] The patient presented in this case study had significant strength deficits of the hip, and gait abnormalities, including a painful limp and Trendelenburg pattern.

The patient's evaluation and treatment notes, which were completed by a different physical therapist prior to her lumbar laminectomy and fusion, indicated that her main complaints were LBP and groin pain with standing and walking. Her hip ROM was significantly limited in several directions, especially internal rotation. She demonstrated significant right hip weakness in a non-myotomal pattern and had gait abnormalities. She also had a positive Flexion Abduction and External Rotation (FABER) test and hip scour test, both of which have been associated with hip pathology.[23,24] Her MRI prior to back surgery demonstrated lumbar degenerative changes throughout with a 4 mm anterolisthesis of L4 on L5. According to the Evidence-based Clinical Guidelines for the Diagnosis and Treatment of Degenerative Lumbar Spondylolisthesis of the North American Spine Society, the majority of symptomatic patients with an absence of neurologic changes did well with conservative care.[13] If this patient had initially been thoroughly evaluated with a comprehensive medical screen and differential diagnostic approach by a medical provider prior to her back surgery, her outcome may have been different, and she may have even been spared a costly back surgery.

The following are examples in the literature of patients who have been treated, and perhaps in some cases even over-treated, for back pathologies while overlooking coexisting hip pathologies. In a retrospective study that examined the prevalence of coexisting spine and hip disease using initial kidney, ureter, bladder (KUB) radiographs in patients who underwent spinal surgery, 388 patients were evaluated for hip pathology. Discernable hip pathology was found in 32.5% of the patients and most had a diagnosis of significant hip OA.[27] In another study, a retro analysis was performed on 43 patients with hip OA. Twenty-four of the patients had been previously diagnosed with hip OA; however, 19 of them were treated solely for coexisting back pathologies without treatment for the hip.[28] As previously stated, several studies have indicated the high prevalence of LBP in patients with primary hip pathology.[2,12,13] Low back pain was often found to resolve after treating the hip first.[10,11] Differentiating signs and symptoms of low back pain from hip pathology can lead to early diagnosis and in turn, the avoidance of costly, unwarranted medical care.

CONCLUSION

This case report demonstrated the importance of screening and developing differential diagnoses in a physical therapy setting. Despite the specific diagnosis for referral, physical therapists should practice as autonomous providers and critically evaluate and perform a medical screen so they can inform physicians of additional issues when they arise. Published research has demonstrated that the key signs and symptoms of groin pain, decreased hip internal rotation, hip weakness, and gait dysfunction can be indicative of hip pathology. Further research is warranted to guide practitioners in developing additional criterion to distinguish between low back and hip pathologies.

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An Adult Patient with Asperger's Syndrome: A Case Example of Behavioral Challenges for the Orthopaedic Physical Therapist

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ABSTRACT

Study design: Case report. **Background and Purpose:** Asperger syndrome, an autistic spectrum disorder (ASD), is characterized by impairments in social interaction and repetitive and stereotyped patterns of behavior. As children diagnosed with Asperger's syndrome transition into adulthood, many will suffer from any number of musculoskeletal problems. Physical therapists must be prepared to treat individuals with ASD and be able to design and implement physical therapy intervention programs that take into consideration behaviors that may pose a challenge to the rehabilitation process. The purpose of this case report is to describe an adult patient with a diagnosis of Asperger's syndrome who sustained a femoral neck fracture and presented to an adult outpatient physical therapy clinic for rehabilitation. **Case Description:** The patient is a 34-year-old male diagnosed with Asperger's syndrome who sustained a traumatic femoral neck fracture. The report from the radiologist indicated a well-healing fracture at the time of referral. Although he presented with many orthopaedic impairments, it was behaviors such as his focus on routine and his fear-avoidance behaviors that posed the greatest challenges to this case. **Outcome:** After 10 weeks of physical therapy intervention, taking into consideration these behavioral challenges along with a home exercise program, the patient was able to return to his prior level of function, riding his bicycle as his primary mode of transportation and doing leaf clean-up to earn money. **Clinical Relevance:** People with disabilities are just as likely as others to suffer from any number of musculoskeletal disorders. The outpatient orthopaedic physical therapist must be prepared to treat individuals with ASD and meet the challenges they may present.

Key Words: fear-avoidance behaviors, femoral neck fracture

BACKGROUND

Asperger's syndrome is an autistic spectrum disorder (ASD), one of a group of neurodevelopmental disorders characterized by impairments in social interaction and communication, and by restricted, repetitive, and stereotyped patterns of behavior.[1-3] Social communication difficulties include a lack of normal back and forth conversation and lack of eye contact, body language, and facial expression. Compared to others on the autism spectrum, individuals with Asperger's disorder have a higher verbal intelligence quotient than performance quotient. Other characteristics of individuals with Asperger syndrome include fixated interests, and an excessive focus on routines, objects, or interests.[2] Table 1 lists the diagnostic criteria for Asperger's syndrome according to the *Diagnostic and Statistical Manual for Mental Disorders (DSM-IV)*.[1] Asperger's syndrome became a recognized disease in 1992 when it was included in the *International Classification of Diseases*. In 1994, Asperger's disorder was added to the *DSM-IV*.[2] The prevalence of this disease in children is about .02% to .03%, affecting boys 4 times more than girls. There are no statistics as to the prevalence of Asperger's syndrome in adults, but it is assumed that the prevalence is similar to that in children.[2,4] The American Psychiatric Association revised the guidelines for ASD in 2013[5] so that Asperger's disorder is no longer a separate category within ASD. However, because this patient had been diagnosed prior to 2013, he is still classified as having Asperger's disorder.

As children with disabilities mature into adulthood, health care professionals must be prepared to provide treatment for this population. Historically, in the field of physical therapy, pediatric therapists have often treated children diagnosed on the autism spectrum in the educational environment because of the impact the diagnosis has on their education. For the most part, orthopaedic physical therapists have not treated individuals with these types of diagnoses. However, as the number of children with autism increases (25% increase since 2007, according to the CDC[3]), more will be transitioning into adulthood and will need medical care as adults. A portion of this increase during the last decade has been attributed to increased awareness and diagnosis of children with autism. People with ASD are just as likely as the general population to have a variety of orthopaedic conditions, such as fractures or low back pain. Thus, they will need to seek care in both inpatient and outpatient physical therapy clinics. The purpose of this case is to describe an adult patient diagnosed with Asperger's syndrome who sustained a femoral neck fracture and sought outpatient physical therapy services for rehabilitation. Although this patient presented with a serious physical injury, it was his behaviors and fear-avoidance that posed challenges to the physical therapist with respect to his rehabilitation process and his return to his prior level of function. Fear-avoidance develops when an individual's fear of pain leads to the avoidance of activities that they associate with the occurrence or exacerbation of pain.[5] Although fear-avoidance is not one of the listed characteristics of Asperger's syndrome, it may have been present in this patient due to his preoccupation with the pain he experienced with his injury and his initial treatment, which included surgery.

CASE DESCRIPTION

The patient was a 34-year-old male with a diagnosis of Asperger's syndrome, who sustained a right femoral neck fracture after falling off his bicycle 3 months prior to being referred to outpatient physical therapy. The fracture was surgically pinned and the report from the radiologist indicated a well-healing fracture at the time of referral. The patient was ambulating independently on bilateral crutches and was instructed to weight bear as tolerated, although he ambulated with a distinct 3 point nonweightbearing gait on the right. At the time of the initial examination, the patient was unable to rate his pain although he complained of significant

Table 1. Diagnostic Criteria

DIAGNOSTIC CRITERIA FOR ASPERGER SYNDROME (DSM-IV)[1]	
A.	Qualitative impairment in social interaction, as manifested by at least two of the following: 1. Marked impairment in the use of multiple nonverbal behaviors such as eye gaze, facial expression, body postures, and gestures to regulate social interaction. 2. Failure to develop peer relationships appropriate to developmental level. 3. Lack of spontaneous seeking to share enjoyment, interests, or achievements with other people. 4. Lack of social or emotional reciprocity.
B.	Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following: 1. Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus. 2. Apparently inflexible adherence to specific, nonfunctional routines or rituals. 3. Stereotyped and repetitive motor mannerisms. 4. Persistent preoccupation with parts of objects.
C.	The disturbance causes clinically significant impairment in social, occupational, or other important areas of functioning.
D.	There is no clinically significant general delay in language, eg, single words used by age 2 years, communicative phrases used by age 3 years.
E.	There is no clinically significant delay in cognitive development.
F.	Criteria are not met for another specific pervasive developmental disorder or schizophrenia.

pain in his right lower extremity, primarily in the area of the right thigh and knee. He reported that he was not able to sleep on his right side due to pain. Most of the history was obtained from his mother. The patient lived with his parents. Although he was on an individualized educational plan (IEP) throughout elementary school, junior high, and senior high school, he was diagnosed with Asperger's syndrome as an adult. His IQ was measured to be in the borderline deficiency range. Prior to his injury, his primary mode of transportation was his bicycle. He walked dogs and did leaf clean-up for some neighbors to earn money. His primary interests included watching movies. His goals and his parents' goals were for him to be able to ride his bicycle independently and to be able to resume dog walking and leaf clean-up activities.

Initial Examination

The results of the initial examination revealed several impairments, including a decrease in active and passive range of motion (ROM) of the right hip and knee. There was considerable muscle guarding with passive ROM, and it was noted that the patient exhibited greater passive ROM of the right hip in some functional activities such as sitting than he allowed during the examination. Strength was affected by pain and atrophy was observed in both the right thigh and calf. Strength was noted to range from a 2+/5-4/5 in muscles in the right lower extremity based on the observation of functional activities such as sit-to-stand and ambulation. Tenderness to palpation was difficult to assess because of inconsistent feedback from the patient. Sensation appeared to be intact. When the patient was asked to do a straight leg raise (SLR) to assess for a quadriceps lag, he reported extreme pain in his knee and was unable to do a straight leg raise. It was also apparent he exhibited some fear-avoidance behavior with respect to moving his right hip and knee. The patient ambulated independently with bilateral crutches and was able to put some weight on his right leg when prompted but reported that it was painful. He was independent in negotiating stairs with crutches. These impairments affected the patient's ability to ride his bicycle and perform leaf clean-up using a leaf blower, impacting his ability to participate in activities that provided him with a small income. In addition, he had lost his primary mode of transportation, increasing his level of dependency on his parents. His inability to clearly communicate specifics about the pain he experienced in his right leg made it difficult to determine a possible cause of the pain and make adjustments. Outcome measures such as the Fear-Avoidance Beliefs Questionnaire and the McGill Pain Questionnaire, although useful in many cases, could not be used because of the patient's inability to fully understand the questions. The patient also exhibited a strong dependency on his mother and she was with him during his physical therapy sessions. He relied on her approval to do what I asked him to do and verify his answers to questions.

Clinical Impression

Although the patient was referred to physical therapy with a diagnosis of a healing right femoral neck fracture, the behaviors he exhibited due to his Asperger's syndrome posed a significant challenge to the physical therapist. The patient presented with impairments (ie, decreased ROM, decreased strength, gait deviations) typical of a patient with a healing femoral neck fracture. Behaviors such as fear-avoidance, focus on routine and repetition, and his attachment to his mother were viewed as challenges to the rehabilitation process. In addition, his lack of being able to describe the specifics of his pain made it difficult to identify the underlying cause of the pain.

Physical Therapy Plan of Care

The patient was seen twice a week for one hour for 10 weeks for a total of 20 sessions. The plan of care divided the focus of therapy into two phases: phase one focused on addressing his impairments and working toward minimizing his fear-avoidance behaviors and phase two focused on integrating improvement in his impairments into functional activities such as actual leaf blowing and riding his bicycle.

Phase one addressed his impairments of decreased ROM in both the right hip and knee, decreased strength in the right lower extremity, and facilitated consistent weight bearing to tolerance on his right lower extremity with bilateral crutches. The author discussed a plan with his mother to lessen his dependence on her during physical therapy sessions because he often looked for her approval. His mother agreed to bring work to do during his appointments and although she initially started the therapy sessions in the clinic, thereafter she excused herself to do her work in the waiting room. The patient initially objected, but over the course of about two weeks adjusted to having his mother working in the waiting room during therapy.

His fear-avoidance behavior further magnified as therapy progressed. When asked to do a SLR, he complained of severe pain in the area of his right knee, but he was unable to be more specific. When trying to execute a SLR, he actually contracted the antagonist muscles (hip extensors) to guard against doing the actual SLR because of his fear of potential pain when executing the exercise. This posed a challenge to several ROM, active assisted ROM (AAROM), and strengthening activities. In order to address this issue, assisted eccentric SLRs were initiated, giving him enough assistance as to avoid the perceived pain in his knee. In doing an assisted eccentric SLR, the patient did not re-enforce the pattern of antagonist activation and minimized the fear avoidance behavior. It was important to ensure his perceived pain was kept at a minimal level in order to show him that he could move his leg without considerable pain. At this same time, the patient demonstrated an independent long arc quadriceps action in sitting and was able to tolerate minimal resistance without any complaint of pain. This indicated that his complaint of significant pain in his knee while trying to execute a SLR was at least partially due to fear-avoidance. Using this approach, after 3 weeks of therapy, the patient demonstrated a right independent SLR with minimal pain in his right knee but still verbalized his fear of potential pain. The therapist continued to maintain very minimal hand contact to reassure the patient and decrease his anxiety while doing SLRs.

Another behavior that presented a challenge as therapy progressed was his focus on a routine. He was resistant to any change in the order of exercises or activities, and often argued about doing exercises out of order, deleting an exercise from the routine, or adding a new exercise to the routine. The therapist tried to maintain the patient on a consistent routine. When introducing a new exercise, the exercise was explained along with the benefits relating to his return to function, and how other patients did this exercise as part of therapy. This approach seemed to satisfy him and he was able to progress in his rehabilitation.

At the end of 4 weeks of physical therapy, the patient had a significant increase in all motions of the right hip and also in right knee flexion and extension. His muscle strength as measured by manual muscle testing improved in the right lower extremity and ranged from 3-/5 - 4/5, with the right hip abductors showing the greatest weakness at 3-/5. An emphasis was placed on trying to wean the patient off crutches by progressing to one crutch. This patient was very comfortable with using crutches because this approach minimized change as much as possible in comparison to progressing to a cane.

During phase two of therapy (week 5), in addition to continuing to work on ROM and strength of the right lower extremity, balance and functional activities were added. Although the introduction of functional activities at this point in the rehabilitation process was appropriate for this patient, it might be helpful with other patients with cognitive deficits to start this type of training earlier in the rehabilitation process. Functional activities included actually using a leaf blower outside and walking around the building using the leaf blower without crutches. The patient enjoyed these activities and had no complaints of pain when completing tasks that included walking 500 feet without crutches. While completing this task, he ambulated with a minimal Trendelenburg gait on the right. However, when ambulating in the clinic without crutches, he demonstrated a significant Trendelenburg gait. He continued to display some fear-avoidance behavior as new activities were introduced. I provided enough support when engaging in a new activity so that he would not experience pain. In order to ensure he was ready to start riding his bike, we worked on simulating getting on his bicycle by straddling a track hurdle set at the height of his bicycle. Although this activity was difficult for him to execute, the therapist continued to give him the amount of assistance necessary to minimize his fear-avoidance behavior. By having him do this task, he is breaking down the activity he needs to do, it is functionally meaningful to him, and he is working on his strength impairments. Within 2 weeks, he was straddling the hurdle without assistance and was able to straddle his bicycle at home independently.

OUTCOMES

At the end of 10 weeks, the patient exhibited both passive and active ROM in the right hip and knee symmetrical to his left. He had mild strength deficits in his right hip muscles with all muscles strength at 4/5, with the exception of the right hip abductors at a 4-/5. He demonstrated a mild Trendelenburg gait but was ambulating without crutches. He was starting to go on short bicycle rides with his father and had assumed leaf clean-up. The patient continued with a home exercise program focused on continued strengthening of the right lower extremity. The patient eventually returned to his prior level of function riding his bicycle independently, assuming leaf clean-up, and walking dogs.

DISCUSSION

Although this patient presented with a primary orthopaedic problem, the behaviors he exhibited associated with Asperger's syndrome and his fear-avoidance behavior were the real challenges in this case. In more than 30 years of clinical practice, this was the most extreme case of fear-avoidance behavior the author has ever observed. Fear-avoidance beliefs are part of the fear avoidance model and have classically been studied in patients with low back pain.[6-8] Through a number of studies on patients with low back pain, it has been shown that patients with elevated fear avoidance beliefs were more likely to have high pain and disability scores.[6] In other studies, it has been shown that patients with low back pain with high fear-avoidance beliefs are more likely not to return to work and experience poor treatment outcomes.[9,10] In 2011, George and Stryker[11] showed that fear avoidance beliefs in patients with musculoskeletal complaints across other anatomical regions (to include the lower extremity) have similar influence on intake and change scores for pain intensity and function. In this case, although I was not able to document the patient's fear-avoidance beliefs upon initial examination, it became apparent that these beliefs interfered with his ability to complete certain activities that were critical to his rehabilitation process. Being able to manage his fear-avoidance behavior was vital to his progression through the rehabilitation process. In addition, behaviors consistent with his diagnosis of Asperger's syndrome needed to be considered as part of his care. Through a thoughtful approach, these behaviors were minimized and the patient was able to progress through the rehabilitation process and return to his prior level of function.

Although the author was not able to measure the patient's initial pain level, the Face, Legs, Activity, Cry, Consolability (FLACC) tool may have been useful.[12] The FLACC is a tool designed for use with children between the ages of 2 and 7 that uses an observer-rated scale to yield a pain score between 0 and 10. However, this tool has been used with adult patients who are unable to clearly communicate their pain.[13]

Initially, exercises like the SLR were difficult for the patient to perform because of fear-avoidance. Although the prescribed approach was effective, another approach such as having the patient engage in a game such a balloon drop with a kick (with an extended knee), either in supine or standing may work as well.

The author chose to progress the patient from bilateral crutches to a unilateral crutch as opposed to a cane. In a patient who is most comfortable with routine and has decreased cognitive accommodation, asking him to learn something completely new would have been extremely challenging. In the author's opinion, using the same device with a slight modification was more effective.

CONCLUSION

Inpatient and outpatient physical therapists must be prepared to treat individuals for any number of orthopaedic problems. Inpatient and outpatient physical therapists must be able to take into consideration behaviors that may challenge the rehabilitation process, especially those that are not necessarily expected within an adult population. Careful thought and consideration must be made in designing and implementing physical therapy intervention programs that not only address the orthopaedic issues the patient presents, but also address and accommodate for behaviors that may pose as a barrier to progression. Although people with disabilities may have received physical therapy services as children from a pediatric therapist, as they become adults, they will be presenting to adult based physical therapy practices. Physical therapists must be able to meet the challenges individuals with ASD may present.

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Clinical Outcomes of Electro-therapeutic Point Stimulation in Conjunction with Exercise for the Treatment of Patients with Chronic Knee Pain: A Case Series

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ABSTRACT

Background and Purpose: Electro-therapeutic Point Stimulation (ETPS) is a novel modality for chronic pain relief. The purpose of this case series is to report ETPS outcomes in physical therapy. **Methods:** This case series includes 7 patients (mean age = 31 years, two females) with chronic knee pain. Five patients received ETPS and exercises while two patients received exercise alone. Outcomes were Numeric Rating Scale (NRS) for pain and Lysholm Knee Scale for function. **Findings:** The mean within-session NRS change for ETPS was 2.2 with 4 ETPS patients exhibiting an immediate clinically meaningful improvement. Over 3 weeks, all ETPS patients achieved a clinically meaningful pain improvement and 3 ETPS patients achieved a clinically meaningful function improvement. **Clinical Relevance:** This paper supports ETPS use for short-term pain relief in chronic knee pain. **Conclusion:** Electro-therapeutic point stimulation use in physical therapy is supported; however, future randomized trials are needed for comparing ETPS to alternative treatments.

Key Words: electrical stimulation, acupuncture, electro-therapeutic point stimulation

BACKGROUND

Chronic musculoskeletal pain, including knee pain, is a common condition that physical therapists treat on a daily basis. Chronic pain is pain that exceeds normal or expected tissue healing times and may occur in the absence of identifiable tissue damage.[1] As such, chronic pain is viewed as a central nervous system condition, rather than a mere symptom secondary to tissue damage. Chronic pain conditions are difficult to manage and are costly for the health care system.[2] This has led the health care industry and researchers to identify therapeutic strategies that provide patients with a significant and lasting reduction in pain that is both timely and cost-effective.

One particular therapy that is used for the treatment of chronic musculoskeletal pain is transcutaneous electrical nerve stimulation (TENS). The term TENS encompasses various application methods. Interferential current, a method that alternates medium frequency current (4,000Hz) with low frequency current (0-250Hz), is based on the theory that this method is able to deliver a low frequency current deep within the treatment area by using an amplitude modulated frequency.[3] There is also high frequency, or conventional TENS (40-150 Hz), which is delivered at low intensity, and low frequency (< 10 Hz) and TENS that is delivered at high intensity.[4] High frequency TENS, otherwise known as sensory or motor TENS, is thought to enhance the release of gamma-aminobutyric acid (GABA) in the spinal cord, increasing the concentration of β-endorphins in the blood stream, and affecting autonomic function and blood flow.[1] Low frequency TENS, also referred to as acupuncture like TENS (AL-TENS), is theorized to mediate classic descending inhibitory pathways, affect the peripheral and autonomic nervous system, and have an anti-hyperalgesic effect suggested by a role of μ-opioid receptors.[1]

While many forms of TENS have been developed and used over the years, the efficacy of TENS for the treatment of chronic pain is controversial and has led to increased attention in the literature. Multiple topical reviews and meta-analyses indicate that any form of TENS, added as a co-intervention to therapy and not conducted in isolation, appears to have an added benefit to pain relief when compared to placebo or control groups.[5,6] However, many reviewers point out numerous inconsistencies regarding the type of parameters applied for treatment (eg, lead placement, settings, duration) making it difficult to compare studies.[6,7] Since evidence regarding TENS is inconclusive as the best pain relief for patients with chronic pain, new delivery methods are being developed.

A TENS-like modality that has recently been used in the clinic by physical therapists is electro-therapeutic point stimulation (ETPS). It is a noninvasive electrical stimulation that applies a brief, low frequency point stimulation to the skin at acupuncture points, motor/trigger points, and contracted motor bands. The use of acupuncture has been shown in the literature to modulate pain.[8] It is plausible that applying ETPS to acupuncture points may be a more effective treatment technique than acupuncture or TENS alone. While the underlying theory behind ETPS is not new, the ETPS approach is unique in that it includes multisystem components. For example, ETPS is not just an electrical modality, but includes components of acupuncture (eg, directing current to acupuncture points) and manual therapy (eg, focused on symmetry of movement or posture), making it more holistic and patient-oriented in its approach to chronic pain relief. To our knowledge, there is no published evidence regarding the use of ETPS as a treatment modality in physical therapy for patients with chronic musculoskeletal pain.

The purpose of this case series is to describe the use of ETPS in physical therapy practice and to examine the effects on pain and self-report function outcomes within a single treatment session and over the course of treatment in patients with chronic knee pain.

METHODS

Patient Characteristics

This report is a descriptive case series of patients with knee pain referred by a primary care manager to the Jacksonville Naval Hospital physical therapy clinic on the Naval Air Station Base between January and February 2012. All patients considered for this case series were active duty enlistees of the Navy with various occupations, including a pilot, aircraft carrier mechanics, hospital corpsman, health unit coordinator, and telecommunications operator. All patients were referred with a diagnosis of knee pain with a recommendation for physical therapy evaluation and treatment.

Criteria for patient consideration of case series

Consecutive patients were considered for this case series if they reported chronic knee pain with insidious onset or from a non-traumatic event. Chronic knee pain was operationally defined as knee pain with a reported duration of greater than 4 months, which was constant (potentially varying in intensity), and affected some aspect of the patients' daily activities. Non-traumatic events were defined as those that did not result from trauma to the knee or cause injuries such as fracture, dislocation, musculotendinous rupture, meniscal, or ligamentous injury. Common diagnoses considered within our definition of non-traumatic injury included patellofemoral joint pain, plica syndrome, osteoarthritis and tendinopathies. Patients were considered if they complained of pain in the patellofemoral region or surrounding knee structures, or reported tenderness upon palpation in structures involving the knee region, and tightness was noted in one or more of the tendons/muscle groups of the knee.

Participants were not considered if they reported knee pain that was a result of traumatic injury, a history of surgery on the involved knee, or a diagnosis of a rheumatic condition or chronic neuropathy of the lower extremities in which sensation was altered.

Patients

Seven patients fit the established criteria for this descriptive case series. Patients agreed to allow their de-identified case information to be used for the completion of this descriptive case series. During their initial evaluation, 5 consecutive patients were educated about the use of ETPS and exercise and two patients were educated solely on the use of exercise for the treatment of chronic knee pain. These two patients served as a comparison group. They were also informed that they could discontinue treatment at any time.

Table 1 is a brief descriptive summary of the included patients. Patients included in this case series were 5 males and 2 females with a mean age (SD) of 31 (7.5) years. None of the patients recalled medical co-morbidities. Three of the 7 patients reported an insidious onset of pain while the rest reported a non-traumatic incident that preceded the onset of pain. All patients exhibited signs and symptoms consistent with chronic tendinopathy.

Examination

Each patient received a standard physical therapy examination focused on knee pain, including patient history, observation (gait and posture), range or motion, strength, and diagnostic tests.[2] The clinical examination began with gait observation as the patients walked from the waiting room to the examination room (a distance of about 400 ft) to identify any obvious gait abnormalities that may indicate some dysfunction of the lower extremity. A structured patient history was taken and involved questions related to the description, onset, and nature of their knee pain and its effect on daily function. Other questions included past medical history, co-morbidities, and previous history of treatment for their current condition. Questions related to the presence of neck pain, jaw pain, headaches, previous surgical history, scarring from previous surgeries or injury, and presence of body piercings were also asked as these questions are relevant for specific ETPS protocols.

A qualitative postural analysis was conducted to identify deviations such as forward head or postural symmetry. Gross manual muscle testing and range of motion were performed for the muscles and joints of the lower extremity. Special tests for the knee included Lachman's test, Apply's Compression Test, Valgus and Varus stress test, and Posterior Drawer test to rule out ligamentous or meniscal involvement.[9] Flexibility tests were included to determine length of iliotibial band, quadriceps, hamstrings, soleus, and gastrocnemius.[9] Finally, patients were also assessed for patellar tracking and crepitus. The initial examination was performed on a separate day prior to the onset of treatment due to scheduling demands of the primary physical therapist.

Outcome Questionnaires
Disability

All subjects were given the Lysholm Knee Scale for measuring disability associated with knee pain. The Lysholm knee scale was administered at initial evaluation and at the end of the course of treatment. The same instructions were given to each patient on how to correctly complete the scale. The Lysholm Knee Scale is a self-report measure for patients with knee pain to assess ability to perform basic daily functional tasks. There are eight items scored on a 100-point scale, with low scores indicating greater disability.[10] The Lysholm Knee Scale contains items assessing degree of limp, need for support, frequency of knee locking, frequency of knee instability, amount of pain, amount of swelling, stair-climbing, and squatting impairment. The Lysholm Knee Scale was modified by replacing the category of frequency of locking (max 10 points) with a category for atrophy of the thigh (max of 5 points). This made the total points possible for the Lysholm knee scale 95 instead of 100. The modified scale was chosen due to its common use as an assessment tool in an athletic population.[10] Since patients in this case series are all active duty enlistees who are required to complete a certain amount of physical training each week, this scale is commonly used in this setting to track outcomes and patient progress. An Intra-class Correlation Coefficient (ICC) of 0.93 was reported for the Lysholm knee scale with a reliability of 84.1.[10] Briggs et al[11] also reported the ICC for the Lysholm knee scale as 0.93 and the standard error of measurement as 3.6, with a minimally clinically important difference reported as 10.1.[11]

Pain Intensity

The patients were asked to rate their current pain based on a numerical pain rating scale (NPRS) for pain intensity. Patients were asked to rate their pain at a level from 0 for no pain to 10 for the worst pain imaginable. This scale was administered at initial evaluation, before and after each physical therapy session, and at the end of the course of treatment. The numeric rating scale was used due to its ease of administration and to show any significant reductions in pain, not only within a single treatment session but over the course of treatment as well. This numeric rating scale for pain has demonstrated good responsiveness, validity and reliability in clinical settings.[12,13] Based on reports from the literature, patients with low back pain reported an ICC of 0.61 and a common standard deviation of 1.64 points have been found in patients with low back pain.[14] The standard error of measurement was calculated to be 1.02. A minimum detectable change of 1.99 points was reported, which indicates that a 2-point change on the NPRS is necessary to exceed measurement error based on a 95% CI.[14] The minimal clinically important differences

Table 1. Demographics and Diagnosis Description for Patients Receiving ETPS (1- 5) and Not Receiving ETPS (A - B)

	Patients						
Variable	**1**	**2**	**3**	**4**	**5**	**A**	**B**
Age (years)	23	40	23	23	41	33	35
Sex	M	F	F	M	M	M	M
Race	Caucasian	AA	Caucasian	Caucasian	AA	Caucasian	AA
Comorbidities	None	None	None	None	None	None	None
Other Reports of Pain	Neck pain	Low back pain, neck pain, jaw pain, HA	Low back pain	R hip pain	Neck pain, jaw pain, HA	Jaw pain, HA	None
Referring Diagnosis	L knee pain	Bilateral knee pain	L knee pain	R knee pain	R knee pain	L knee pain	R knee pain
Type of Onset	Playing Basketball	Insidious	Running	Insidious	Fell off ladder well	Playing basketball	Insidious
Duration	6 months	60 months	12 months	4 months	96 months	60 months	5 months
PT Diagnosis	ITB tendinopathy	Quad and patellar tendinopathy	Pes anserine tendinopathy	Patellar and ITB tendinopathy	Patellar tendinopathy	ITB tendinopathy	Pes anserine tendinopathy

Abbreviations: M, male; F: female; AA, African American; HA, headache; R, right; L, left; ITB: iliotibial band. PT diagnosis refers to diagnosis given to patient based on problem list and associated impairments found during initial exam

(MCID) were also calculated at time frames of one-week follow-up and 4-week follow-up by using a receiver operating characteristics curve. This data reported a MCID of 2.2 at one-week follow-up and 1.5 at 4-week follow-up, which is useful for establishing expected levels of change throughout the course of treatment.[14]

Interventions

ETPS Intervention

The primary component of ETPS is the application of direct current (DC) to a specific acupuncture point, motor/trigger point, or contracted motor band in order to achieve a desired release of a specific area. A release is defined as the conduction of ETPS over the designated or targeted area in conjunction with the established protocol specific to treating the painful area as reported by the patient. The areas targeted can include the neck, jaw, or iliopsoas (see Appendix). The ETPS protocols are subsequently termed neck release, jaw release, and iliopsoas release to indicate the region targeted with the use of ETPS. This also includes the use of ETPS around the area of a scar. Other components of the ETPS protocol include manual therapy for restoring optimal symmetry or balance (eg, sacral balance) prior to the application of the stimulus.

The ETPS stimulation uses a pulsed DC wave at a frequency of 2.5Hz and 50% duty cycle. This microcurrent stimulus is delivered through a fine retractable tip, similar to a ball-point pen, which minimizes spreading effects of the stimulus. The device has a skin resistance sensor to aid in location of trigger/acupuncture points. It provides an audible and visual feedback to the user in which pitch intonation increases as resistance decreases. A green light indicator switches off when the resistance decreases past a particular threshold, indicating that a motor/trigger point has been reached. Once located, each point then receives the DC stimulus for an average of 15 to 30 seconds to achieve a release of the desired site of application. Please see the Appendix labeled ETPS protocol below for a description of the location of the acupuncture/trigger points used. The ETPS device delivers a negative DC current during all applications with the exception of performing a scar release in which one unit is set on biphasic (neg/pos) and the other on negative to deliver a biphasic and negative DC current simultaneously

All release protocols, including the specific order and location of applied acupuncture points to the targeted area, desired amount of time, and positioning of patient are described in full detail in the Appendix.

Exercise Intervention

The exercise session started with a warm up on the upright bike for 10 minutes, followed by stretches that were tailored to individual patients based on flexibility deficits and reports of pain noted in the initial examination (eg, hamstring stretch, iliotibial band stretch, etc). Stretches were held for 30 seconds and performed twice for each muscle group being stretched. Patients then performed specific open chain and closed chain resistive strengthening exercises that are designed to increase knee stability (eg, hip abduction, adduction in standing with appropriate Thera-Band, single-leg leg press with focus on slow eccentric movement, lateral touch downs, etc). Exercise parameters were tailored for each individual patient and patients were advised to work in a pain free range. Patients were given instructions and demonstrations for all exercises and monitored by the physical therapist assistant for proper form and alignment.

Intervention Sessions

Five of the 7 patients received physical therapy treatment which included ETPS 3 times per week for 3 weeks. These patients received only ETPS treatment for the first 3 sessions during the first week, followed by 6 sessions of a standard exercise protocol, including stretching and strengthening over the second and third week. At all ETPS sessions, patients received the standard protocol and iliopsoas release with the addition of scar release on day one, and neck and jaw release on day 3. These subsequent applications of ETPS are part of the standard procedure designed for treating patients with knee pain (see Appendix). Each ETPS session lasted an average of 30 minutes. Each of the 6 exercise intervention sessions during the second and third week lasted approximately 50 to 60 minutes.

Two patients, who served as control patients, received standard physical therapy treatment of exercise (without ETPS) 3 times per week for 2 weeks. The standard physical therapy treatment was the same exercise intervention administered to those in the ETPS treatment group. Each exercise session for these 2 patients lasted approximately 50 to 60 minutes.

The primary treating physical therapist who conducted the initial evaluation of all 7 patients provided the 3 ETPS treatments during the first week and examined all 7 patients at discharge. The first treatment session (whether ETPS or exercise) occurred 2 to 3 days after the initial examination was conducted, depending on scheduling availability. Exercise sessions were monitored by the same physical therapy assistant during each visit. Progressions were tailored to patient progress and determined collaboratively by the primary physical therapist and physical therapy assistant.

RESULTS

Results of all 7 patients in the case series were included in a final outcome analyses. Table 2 depicts the results of the immediate within-session change in NRS scores following the first session of ETPS intervention. The mean difference in NRS scores from pre- to immediate post-treatment was 2.2 points. Four of the 5 patients receiving ETPS exhibited a clinically meaningful improvement in pain ratings.

Table 3 depicts initial and final NRS and Lysholm knee scale scores for each patient, as well as the percentage of patients reporting a clinically meaningful improvement. All 5 patients receiving ETPS exhibited a clinically meaningful improvement in pain, while neither of the comparison patients exhibited a clinically meaningful improvement in pain. Three of the 5 patients receiving ETPS exhibited a clinically meaningful improvement in Lysholm Knee Scale scores, while one of the 2 control patients exhibited a clinically meaningful improvement.

Group data was computed for initial and final ratings. The mean and standard deviation (SD) NRS rating for the ETPS group was 5.8 (2.5) at initial evaluation and 1.6 (1.7) at final assessment (% change = 72.0%). The mean (SD) NRS rating for the comparison group was 3 (SD = 0) at initial evaluation and 3 (0.0) at final assessment (% change = 0%). The mean (SD) Lysholm rating for the ETPS group was 59.4 (22.2) at initial evaluation and 72.6 (19.1) at final assessment (% change = 22%). The mean (SD) Lysholm ratings for the comparison group was 57 (41.0) at initial evaluation and 67 (26.9) at final assessment (% change = 17.5).

DISCUSSION

The goal of this case series was to describe the use of ETPS as an adjunct to standard physical therapy and to examine whether ETPS was associated with additional therapeutic benefit for pain or disability. As this case series was merely descriptive and not designed to examine causation, our results suggest that ETPS may be beneficial for immediate and short-term pain relief for patients with chronic knee pain. In contrast, it appears that ETPS was not associated with apparent improvements in disability, especially when compared to two of the control patients who did not receive ETPS.

The principle element of the ETPS approach is the application of an electrical stimulus to acupuncture points and the utilization of the ETPS device as a modality. Thus, it was expected that there would have been greater changes in pain as compared to changes in disability. Research has examined the effects of physical therapy modalities, including manual therapy and electrical stimulation and showed immediate and short-term improvements in pain.[15] The results of this case series are consistent with these observations and also highlight the potential disconnect between changes in pain and changes in disability. The association between immediate within-session and between-session changes in impairments and activity limitations in patients with neck pain was specifically studied with results demonstrating that within-session changes in impairments (ie, pain location) predicted between-session changes in that same impairment. However, these changes in impairment did not predict improvements in activity limitation.[16] In this case series, all of the ETPS patients showed beneficial within-session reductions in pain at the first session, as well as changes between the initial and final outcome sessions. However, there was an apparent lack of clear benefit (or carryover) to disability, especially when comparing disability scores to our comparison sample.

Based on the results of the within-session change in pain ratings, it is possible that ETPS may be related to a conditioning effect due to the method of application. There are multiple explanations for this type of response in patients. For example, the beneficial effect could be attributed to aspects of the ETPS unit. For example, perceived changes in pitch intonation of the ETPS unit may alter patient expectations during each ETPS application and ultimately influence the outcomes of each treatment session. Alternatively, the effects could be related to the overall experience that the patient has related to the ETPS protocol and the patient's perception of the treatment. Some studies have investigated how expectations relate to improvements in overall function post treatment. One such study examined the effects of patient expectations prior to either acupuncture or massage.[17] Results showed that patients with higher expectations had better improvements in function. Further, those who perceived one treatment to be superior to another were more likely to experience better outcomes with that specific treatment.[17] These findings support the role of patient expectation

Table 2. Immediate Within-Session Change in NRS Scores After the First Session of Electro-therapeutic Point Stimulation Intervention

	Pt 1	Pt 2	Pt 3	Pt 4	Pt 5	Mean (SD)
Pre-NRS (x/10)	4	3	8	6	2	4.6 (2.4)
Post-NRS (x/10)	1	1	6	3	1	2.4 (2.2)
Difference (Pre – Post)	3	2	2	3	1	2.2 (0.8)

Abbreviation: Pt, patient; NRS, Numeric Rating Scale

Table 3. Initial and Final NRS and Lysholm Knee Scale Scores for Patients Receiving ETPS (1- 5) and Not Receiving ETPS (A - B)

	Pt 1	Pt 2	Pt 3	Pt 4	Pt 5	Pt A	Pt B
Initial NRS (x/10)	4	10	6	4	5	3	3
Final NRS (x/10)	0	2	4	2	0	3	3
Meaningful change – NRS	Y	Y	Y	Y	Y	N	N
Initial Lysholm (%)	85	33	41	62	76	28	86
Final Lysholm (%)	100	77	47	67	72	48	86
Meaningful change-Lysholm	Y	Y	N	N	Y	Y	N

Abbreviations: Pt, patient; NRS, Numeric Rating Scale; Y, yes; N, no

of benefit in influencing outcomes following conservative interventions.

The ETPS unit can be compared to AL-TENS, which has been extensively researched in the literature. The parameters for ETPS are similar to AL-TENS in that AL-TENS also uses a very low frequency and the stimulus can be applied to acupuncture or myotomal points.[18] A review of the literature examined the effectiveness of AL-TENS when applied to acupuncture points.[19] A number of limitations were noted in AL-TENS studies, including parameter variations and the use of different outcome measures.[19] The review concluded that while many of the randomized controlled trials demonstrated a favorable response to AL-TENS on acupuncture points, there was a lack of power and incorporation of adequate placebo control groups.[19]

There are several limitations to consider in this case series. First, the design of this case series is strictly descriptive, thus cause and effect relationships are unable to be determined. Further, the outcomes of ETPS treatment shown in this case series may possibly be related to a placebo effect or alteration in patient expectations associated with this type of therapy.[20,21] In this case series, patient expectations prior to and following treatment were not examined. These issues require more advanced designs for assessing whether ETPS offers an advantage over other forms of care. In this case series, the use of the two control patients not receiving ETPS may be an advantage when making comparisons to a similar group of patients; however, these comparisons are limited as other potentially confounding factors (eg, via randomization) were not controlled. Also, the group sizes were different and included small samples of 5 and 2 patients We limited our interpretation largely to changes observed within each group, with emphasis on what was observed in the patients receiving ETPS. While we did examine the initial immediate effects of ETPS, our final analysis of outcomes suggests a potential benefit of ETPS as an adjunct to a standard stretching and strengthening exercise protocol. Thus, this case series does not establish the beneficial effects of using ETPS alone as a therapeutic strategy. Our criteria included only patients with apparent chronic knee tendinopathies, thus our findings are limited in generalizability to this population. Finally, it is possible that the short duration of 2 to 3 weeks was not enough to observe drastic changes in disability scores. Additionally, the Lysholm Knee Scale was modified, which may have potentially influenced patients' self-report ratings and caution should be used when interpreting these results.

There are potential implications for future research on ETPS as a treatment modality. Future investigations could include a longer randomized, controlled trial with a larger patient sample. The inclusion of randomized comparison groups would be necessary to determine if ETPS is a useful modality for clinical use. Further, comparing ETPS to a sham or placebo and control interventions would help elucidate if the pain relieving effects are due to non-specific or placebo effects.

CONCLUSION AND CLINICAL APPLICATION

The ETPS appears to be associated with immediate, clinically meaningful changes in pain relief and may contribute to lasting changes in pain over a course of treatment. This may be beneficial to the treating therapist, as it may provide patients with enough pain relief to acutely participate in a prescribed physical therapy treatment. Similar beneficial effects on disability are not apparent following short term ETPS treatment. Thus, ETPS may be a useful treatment approach for managing pain in patients with chronic pain, but should be included as an adjunct to active exercise to achieve desired improvements in function. The ETPS may also be a useful tool in alleviating or decreasing acute pain in patients in order to allow them to participate in more functional activities. Additional research is needed to examine the efficacy of ETPS in physical therapy practice.

ACKNOWLEDGEMENTS

Thank you to Tonya Sauls, PT, OCS, CSCS, and the staff at the rehabilitation department at the Jacksonville Naval Hospital for their time and assistance with this case series and to the patients for their participation.

Lauren Gornoski was a student at the University of Florida during the period of time in which this case series was conducted.

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Appendix. ETPS Protocol Description

Abbreviations: Gb, gallbladder; B, bladder; K, kidney; St, stomach; Liv, liver; Sp, spleen; Si, small intestine; Tw, triple warmer. • Indicates location of ETPS application (acupuncture points)

The direct current from the ETPS unit is applied to each point for about 10 to 30 seconds. For references regarding standard acupuncture terms and definitions and methods for proper location of acupuncture points please refer to article published by Lim 2010 and text published by WHO Regional Office for the Western Pacific 2008.[22,23] Figures from text Hocking, ETPS Neuropathic Acupuncture 2001, are referenced throughout each protocol with corresponding page numbers for further guidance regarding use of ETPS on acupuncture point locations.[24]

Sacral Balance: With the patient in the prone position, approach the patient from the right side. Place the left hand 6" below the knee and the right hand 6" above the knee and ABD and externally rotate simultaneously. Place the right hand on the greater trochanter at a 45 degree angle towards the pelvis. Oscillate the pelvis, while leg is in external rotation, by applying a gentle pressure, supporting the knee with the left hand. Return the leg to the starting position by internally rotating the leg, using the same hand position described above. Repeat on the other side.

Standard Protocol: With the patient lying in prone, ETPS is applied to all segments two fingers width bi-lateral from the spinous process interspace starting at L2 through S2 (Shu Points), as shown in Hocking. Fig. 54.21 pg 681. Apply one ETPS unit on the tender point of the piriformis muscle with the acupuncture point GB31 then the same piriformis point with GB 34, as shown in Hocking. Fig. 54.20 pg 679. Lastly the same two fingers width disc interspace at the L2-3 level can be circuited with B40, which can be found in the popliteal fossa of the knee. Repeat bilaterally for each of the above listed points.

Scar Release: Using two ETPS units, ETPS is applied around the borders of the entire scar with each point about 1-2mm apart depending on the size of the scar.

Iliopsoas Release: With the patient lying in supine with both knees flexed at a comfortable position and feet on the mat table, ETPS is applied to the Jing Well points on bilateral feet with the addition of acupuncture point GB41 on each foot after the Jing Well point on the 5th phalanx is stimulated as shown in Hocking, figures 54.14 pg 676 and 54.23 pg 683.

Posterior Neck: With the patient in sitting, ETPS is applied to two fingers width bilateral from the spinous process interspace at the levels of C2 through T2. Next the acupuncture points are stimulated in the following order; GB21, Si12 and Tw15 bilaterally, as shown in Hocking, Fig. 54.27 pg 685).

Jaw Release: With the patient in sitting, ETPS is applied to acupuncture points ST7, ST6, and Si18 simultaneously and bilaterally. Patient is instructed to open and close jaw slowly, midway through available range while dorsi flexing and plantar flexing the feet simultaneously. Have the patient open through full range ahead of time to show them what "half way" looks like.

Book Reviews

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

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

Physical Therapy Case Files: Neurological Rehabilitation,
McGraw-Hill Companies, 2014, $40
ISBN: 9780071763783, 396 pages, Soft Cover

Author: Burke-Doe, Annie, PT, MPT, PhD

Description: Part of the Physical Therapy Case Files series, this book describes 31 cases with patient scenarios, information about the neurological conditions, and evidence-based treatments. It joins other books in the series on orthopedics and acute care. **Purpose:** Patient scenarios define cases for instructors to educate and maximize students' abilities to use evidence for patient care. The book partially meets the purpose with patient integration into some of the cases. **Audience:** The book targets students and serves as a reference for practitioners who infrequently treat patients with neurological conditions. The editor has selected 24 contributors with neurological experience to provide true-to-life scenarios. **Features:** Each chapter stands alone and starts with a patient encounter. Key definitions, objectives, physical therapy considerations, and health condition information support an understanding of the patient's situation. The chapters continue with evaluation and diagnosis; plan of care and interventions; and evidence-based recommendations. The authors include information pertinent to the patient scenario in nearly 60 percent of the cases. The other cases provide general knowledge. Research and current evidence substantiate the cases. Strength of Recommendations Taxonomy (SORT) provides a rating for selected evidence-based treatments. A few comprehensive questions and detailed answers allow readers to test their understanding. Chapters end with references specific to the case material. **Assessment:** This book offers excellent information for students and practitioners looking for improved neurological understanding. I appreciate the cases that include ideas specific to patients' conditions and treatment. Chapters that focus on general information provide a good resource, but don't give as much insight into evaluating, planning for, and treating different patients. The table of contents doesn't list the cases, but refers readers to lists near the index. It would be helpful to chronologically list the cases by health condition in the table of contents. Additional photographs and figures would complement the text and improve understanding.

Karin J Edwards, MSPT
Providence Health & Services

Sleep and Rehabilitation: A Guide for Health Professionals,
Slack Incorporated, 2014, $55.95
ISBN: 9781617110337, 421 pages, Soft Cover

Editor: Hereford, Julie M., PT, DPT

Description: This book reviews the science underlying sleep and sleep dysfunctions and how these can affect the recovery of patients in rehabilitation. **Purpose:** The purpose, according to the author, is to "provide rehabilitation professionals with a source of information that will help them gain a better understanding of sleep and its impact on the rehabilitation process." This is a much needed book that explains the science behind sleep and how it impacts patients undergoing rehabilitation. **Audience:** The audience is healthcare professionals in all fields of rehabilitation. The book is written in a manner that is easy to understand by those unfamiliar with sleep terminology. The author, who holds a doctor of physical therapy degree, is a codeveloper in a course series for sleep sciences. **Features:** The book is divided into four sections that cover the basic science of sleep, disordered sleep, evaluation and treatment of sleep disorders, and implications of sleep in rehabilitation. The well-organized chapters review sleep definitions and sleep development throughout the life span, consequences and manifestations of disordered sleep, clinical pharmacology, and implications for rehabilitation professionals, including the effects on pain, memory, sensory integration, and insomnia. The book does an excellent job of explaining sleep-related disorders and current treatments. Although there are illustrations in each chapter, they do not add much. The practical applications chapter reviews assessment tools for sleep, breathing exercises to improve respiratory function, and tips on sleep hygiene, but it could be more thorough. For example, additional helpful material could include specific questions to ask the patient, the role of the use of scales or questionnaires, and a list of what type of practitioner to refer the patient to if a sleep disorder is discovered. I would consider the lack of these features a significant shortcoming of the book. **Assessment:** Nevertheless, this is an excellent addition to the field of rehabilitation and fills a gap for practitioners. It is a good choice to learn more about the physiology of sleep and sleep disorders and current treatments. Future editions would benefit from color photos that enhance the text and some online videos of exercises. This book is certainly a step in the right direction, and I would recommend it for learning how sleep is affecting your patients.

Amisha Klawonn, PT, DPT, OCS, FAAOMPT
A. T. Still University

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Dear Orthopaedic Section Members:
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Practical Pharmacology in Rehabilitation: Effect of Medication on Therapy, Human Kinetics, Inc., 2014, $87.95
ISBN: 9780736096041, 627 pages, Hard Cover

Authors: Carl, Lynette L., BS, PharmD, BCPS, CP; Gallo, Joseph A. , DSc, ATC, PT; Johnson, Peter R., PhD, CCC-SLP

Description: This reference guide for rehabilitation clinicians describes medications in the context of specific conditions encountered in rehabilitation and their effects on treatment. **Purpose:** The authors' goal is to integrate pharmacology into clinical practice in an easy-to-use format that assists rehabilitation professionals in designing effective treatment plans that keeps the patient's condition, comorbidities, and current medication therapies in mind. By organizing the book according to medical condition, including case studies, noting rehabilitation implications of specific medications, and indexing by medication as well as important terms, the authors have met their objectives. The authors include a pharmacist, a speech-language pathologist, and a physical therapist/athletic trainer. Including an author who commonly prescribes medication might have further advanced the goal of presenting an interdisciplinary approach to this topic. **Audience:** The intended audience includes students as well as practicing clinicians. Although this is a practical reference for practicing clinicians, the book does not go into enough detail on pharmacokinetics for students. There are no illustrations, which may make learning concepts of pharmacology for the first time difficult. The tables in each chapter that list the medication, side effects affecting rehabilitation, and other side effects or considerations make this book an easy reference for busy practicing clinicians. **Features:** Part one of the book's six parts has chapters on foundations in pharmacology including how medications are monitored, their effects on the nervous system and muscle function, and the impact of medication on nutrition in rehabilitation. Parts two through six are organized by disorders and diseases encountered in rehabilitation that therapy has a direct effect on, from neurological diseases including Parkinson's to the treatment of musculoskeletal diseases such as osteoarthritis. There is also discussion of disorders and diseases for which therapy does not have a direct effect on treatment, such as inflammatory bowel disease and schizophrenia. The book includes brief descriptions of pathophysiology followed by commonly used medications and their side effects and considerations in rehabilitation. The tables in each chapter that list medications and side effects have a corresponding web resource that is more in depth. There is a good section in the appendix on iontophoresis and phonophoresis that lists medications commonly used in these interventions as well as treatment parameters. The chapter on pain is superficial in its description of the pathophysiology of pain and makes understanding the mechanism of a medication's effect on pain more difficult. **Assessment:** This book's descriptions of pharmacokinetics and pharmacodynamics are not as in depth as those in "Pharmacology in Rehabilitation", 4th edition, Ciccone (F. A. Davis, 2007). However, it is a useful resource for busy practicing clinicians looking to gain more of an understanding of how their patients' medications can impact therapy and it may assist clinicians in educating patients about these effects.

Monique Serpas, PT, DPT, OCS
HealthReach Rehabilitation Services

Congratulations

to the 2014 Honors and Awards Recipients

The American Physical Therapy Association (APTA) has announced the 2014 Honors and Awards Program recipients. The following Orthopaedic Section members have been selected by APTA's Board of Directors to receive the following awards:

Catherine Worthingham Fellow of APTA
John D. Childs, PT, PhD, MBA, OCS, FAPTA
Pamela Duffy, PT, PhD, OCS, RP, FAPTA
Julie M. Fritz, PT, PhD, ATC, FAPTA
William H. O'Grady, PT, DPT, OCS, DAAPM, FAAOMPT, FAPTA

Lucy Blair Service Award
Susan A. Appling, PT, DPT, PhD, OCS
William G. Boissonnault, PT, DHSc, FAPTA
David W. Qualls, PT
John G. Wallace, PT, MS

Helen J. Hislop Award for Outstanding Contributions to Professional Literature
Anthony Delitto, PT, PhD, FAPTA

Dorothy E. Baethke-Eleanor J. Carlin Award for Excellence in Academic Teaching
Beth Moody Jones, PT, DPT, MS, OCS

Henry O. and Florence P. Kendall Practice Award
Jan Dommerholt, PT, DPT, MPS, DAAPM

Eugene Michels New Investigator Award
Terry L. Grindstaff, PT, PhD, ATC, SCS
Richard B. Souza, PT, PhD

Chattanooga Research Award
Lee Dibble, PT, PhD, ATC

Minority Scholarship Award
Amy N. Tran, SPT

Mary McMillan Scholarship Award
Matthew DeBole, SPT
Sarah Beth Martin, SPT, PhD
Samantha Paige Grubb, SPTA

Award recipients were recognized at APTA's Honors and Awards Ceremony at the NEXT Conference and Exposition held in Charlotte, North Carolina, this past June.

Annual Orthopaedic Section Meeting: Another Resounding Success

Nancy Bloom, PT, DPT, MSOT

The Triangle of Treatment: Integrating Movement System Impairments, Manual Therapy, and the Biopsychosocial Approach in the Treatment of the Upper Quarter

The American Physical Therapy Association (APTA) recently adopted the following vision statement, "transforming society by optimizing movement to improve the human experience." What a great theme for the Orthopaedic Section to embrace during the Second Annual Meeting held in St. Louis, MO. Outstanding researchers, clinicians, and educators were brought together to provide the newest evidence, teach skills to improve practice, and offer thought provoking discussion to direct our future as we integrate various treatment approaches to best manage the movement system.

Close to 200 attendees participated in the conference, which followed a similar format as the First Annual Orthopaedic Section Meeting in Orlando, FL. The conference began Thursday evening with a thought provoking keynote presentation by Dr Alan Jette. Friday and Saturday started with general sessions presented by a panel of outstanding speakers followed by smaller breakout sessions with lab. Each attendee was able to select 3 of 4 possible breakout sessions to attend.

The health care environment is changing and Dr Alan Jette helped prepare us by introducing the concept of "system skills" for physical therapists. He emphasized the need for physical therapists to be intrinsically interested in data, to use data to devise solutions for system problems, and to be innovative in developing strategies to implement solutions on a large scale. Several examples were used to illustrate the use of system skills and factors that influence the speed with which innovation becomes widespread adoption. Physical therapists, working together with innovators, researchers, and professional associations, can be successful in providing quality care with low cost and best practices.

The general session on Friday was led by Dr Gwendolen Jull, Dr Shirley Sahrmann, Patricia M Zorn, and Dr James Elliott. In a pre-recorded session, Dr Jull described the metamorphosis of manipulative therapy to musculoskeletal physical therapy. She illustrated the complementary rather than competitive nature of using the movement system impairment, manual, and biopsychosocial approaches to the examination and treatment of patients with neck pain. Dr Shirley Sahrmann presented movement system impairment syndromes of the cervical spine and discussed the importance of using manual skills to assess where motion is occurring and to determine the impact of resistance from the shoulders and shoulder musculature. Faulty alignment and alterations in the intrinsic cervical musculature were also discussed as contributing factors to movement impairments of the neck. Patricia Zorn stated, "combining manual therapy and movement can effectively improve your patients quickly and empower the patient with tools for prevention of recurrences." Patricia emphasized the importance of identifying ourselves as "physical therapists," not simply manual or movement therapists. The next speaker in the general session was Dr James Elliott who framed his presentation around whiplash. Dr Elliott explained, "operating within a biopsychosocial model facilitates appreciation of all features in assessment and management." He presented the most recent evidence on key factors that clinicians can use to help identify individuals at risk for developing chronic moderate to

The Education Committee—Neena Sharma, Nancy Bloom, Tess Vaughn, and Manny Yung.

severe disability compared to those who can expect full recovery after sustaining a whiplash injury. As a result, physical therapists are able to apply the most appropriate treatment and "avoid stigmatizing the patient as having psychosomatic illness with non-injury, or non-organic factors." Last but not least, Dr Gwen Jull wrapped up the session with a presentation on cervicogenic headache. Dr Jull provided evidence to support her belief that cervicogenic headaches are associated with cervical musculoskeletal impairments, including altered movement and neuromuscular performance. She stated that physical therapists should "stake a claim on cervicogenic headaches" and at

(Continued on page 192)

Dr James Elliott was the speaker for the Opening Session. He discussed the neck disability index and clinical prediction rules.

Dr Marshall LeMoine and Dr Paula Ludwig were speakers day 2.

best, physiotherapy is a minor player in the management of migraine or tension-type headaches.

Breakout sessions on Friday reinforced the theme of integration of approaches with an emphasis on the head and neck. Participants learned about the best evidence for the examination and treatment of traumatic neck disorders, pain management, and neck pain of musculoskeletal origin. Practice in the sessions included performance of an oculomotor examination and positional testing (Dr James Elliott and Dr Janet Helminski), assessment techniques using the science of pain to direct mechanism-based management of pain (Dr Kathleen Sluka), and examination and treatment of the cervical spine incorporating movement and manual skills (Dr Kenneth Olson, Dr Michael Wong, and Dr Shirley Sahrmann/Patricia Zorn).

Saturday's general session continued the theme of the conference while focusing on the topic of the shoulder. Dr Paula Ludewig discussed diagnostic labels and explored the advantages and limitations in using traditional pathoanatomic labels as compared to movement system diagnostic labels, particularly as they relate to "shoulder impingement." Dr Ludewig reviewed her research regarding the biomechanical evidence for mechanical impingement and discussed the wide variety of structures that can be injured with impingement. In the end, diagnostic labels need to guide intervention. Dr Marshall LeMoine reinforced these concepts based on evidence from the literature and clinical experience. While he stated that the pathoanatomic diagnosis matters and identification of the tissue source is still important, he clearly illustrated the significance of also using a movement system impairment diagnosis to guide intervention.

The breakout sessions on Saturday focused on the integration of the 3 approaches for impairments of the masticatory system, shoulder, elbow, and hand. More in depth information was provided for each topic and lab sessions included a wide variety of activities. Dr Steve Kraus lead sessions that taught the evaluation of the muscles of mastication that impair mandible movement and treatment for masticatory muscle pain. He also emphasized the importance of understanding the impact of the biopsychosocial variables on treatment outcomes for patients with temporomandibular disorders. Dr Shirley Sahrmann and Dr Paula Ludewig teamed together to present an integration of biomechanical knowledge with movement impairment assessment for the shoulder. Diagnostic subgroups with movement labels for the scapula and the humerus were proposed for the traditionally broad diagnostic classification of shoulder impingement and rotator cuff disease. The lab session included practice of tests for both alignment and movement in a variety of positions. Dr Marshall LeMoine and Dr Michael Wong also provided a framework for classifying patients with shoulder pain into subgroups based on the movement impairments and described treatment that combined both movement correction and manual techniques. Evidence was presented in the context of the International Classification of Functioning and Health (ICF) as described in the Orthopaedic Section Shoulder Pain Guidelines. Lab consisted of practice of tests for identification of anterior humeral glide, insufficient scapular upward rotation or excessive scapular abduction, and thoracic kyphosis. Interventions for improving mobility or coordination were also included. Dr Cheryl Caldwell presented key concepts and principles of examining alignment and movement in the elbow, wrist, and hand. Concepts of manual therapy and the biopsychosocial approach were also included with an emphasis placed on two diagnoses: Wrist extension with Forearm Pronation (lateral epicondylalgia) and Thumb Carpometacarpal (CMC) Accessory Hypermobility (early osteoarthritis of the CMC joint of the thumb).

The goal of the Orthopaedic Section is to bring advanced, hands-on continuing education programming to the master clinician. Time is also allowed for socializing and networking with colleagues. Remember to mark your calendars now and plan to join us next year in Phoenix, AZ, on May 14-16, 2015, for our Third Annual Orthopaedic Section Meeting on "Maximizing Outcomes: Multidisciplinary Advances in the Continuum of Care of Lower Extremity Dysfunctions" at the beautiful Arizona Grand Resort and Spa.

The general session May 16, 2014, opened with Dr Shirley Sahrmann and Dr Patricia Zorn and then were joined by Dr Jim Elliott and Dr Gwen Jull.

OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

President's Message

Lorena P. Payne, PT, MPA, OCS

The Orthopaedic Section and the OHSIG are proud to announce the most **recent independent study course, The Injured Worker**. This is your chance to learn from the experts and add value to your practice without traveling or taking time away from the clinic. Increase your expertise in all areas of work-related health with 6 separate monographs. You probably know the expert coauthors of the first monograph: Deidre Daley, PT, DPT, MSHPE, Jill Galper, PT, MEd, and Margot Miller, PT. Check out all of the authors and topics covered. The course is available now at the Orthopaedic Section web site http://www.orthopt.org/content/education/independent_study_courses.

Occupational Health/Work Compensation Advocacy Agenda

Following is a summary of 4 primary objectives for physical therapist advocacy in workers' compensation and occupational health. A staff-selected workgroup met on April 12, 2014, to review and update this document. Strategies were developed to achieve each priority and objective. Reach out and connect with these participating colleagues to give your input and comments regarding Physical Therapists in the realm of work: Reuben Escorpizo, Gary Lusin, David Hoyle, Heidi Ojha, John Lowe, Lorena Pettet Payne, James Hughes, Joe Koloc, Jill Floberg, Trisha Perry, Karen Jost, Sean Stratmoen, Lisa Culver, and Justin Elliott.

Objective 1: Position PTs as leaders and valuable contributors to workers' compensation/occupational health

Highest priority: *Develop Clinical Practice Guidelines for work rehabilitation to highlight*
- o *Value of physical therapists in keeping workers at work/returning to work*
- o *Value of early access to physical therapists*

Objective 2: Ensure PTs are aware of and compliant with workers' compensation regulations (including WC, ADA, OSHA, etc.)

Objective 3: Educate PTs in best practices for managing workers with health conditions

Highest priority: *Create a toolbox of resources and educational materials for PTs*

Objective 4: Ensure PTs have influence on regulation/legislation/policy

Highest priority: *Increase presence of PTs on workers' compensation commissions and advisory boards*

APTA has **submitted comments to the Bureau of Labor Statistics** regarding the Occupational Requirements Survey. Thanks to Karen Jost at APTA and Rick Wickstrom for drafting the comments. Below is an excerpt from the comment letter.

"BLS requested comments that focus on four specific areas related to the proposed Occupational Requirements Survey (ORS): evaluate whether the proposed collection of information is necessary for the proper performance of functions of the agency, including whether the information will have practical utility; evaluate the accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used; enhance the quality, utility, and clarity of the information to be collected; and minimize the burden of the collection of information on those who are to respond.

"APTA supports the necessity of collecting updated occupational data to better inform SSA decision-making, particularly in terms of identifying appropriate and relevant job categories for disability claimants. The vision statement for the physical therapy profession is "Transforming society by optimizing movement to improve the human experience." The ability to move about and interact in work and daily life is a critical component of the human experience. As such, we encourage BLS to ensure that the ORS data collected is valid and clear such that it enables appropriate identification of potential work opportunities.

"APTA is concerned that the ORS data being collected may not be accurate, and that subsequent use of the data may result in inappropriate disability adjudication decisions. APTA encourages BLS to conduct a validation study to verify that the ORS data being collected is truly representative of the job demands."

The Effects of Dynamic Intervention on Reducing the Risk of Work-related Reinjury

Trisha Perry, PT, DPT, CWcHP
Vice President, Therapy Services, National Therapy Director,
Nova Medical Centers in Houston, TX

INTRODUCTION

Every year millions of workplace injuries occur and cost the country billions of dollars. Despite implementation and focus on workplace safety and health programs, the incidence, prevalence, and costs of work-related injuries continue to rise. According to the U.S. Bureau of Labor Statistics, private industry employers reported 2.8 million nonfatal workplace injuries in 2012.[1] The Occupational Safety and Health Administration (OSHA) estimate that employers spend almost $1 billion per week for direct workers' compensation costs.[2]

A key factor in the direct costs and severity of these reported injuries are the recorded days away from work. In 2012, the median days away from work had increased from 8 days in 2011 to 9 days. When the injury was classified as a musculoskeletal disorder the median number of days before returning to work increased to 12 days.[3] This is an alarming number of days for many organizations because 34% of all workers who sustained a workplace injury requiring days off work, sustained a musculoskeletal disorder.

Workers with back injuries alone are the most prevalent and costly occupational injury after returning to work because a substantial portion have recurrences.[4] There are limited studies that looked at methods to reduce the recurrence rate or discussions on data collection of cases with reinjuries. Radoslaw et al[5] are among the few authors who have conducted studies to examine whether recurrences substantially contribute to the total medical and indemnity costs as well as the total duration of work disability. The high burden of recurrent episodes of low back injury is robust, and total costs and duration of work disability have substantially higher costs and longer duration of work disability than those without recurrence, suggesting an intensive application of worker education and an active exercise program to reduce the risk of reinjury. This is the only evidence of its kind in the workers' compensation arena to suggest a link between the reductions of work-related reinjury to dynamic intervention post initial injury.

There is agreement that many workers with acute low back injuries will suffer a recurrence, but the only meaningful way to study the incidence of recurrence is to enroll a cohort of patients at risk of recurrence, use a standardized definition of an episode of low back pain, and follow all patients for the same length of time. Further research is warranted because few studies have examined the recurrence of injury and the lack of a standard definition for recurrence of injury have resulted in potentially flawed estimates.[6] The purpose of this literature review is to examine the evidence that supports the effectiveness of dynamic intervention on reducing the risk of work-related reinjury.

METHODS

Various electronic databases were searched from February 15-18, 2014, including PubMed, Science Direct, *Journal of Orthopaedic and Sports Physical Therapy, Physical Therapy, Journal of Strength and Conditioning*, and Google Scholar. Initially, an advanced search was performed using the terms "functional training AND risk of reinjury" resulting in 6 articles and "dynamic training AND risk of reinjury" with no results. The search was then broadened to find more research studies using the simple search with terms such as "movement," "reinjury," "specificity," "exercises," and "dynamic," along with cross-referenced articles. The studies found were then screened by their titles and the relevance of the abstracts to the clinical question, resulting in 31 articles of interest. Of the total articles found, 4 articles met the inclusion criteria of research with adult human subjects published within the previous 10-year period. The articles included musculoskeletal injuries only; those involving cardiopulmonary and neurological disorders or dysfunctions were excluded. Only one systematic review was found. No randomized controlled trials were discovered. All relevant research studies used in this review regarding the effects of dynamic intervention referred to the athletic population, rather than our primary interest in the occupational health population.

REVIEW OF THE LITERATURE

Herman K, Barton C, Malliaras P, Morrissey D. The effectiveness of neuromuscular warm-up strategies that require no additional equipment, for preventing lower limb injuries during sports participation: a systematic review. *BMC Med.* 2012;10:75.

Herman et al[7] conducted a systematic review to determine which neuromuscular strategy is most effective in preventing lower extremity injuries during sports and in which sporting group they are effective. According to the authors, stretching alone is not sufficient enough to prevent injuries, and they mention various neuromuscular strategies that have been hypothesized to be necessary in improving joint position sense, joint stability, and protective joint reflexes. The studies included in their review involved an average of 1500 participants investigating both male and female athletes in two studies and only females in the remaining 7 studies.

The studies researched the effectiveness of various neuromuscular strategies, such as the Knee Injury Prevention Program (KIPP), the 11+, the 11, and the HarmoKnee program. For undefined lower limb injuries, the 11+ and KIPP strategies were found to be significantly more effective in reducing the risk of overall lower limb injuries and lower limb overuse injuries. For hip and thigh injuries, the 11 program demonstrated reduced risk of groin injuries. The HarmoKnee and the 11+ program significantly reduced the risk of knee injuries. The Prevent Injury and Enhance Performance (PEP) strategy was found to be the most effective neuromuscular strategy in reducing ACL injuries. The PEP strategy significantly reduced the risk of reinjury in previous non-contact ACL injuries. The Anterior Knee Pain Prevention Training Programme (AKP PTP) strategy significantly reduced the incidence of anterior knee pain. The KIPP strategy was found to reduce non-contact ankle sprains.

The authors discussed that, apart from a few methodological weaknesses, the studies demonstrated that better injury prevention could be attained when these neuromuscular strategies include a combination of stretching, strengthening, balance exercises, sport-specific drills, and landing techniques. Positive benefits were also reported when the strategies are continued for longer than 3 months.

Herman SL, Smith DT. Four-week dynamic stretching warm-up intervention elicits longer-term performance benefits. *J Strength Cond Res.* 2008;22(4):1286-1297.

Herman and Smith[8] conducted this study to evaluate whether a dynamic stretching warm-up (DWU) performed daily over 4 weeks positively influenced power, speed, agility, endurance, flexibility, and strength performance measures when compared to a static stretching warm-up (SWU) in collegiate wrestlers. The authors included 24 National Collegiate Athletic Association Division-I male wrestlers and assigned them randomly to two intervention groups of the treatment condition; DWU or the active control condition, and SWU by using a random digit algorithm. In total, 13 wrestlers were assigned to the SWU group and 11 to the DWU group; however, due to withdrawals such as injury, quitting, and/or the inability to continue participation, only 10 wrestlers concluded the study in each group. Each participant underwent (1) an orientation that included screening for eligibility to participate, (2) introduction to the purpose and methods of the study, and (3) verbal and visual presentation of DWU and SWU interventions and functional performance tests. The participants were then asked to rehearse the warm-ups and the tests. The experimental period included 4 weeks of either 11 DWUs or 8 SWUs, depending on the group and baseline, and 4-week follow-up measurements were taken for anthropometric measurements and performance tests.

The performance tests that were used in the study assessed total body explosive power, anaerobic fitness, muscle strength and endurance of the arms, shoulder girdle and the abdominal muscles, lower body power, acceleration, and agility. The authors noted various researchers have validated the use of these measurements for the properties required in wrestling, hence making the measurements sport-specific. The baseline characteristics demonstrated no difference except the decreased muscular endurance and longer time to finish the 600-m long run in SWU group as compared to DWU, with no difference in peak torque for hamstring, flexibility of hamstring and trunk and pull-up specific endurance. The 4-week follow-up revealed improvement in quadriceps peak torque, broad jump, medicine ball underhand throw for distance, sit ups, push-ups, time to complete a 300-yard shuttle run, as well as the 600-m run in the DWU group, as compared to a decreased push-up performance and 600-m run with no improvement in other measurements in the SWU group; thereby accentuating the improvement in push-ups and 600 m in the DWU group.

The authors proposed that the DWU group demonstrated improvements in the physical performance test 24 hours after the last DWU was performed, supporting the long-term effects of DWUs, which also reflects possible improvements. Herman and Smith[8] suggested that the improvement might be a result of the involvement of multiple contributing factors, which included, but were not limited to, sport-specific movements, increased muscle, and core temperature. This study suggests that when athletes are trained using sport-specific dynamic movements, it is possible for these physiological improvements to be sustained for a longer duration; therefore, long-term improvements can be seen in their sport performance.

Strengths of this study included the avoidance of group contamination by allowing no contact between the intervention groups, by allowing no other physical training apart from standardized wrestling drills, and by requiring measurements to be recorded at the same time. The design of the study was quasi-experimental with inadequate randomization, no blinding, and no treatment control group; thereby, decreasing the strength of the study.

Sherry MA, Best TM. A Comparison of 2 Rehabilitation Programs in the Treatment of Acute Hamstring Strains. *J Orthop Sports Phys Ther*. 2004;34(3):116-126.

In their prospective randomized comparison of two rehab programs, Sherry and Best[9] found a difference in the percentage of recurrent hamstring strain when following up at two weeks and one year after return to sport. Only 7.7% of subjects who completed a progressive agility and trunk stabilization program suffered a recurrent injury compared to 70% of the subjects who completed a hamstring protocol consisting of static stretching, isolated resistive exercise, and icing.

In the article, the effectiveness of two rehabilitations programs used to treat acute hamstring strains were compared by assessing time needed to return to sports and reinjury rate at two weeks and the first year post return to sport. A total of 24 subjects with acute hamstring strains were recruited by means of posters, local physicians, athletic trainers, and physical therapists. Using a 4-block fixed-allocation randomization process, 11 subjects were assigned to a hamstring stretching and strengthening (STST) intervention group while the other 13 subjects were assigned to a progressive agility and trunk stabilization (PATS) intervention group. Both rehabilitation programs were completed as home exercise programs on a daily basis and subjects were encouraged to continue their programs at least 3 days a week for two months after returning to sports. Subjects were evaluated every 7 days to monitor progress, and readiness to return to sports was determined by meeting specific criteria for manual muscle testing, absence of palpable tenderness, and demonstrating subjective readiness following agility and running screens. In addition, functional testing consisting of variations in hopping and a single sprint were also performed on the day of return to sport to ensure a safe return.

The authors found that recurrence of hamstring strain within the first 16 days of return to sports occurred in 54% of athletes from the STST program and 0% from the PATS program. Within the first year of returning to sports, recurrence of hamstring strain was present in 70% of athletes from the STST program versus an impressive 7.7% from the PATS program. The likelihood of reinjury was significantly less for the athlete in the PATS group at two weeks and one year after return to sport. Other findings showed that time needed to return to sports, number of days of rehabilitation, performance on the functional testing profile, and severity of injury were not statistically significant.

A rehabilitation program consisting of agility and trunk stabilization exercises proved to be more effective than a traditional stretching and strengthening program when considering the effect on preventing injury recurrence in athletes with acute hamstring strains. However, the authors identified that there were no measurements taken to assess both trunk stability and neuromuscular control pre- and postintervention programs. Therefore, the results of this study could not be attributed to changes in trunk stability, coordination, or other aspects of motor control. Perhaps an improved functional test profile should be designed to better predict successful return to sports.

Comfort P, Green CM, Mathhews, M. Training considerations after hamstring injury in athletes. *Strength Cond*. 2009;3(1):68-74.

The purpose of this study was to propose an effective treatment approach for athletes with a hamstring strain and to reduce its recurrence upon their return to sport. Comfort et al[10] reviewed the effects of sport-specific and advanced strength and conditioning training involving stretching, strengthening, eccentric training, plyometric and agility drills on athletes returning to sport. The review suggested the importance of tailoring the treatment and rehabilitation of an athlete to the healing process and the demands of the specific sports.

According to the authors, healing of the strained muscle fibers was marked by formation of both shorter and less elastic connective tissue. This formation resulted in decreased flexibility, impaired functions, replacement of muscle fibers with scar tissues of decreased tensile strength, and disrupted stretch shortening cycles. These results ultimately end in restricted contraction, poor lengthening, and increased risk of re-rupture. To regain the lost flexibility, the authors discussed the use of concurrent stretching and strengthening exercises progressing to dynamic activities; which stimulate the muscle protein synthesis and muscle growth in the direction of stress lines. Adding or removing the sarcomeres then leads to increasing the functional length. When performed in conjunction with advanced and functional strength training, the stretching aligns the sarcomeres for optimum force, velocity, and power generation.

This review supported a decreased risk of reinjury when training included drills that met sport-specific demands such as the combination of strength training, stretching, agility, trunk stabilization, running, and plyometrics. It is also recommended that training should consider factors that include mechanism of injury, force exertion, and type of muscle actions and movement patterns involved in the sport in order to fully rehabilitate athletes prior to return to their sport and to reduce the potential recurrence of injury.

DISCUSSION AND CLINICAL APPLICATION

The literature presented in this review reported the positive effects of incorporating a sport-specific, dynamic intervention approach to an athletic patient population resulting in reduced recurrence of injuries. Comfort et al[10] reported a 7% decrease in recurrence of hamstring injury when tailoring the treatment and rehabilitation programs of athletes to their sport-specific demands. Findings of lower recurrent hamstring injuries were significantly less when agility and trunk stabilization exercises were compared to stretching and strengthening activities alone. In their prospective randomized comparison of two rehabilitation programs, Sherry and Best[9] also reported similar findings, suggesting a decreased likelihood of reinjury for an athlete participating in a progressive agility and trunk stabilization intervention group. Results were recorded after return to their respective sport, at both the two-week and one-year time frame.

Although none of the studies directly mentioned the occupational health population, many of the same physical demands are shared in both sport and work settings. An understanding of sports athletes may be applied to the working population, which is required to meet physical demands in extreme conditions. The articles reviewed show the promise of positive clinical implications toward the plan of care for work-related reinjuries.

Following the review of these 4 articles, further research is still warranted in order to validate our suggestion of the effectiveness of dynamic intervention on reducing the risk of work-related reinjury in the occupational health setting. Understanding work-related movements and physical demands, while incorporating job-specific training, may result in faster conditioning and lower recurrence of injuries upon return to work. There is promise that applying the same dynamic intervention approach toward an occupational health population may elicit results similar to the athletic population.

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PERFORMING ARTS

SPECIAL INTEREST GROUP

President's Letter

Annette Karim, PT, DPT, OCS, FAAOMPT

Following CSM 2014, our PASIG leaders have been hard at work. Mandy Blackmon is compiling a list of clinicians by region to better link us together. Brooke Winder continues to promote evidence-based practice via our monthly citation blasts. Sarah Wenger is organizing dancer screens. Mark Sleeper is updating clinical sites. We have appointed Dawn Muci as PR/Marketing Chair, Mariah Nierman as Fellowship Task Force Chair, and Reginald Cociffi Pointdujour as Practice Committee Chair. If you are interested in participating in our leadership, please contact Rosie Canizares. CSM 2015 is coming! If you have an accepted poster or platform, you can apply for the student scholarship; contact Amy Humphrey. The PASIG course for next CSM will be very exciting and informative: Dynamic Neuromuscular Stabilization in Spinal Rehabilitation & Performance in the Performing Artist: a Look Through Lifespan and Level by Dr Clare Frank, PT, DPT, MS, OCS, FAAOMPT. We hope to see you there!

NEWS!

CHECK OUT THE APTA ORTHOPAEDIC SECTION FACEBOOK PAGE FOR PASIG MESSAGES!

We need case reports and original research papers that focus on clinical applications in caring for performing artists. Please contact Annette Karim if you are interested in submitting your writing to *Orthopaedic Practice*, the PASIG newsletter pages.

Effectiveness of a PNF Intervention on Active and Passive Range of Motion During "Développé á la Sécond" in Ballet Dancers

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INTRODUCTION

Flexibility and the ability to perform complicated body movements are among the most important physiological characteristics that characterize ballet dancers.[1] It is common knowledge that ballet dancers are more flexible than the general population and the time spent training this component is a priority in attaining professional standards.[1,2] Flexibility in dance is comprised of passive and dynamic components. Passive flexibility does not require muscle action of the muscles under stretch or their antagonists to maintain the position. Dynamic flexibility requires the dancer to use her own muscles to hold the stretch position for a specific amount of time without any assistance.[1,2] Therefore, without adequate specific dynamic flexibility, ballet dancers are unable to meet their performance requirements.[1] Investigations assessing flexibility outcomes in ballet dancers are scarce; meanwhile, the passive stretch is a training priority without sufficient evidence demonstrating improved performance. The most common single plane movements in ballet requiring a large amount of flexibility are hip external rotation, hip flexion, hip extension, spine hyperextension, and ankle plantar flexion.[1,2] Due to the nature of ballet movements specifically at the hip joint, which may have morphological limitations, ballet dancers need to overcome active and passive insufficiency throughout multiple joints.

Limiting factors take place primarily within biarticular muscles that limit the ability of holding positions for a prolonged period of time. Although great flexibility is considered an advantage for the ballet dancer, joint instability predisposes dancers to injuries.[2] Osseous structures, soft tissue, joint morphology, and intramuscular adipose tissue are among the hereditary components affecting flexibility.[3] It has been recognized that 85% of these flexibility components are intraarticular in nature, 10% muscular factors, and 5% general factors making the latter 15% highly trainable.[1] Imbalances between agonists and antagonists during ballet positions impair performance and could also increase the risk for injuries in dancers.[3,4] Improving strength could be a training modality used to enhance ballet performance and prevent injuries, but it has not been considered as a performance enhancement technique. The obstacle is the notion that performing strengthening exercises impairs flexibility while creating hypertrophy, which jeopardizes the look of the ballet performance.[4]

Determining the specific components to improve ballet performance during specific moves is imperative to help these performers reach their maximum potential. The "développé a la second" movement is comprised of hip flexion, abduction, and external rotation. The movement also requires use of antagonist muscles, such as hip internal rotators, extensors, and adductors to achieve extreme active ranges. The range of motion (ROM) during this dance move is limited, not only by the flexibility of these muscles, but also due to lack of muscle strength to hold the leg in such position. There are 3 main techniques to improve flexibility, namely static stretch, dynamic stretch, and proprioceptive neuromuscular facilitation (PNF). Static flexibility stretches have demonstrated a reduction in muscle power, vertical jump height, reaction time, and balance up to two hours following the stretching, making dance moves slower than expected.[1] Dynamic flexibility has shown greater outcomes in vertical jump height and balance,[5] but no advantage over PNF techniques.[6] The two most commonly used PNF variations to improved flexibility are contract-relax (CR) and contract-relax-agonist contraction (CRAC).[7] The effectiveness of PNF in improving ROM in several muscle groups has been widely documented.[8] Among the CR and CRAC techniques, CRAC has been found to be more effective in not only increasing flexibility, but also maintaining the gains obtained with training.[9] The purpose of this investigation was to evaluate the effectiveness in hip passive ROM and during a "développé a la second" maneuver of a twice-weekly PNF-CRAC intervention during 3 distinct ballet-specific positions. We hypothesized the group performing the PNF intervention would achieve greater flexibility in comparison to the control group.

METHODS

Participants

A total of 57 ballet dancers of both sexes between the ages of 12 to 25 years in beginner and intermediate technique levels were recruited from 3 ballet academies within the San Juan, Puerto Rico, vicinity (Table 1). Dancers were excluded from participation if they had suffered a low back or lower extremity injury within the last 3 months or had a history of low back or lower extremity surgery. Academies and their dancers were randomized into experimental (n = 34) and control groups (n = 23). Before participating in the study, academy directors and their dancers agreed to participate by signing an informed consent approved by the University of Puerto Rico Institutional Review Board.

Table 1. Descriptive Characteristics

Group	Age	*Years of training	Height (cm)	Weight (kg)
Control	15.39 ± 3.07	3.78 ± 3.55	161.44 ± 10.98	55.60 ± 12
Intervention	14.58 ± 1.33	6.12 ± 3.91	158.05 ± 7.78	49.34 ± 7.96

*$p < 0.05$

Instrumentation

The equipment used in this investigation was portable to allow the use of the same instruments in each setting. To measure weight and height, a Tanita weight scale (TBF-521, Tanita Corporation of America, Inc., Illinois) and a SECA stadiometer (S-213, Creative Health Products, Hamburg, Germany) were used, respectively. A fiberglass anthropometric Gluick measuring tape (M-22C, Creative Health Products, Inc., Plymouth, MI) was used to measure leg length. Passive range of motion was measure with an AcuAngle inclinometer (T-38, Creative Health Products, Inc., Plymouth, MI). To assess functional range of motion we used a consumer video recording camera (60 Hz) and Dartfish Pro Suite software™ (Dartfish, Georgia).

Procedures

After subjects consented to participate in this study, we proceeded to assess the day-to-day reliability of passive ROM measurements (Figure 1) of the tester (CCG) visiting the ballet academies. Range of motion measurements were randomized for each participant before testing. Passive ROM measures were performed per standardized procedures depicted in Figure 1. Day-to-day reliability values were good (ICC ≥ 0.80) for all passive ROM measures. Once reliability was established, the tester proceeded to perform all baseline measures in each academy. Each participant filled out a demographic questionnaire before ROM testing. Each participant performed their regular warm-up within their training session. Passive ROM and functional ROM measurements were randomized for each participant previous to data collection. Passive ROM measures were performed as previously described. Functional hip ROM was measured during a "développé a la second" maneuver. A spherical marker was placed in the anterior superior iliac spine and mid-patellar regions. Participants stood up close to the bar and performed the maneuver in a passive and active manner (Figure 2). The passive functional ROM was operationally defined as performing the maneuver and holding the leg with their arms at their highest point (Figure 2A). Active functional ROM was operationally defined as performing the maneuver and holding the leg unassisted (Figure 2B). Participants were videotaped 3 times while performing both maneuvers and the average of 3 trials was considered for analysis. The angle formed between the stance and extended leg was operationally defined as the

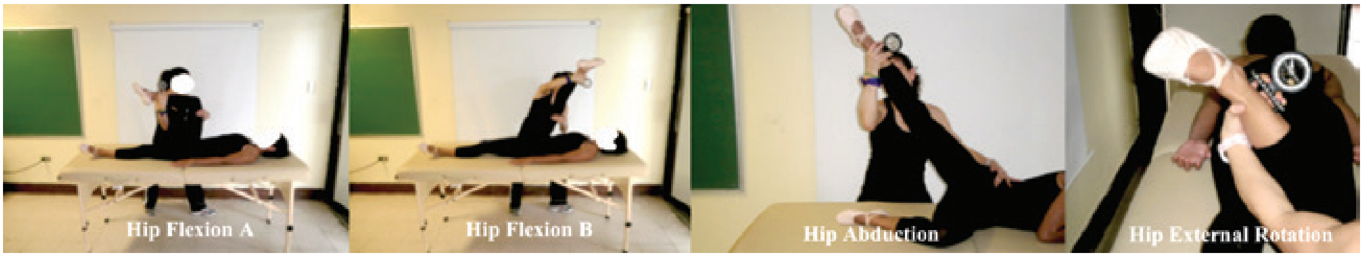

Figure 1. Passive range of motion measurements.

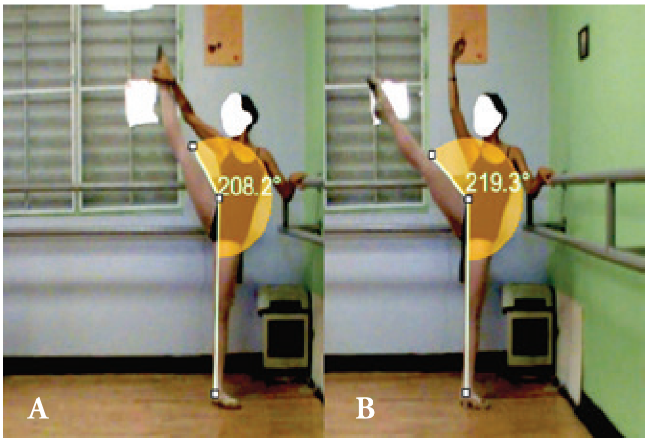

Figure 2. Functional passive (A) and active (B) range of motion. The ROM measured through Dartfish™ was subtracted from 360° as the software by default starts circular ROM measurements from the top. For example: in figure A, passive ROM was 152° and 141° active ROM in figure B.

functional ROM (Figure 2). To estimate this functional ROM the number obtained from Dartfish was subtracted from 360°. This calculation needed to be performed given the Dartfish software by default starts counting circular joint angles from the top starting at 0°.

Proprioceptive neuromuscular facilitation intervention

The CRAC PNF intervention was performed twice a week for a total of 8 weeks. Each ballet-specific stretching position was performed on a mat a total of 3 times with a specific contraction and rest interval (Figure 3). The specific stretching positions were: the transversal split (Figure 3A), the sagittal split (Figure 3B), and the "froggie" (Figure 3C), stretches typically done by ballet dancers. From the first to the fourth week, the following sequence was followed: 10-second static stretch in the specific position, 6-second contraction against the floor, two seconds relaxation, 6 seconds antagonist contraction trying to lift legs from floor, and 15 seconds stretch holding the reached position (10-6-2-6-15). From the fifth to the eighth week, the sequence was progressed to a 10-10-2-10-15 order.

Statistical analyses

All variables met assumptions for normality and homoscedasticity. Descriptive statistics were calculated for all ROM variables. T-tests were used to compare groups at baseline. A 3x2 ANOVA was used for time by group comparisons. Given the t-test analyses revealed statistically significant differences in years of experience and ROM between groups with the experimental group showing more years of experience and greater ROM, an ANCOVA with a priori alpha level of 0.05 using baseline differences as covariates was used as the main statistical analysis to compare the effectiveness of the intervention. Tukey post-hoc comparisons were estimated when differences across time and groups where found to be significant.

RESULTS

From the 57 participants initially recruited, a total of 48 completed the study. Among the reasons for not completing the intervention were sickness, injury, and missing class on the day measurements were performed. None of these reasons were related to the intervention or measurement sessions. Detailed results for each variable are depicted in Table 2. An intention-to-treat analysis was performed using the last observation carried over.

Passive Assisted Range of Motion

The group by time interaction ANCOVA showed statistically significant differences ($p < 0.02$) for all 3 variables (flexion, abduction, and external rotation) with the intervention group exhibiting greater improvements over time. Post-hoc group comparisons for all 3 measurements showed statistically significant differences at both, fourth ($p < 0.001$) and eighth week ($p = 0.01$) follow-ups. Post-hoc time analyses for hip flexion and external rotation showed significant changes from baseline to both follow-ups in the intervention group and from baseline to the eighth week in the control group. Although the control group decreased their hip abduction ROM these changes were not statistically significant.

Functional Passive Range of Motion ("développé a la second")

Time by group interaction was significant ($p = 0.006$) with the intervention group showing improvements over time. Post-hoc group comparisons showed significant differences between groups at both follow-ups. Post-hoc time analyses showed statistically significant changes only in the intervention groups at the fourth ($p < 0.001$) and eighth week ($p < 0.001$).

Functional Active Range of Motion ("développé á la second")

The time by group interaction was not statistically significant ($p = 0.142$).

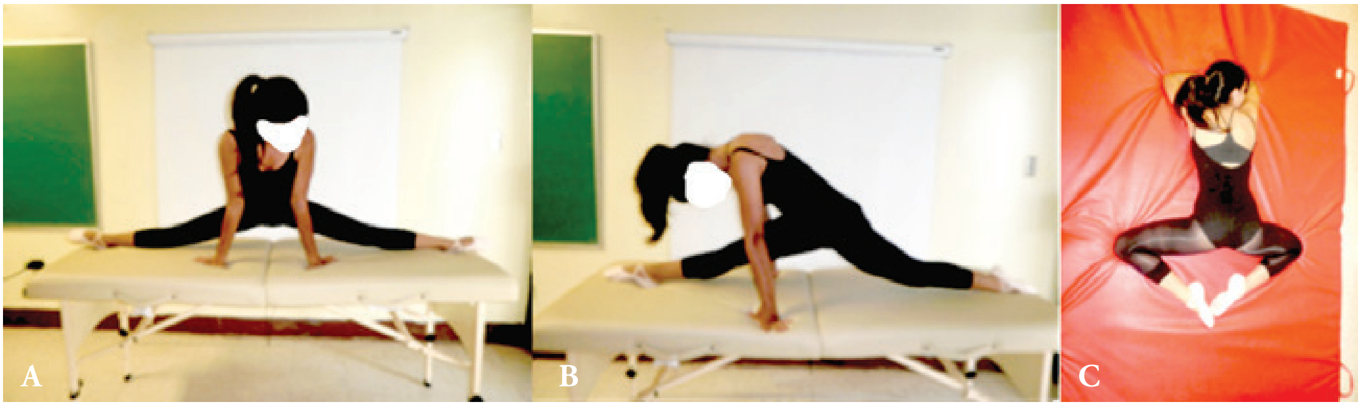

Figure 3. PNF-CRAC intervention. All exercises were performed on a mat placed on the floor of the training room.

Table 2. Outcome Measures

Group	Time	Passive ROM (º)			Functional ROM (º)	
		Hip Flexion**	Hip ABD**	Hip ER**	Passive**	Active
Control	Baseline*	120.63 ± 17.12	56.78 ± 9.19	61.48 ± 8.8	147.48 ± 17.88	100.80 ± 17.20
	4th Week	129.30 ± 16.30	53.57 ± 9.08	59.27 ± 6.52	148.59 ± 19.68	103.60 ± 19.81
	8th Week	132.22 ± 17.03‡	51.96 ± 6.04	56.96 ± 6.74‡	148.59 ± 17.02	105.27 ± 19.78‡
Intervention	Baseline*	130.55 ± 7.59	57.33 ± 6.43	54.61 ± 11.03	156.71 ± 8.96	120.37 ± 18.40
	4th Week	147.46 ± 10.99†	59.90 ± 6.49	64.62 ± 7.76†	161.32 ± 7.17†	124.54 ± 19.39†
	8th Week	144.08 ± 12.05‡	58.42 ± 4.72	63.00 ± 6.15‡	160.94 ± 7.69‡	127.48 ± 17.45‡

* Differences between groups at baseline ($p < 0.05$). ** Between groups differences at 4 and 8 weeks ($p < 0.01$). † Difference from baseline to 4 weeks ($p < 0.001$). ‡ Difference from baseline to 8 weeks ($p < 0.001$). Intention-to-treat analysis was performed by carrying over the last observation.

DISCUSSION

The results of this study supported our hypothesis that adding a PNF intervention to ballet training would improve both passive and functional passive ROM. Our results agreed with results reported by other investigators[10] showing that a PNF-CRAC intervention increased passive ROM in the lower extremities across multiple planes of movement. Even though the control group improved their passive assistive hip flexion ROM, the intervention group doubled their passive ROM over the control group in the first 4 weeks of treatment for all hip variables. Moreover, even though the improvements in passive ROM for hip abduction and hip external rotation where small in the intervention group, the control group decreased their ROM across time. These results support the notion that using a PNF-CRAC intervention helped reach higher levels of flexibility in a shorter period of time and protected against the detrimental effects of high training volume across time.

One of the greatest advantages of using PNF-CRAC is its functionality in improving ROM throughout specific movements. We used a "développé a la second" dance posture as a representation of functional ROM specific to ballet. Our results demonstrated that the elevation of the leg in this dance posture, while the dancer is holding the leg in its higher point could be improved by almost 5° passively and 8° actively when PNF-CRAC was combined within ballet training. Even though the intervention group exhibited doubled the functional active ROM than the control group, the differences between groups were not statistically significant. However, the increased of range of motion in the intervention group (+7.11°) could be considered clinically significant at this level of performance. We hypothesized that the lack of difference between groups for this measure was mainly related to muscle strength or the high variability exhibited by both groups. Several investigators[11-14] have suggested that ballet dancers need alternate methods of strength training to help with joint stability and reach desired dance postures. Therefore, if a strength training component would have been added to the intervention groups we could have hypothesized that the functional active ROM would have increased as well, because they could have been able to hold their legs with a lower difference than their functional passive ROM.

Limitations

Several limitations need to be considered before conclusions can be drawn. The biomechanical analysis performed using the Dartfish™ software was two-dimensional in nature. Therefore, no specific analysis in each of the 3 primary planes can be deducted, preventing our ability to determine the magnitude of improvement in specific joint ROM (ie, hip flexion, hip abduction, hip external rotation). However, the improvements reported in this investigation are evidence of functional or clinical improvements, given the complexity of ballet movements. Also, portable motion analysis technology allowed us to measure pertinent ballet-specific movements without the possibility of decreasing our sample size by asking participants to present at our 3-dimensional research biomechanics laboratory. Secondly, after the education session, the intervention was performed independently with minimal supervision of dancers within their academies. This could weaken the benefits of stretching specific soft tissues, such as ligaments over muscles, as dancers could present with different soft tissue restrictors to accomplish the desired ROM.[1] In addition, lacking the supervision of a trained clinician minimizes the effectiveness that appropriate feedback could have in technique by allowing the dancer to use undesired compensatory movements, predisposing them to injury.

CONCLUSIONS

Incorporating a CRAC PNF to regular ballet training seems to improve not only single-plane flexibility of targeted muscles, but also range of motion in ballet-specific movements such as "développé a la second." Physical therapy clinicians and researchers with the desire to enhance the performance of ballet dancers should attempt to attain outcome measures within the natural environments of ballet dancers in an effort to influence a greater number of participants.

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PAIN MANAGEMENT

SPECIAL INTEREST GROUP

President's Message

Dana Dailey, PT, PhD

I am new to the position of President of the Pain Management Special Interest Group. Over the years, I have seen an increase in membership of this group and an increasing presence in education regarding pain and the hard work of this group and its participants. Did you know we have over 400 members in the PMSIG?

To introduce myself, I currently spend part of my time as a clinician and part of my time as a pain researcher. Pain research can often be daunting to a therapist to read and apply. Pain management is a topic that is often viewed as a specialty, yet many clinicians deal with pain on a daily basis without a full understanding of pain. I believe the translation of research into clinic practice and the translation of clinic practice into research is becoming important and necessary for the benefit of our profession in both clinic activities and research activities. It is so important that these two areas come together and be able to integrate and benefit the other.

I would like to see the Pain Management SIG become a greater resource for clinicians as well as researchers. This may be accomplished through many avenues, including continuing education and research, as well as greater involvement in promoting and representing the work of our membership in both clinic activity and research activity.

As a clinician, my first questions are usually, "What brings you to physical therapy? and What are your goals?" As a researcher, my first questions include, "What is my research question? and What is my hypothesis?" So as a new President, my first questions to you are "What are your needs? How can the special interest group help you? What would you like to see as a mission and vision for our organization? What information would be helpful on our web site?"

My initial plan is to send out a survey asking these questions and more to get a better idea of your thoughts and considerations. I look forward to hearing from you soon. My contact information is listed below.

Dana Dailey, PT, PhD
President, PMSIG
dana-dailey@uiowa.edu

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Joel Bialosky, PT, PhD (2011-2014)

FOOT & ANKLE

SPECIAL INTEREST GROUP

Clinical Advantage: Making Your Own Temporary Foot Orthosis

Clarke Brown, PT, DPT, OCS, ATC
President, FASIG

Perhaps no other skill is more important to the foot and ankle specialist than the fabrication of a temporary foot orthosis. The foot orthosis, or shoe insert, has been shown to be a reliable intervention for multiple diagnoses, through a variety of mechanical mechanisms. Mastering the fabrication and fitting of a temporary custom foot orthosis (TCFO) further allows the clinician to adapt the device through clinical phases and for differing footwear. Most importantly, the TCFO can be used for short-term effect and as an inexpensive alternative to lab-made inserts.

Foot orthoses comprise a custom made insert or footbed fitted into a shoe. Orthotics provide support for the foot by redistributing ground reaction forces. They are used by everyone from athletes to the elderly to accommodate biomechanical deformities and a variety of soft tissue inflammatory conditions, and they are also used in the prevention of foot ulcers for the at-risk diabetic foot.

Origins of Orthotics

The evolution of foot orthoses began at least 2,000 years ago with underfoot shoe cushioning. Layers of wool were placed inside sandals to give relief to foot fatigue or strain. The first recorded use of a leather arch support orthotic, introduced by Everett H. Dunbar of Bridgewater, MA, dates back to 1865. The first full-fledged foot orthotic was known as the Whitman Brace, introduced in 1905 by Boston orthopedist Royal Whitman. About 1910, Dr William Scholl introduced a lighter, more flexible metal arch support known as the Foot-Easer. Over subsequent years, millions of pairs were sold. During the 1920s and 1930s, many shoe manufacturers began producing corrective shoes with built-in orthotic features, promising to prevent, relieve, or cure a wide range of foot disorders. This footwear became a major and lucrative part of the shoe industry.

Beginning in the 1960s, the steady introduction of lighter and stronger materials gave orthotics a new direction. Custom-made orthotics, fabricated via plaster casts, were offered to patients and became the staple of conservative foot-care by most all podiatrists. The principles of fabrication taught by Merton Root, DPM, (ie, neutral suspension casting) involved the creation of a positive cast model, balancing that model to correct for frontal plane forefoot to rearfoot deformities, and then molding the customized device to the corrected cast. This practice kept orthotic labs busy for decades.

Modern orthotics developed rapidly in the 1970s, with the phenomenal rise of athletic footwear and the jogging boom. As runners complained of assorted ailments, athletic shoes began incorporating orthotic devices or features: contoured sole inserts, flared heels, wedges, rear foot and forefoot controls, special traction sole designs, and especially underfoot cushioning. Materials for making orthotics evolved rapidly too, using assorted densities of foams and thermo-moldable polymers.

Today's Terms of Use

Today, the term foot orthosis may be accompanied by customized. While clinicians can still create a positive mold of the foot, and prescribe features to accommodate or restrict motion and enhance or reduce ground forces at specific areas of the foot, the customization suggests that the mold is still exclusive to that one foot. On the other hand, off-the-shelf (OTS) inserts are generic; a sort of generalized and perhaps computer-generated (CAD) device sold largely by foot size.

Recent research suggests that many foot conditions, such as plantar fascitis, may require only a brief period of orthotic use. Hence, the term temporary has appeared in the description of foot orthotics.

The appropriateness for the use of orthotics in a myriad of medical conditions and dysfunctions is no longer questioned, particularly for conditions such as plantar fascitis, patello-femoral pain, shin splints, arthritis, and Achilles tendonitis. The effectiveness of an orthotic in attenuating, altering, or controlling ground reaction forces is still a fertile area of research. Furthermore, the role an orthotic in reducing a patient's symptoms in the lower extremity is a practical clinical intervention that makes shoe insert fabrication an essential clinical skill. Physical therapists with knowledge and experience in orthotic fabrication should pass this expertise on to new PT graduates and students.

Fabricating the Orthotic

The purpose of the orthotic, to control or to accommodate ground reaction forces, should determine the materials to be used in concert with the posture and stiffness of the foot. In general, the rigid, cavus-type foot may require cushion and plantar force attenuation. The more flexible foot may need a stable foundation of stiffer materials. The molding of the foot can be nonweight bearing or weight bearing.

The following two techniques are examples of temporary orthotic fabrication.

1. Drake, Bittenbender, and Broyles[1] investigated the use of a temporary custom foot orthosis (TCFO) cast in a nonweight-bearing position, with the foot in plantar flexion and inversion, as a treatment option for plantar fascitis. During weight bearing, the orthosis simulates a heel lift and provides a stable base for the plantar fascia to rest through the stance phase of gait by preventing excessive foot pronation and decreasing load from heel to forefoot.

Aquaplast (Patterson Medical, Warrenville, IL) is heated in 160° F water using a hydrocollator or large electric skillet. With the patient prone, the softened material covers the heel and extends to the metatarsal heads. In this case, the foot is held in a position of inversion and plantar flexion. The soft Aquaplast is further stretched to allow for soft tissue spreading with weight bearing and final trimming will allow placement in the shoe.

2. Thermo-moldable plastics such as Orthoplast can be used to create an orthotic that can be adapted to almost any shape or purpose.

Molding can be done in partial or full weight bearing (Figure 1) once the material is softened in a hydrocollator (Figure 2).

The foot can be positioned relative to posture, neutral, plantar flexed or dorsiflexed, using low-density foam to impress the foot (Figure 3).

The Orthoplast can be thickened (doubled) for rigidity or heel height adjustment (Figure 4).

Once trimmed, grinding can optimize internal posting and fit (Figure 5).

External posts for further biomechanical control can easily be added with softened material (Figure 6).

Temporary foot orthotics are an essential tool for practitioners in an orthopaedic setting. Sulcus-length, full-contact inserts, with or without posting, may assist in an array of lower extremity cases including plantar fascitis and heel pain.

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Figure 1.

Figure 2.

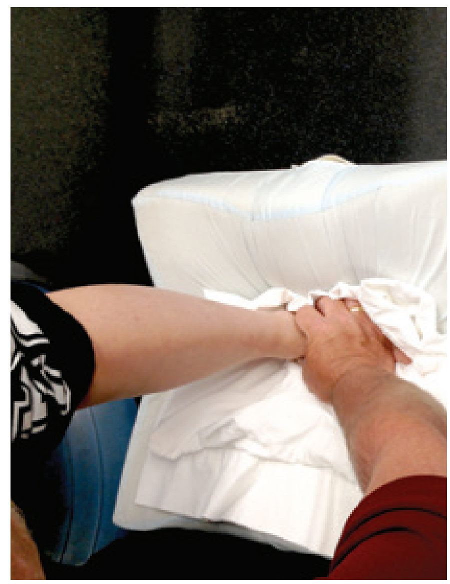

Figure 3.

Figure 4.

Figure 5.

Figure 6.

IMAGING

SPECIAL INTEREST GROUP

The Imaging Special Interest Group (ISIG) is pleased to report an update on current initiatives.

Survey of Physical Therapy Education

Our project to survey imaging in physical therapist education programs has been submitted for publication. We are hopeful for publication in the next few months.

Research Committee

We are excited to report our newly formed Research Committee is up and running with initial exploration of an NIH R13 Conference proposal. The Research Committee is comprised of:

George J Beneck, PhD, PT, OCS, KEMG, Chair
Daryl Lawson, PT, MPT, DSc
Murray E. Maitland, PhD, PT
Robert C. Manske, PT, DPT, SCS, MEd, ATC, CSCS
Chuck Thigpen, PhD, PT, ATC
Teonette Velasco, PT, DPT, OCS

Imaging Education Manual

We have a formed a Steering Committee to start writing the manual. The Committee is comprised of:

Douglas White, DPT, OCS, RMSK Chair
Bill Boisonnault, PT, DHSc, FAPTA
Bob Boyles, PT, DSc
Chuck Hazel, PT, PhD
Aimee Klein, PT, DPT, DSc, OCS
John Meyer, PT, DPT, OCS, FAFS
Becky Rodda, PT, DPT, OCS
Rich Souza, PT, PhD
Deydre Tehen, PT, PhD, OCS

Call for Imaging Submissions

The Imaging SIG is soliciting submissions for publication in this space. Types of submissions can include:

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

Submissions should be sent to John C. Gray, DPT, FAAOMPT, Publications Editor at jcgray@san.rr.com.

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Gerard Brennan, PT, PhD – Orthopaedic Section Board Liaison

Use of Magnetic Resonance Arthrogram to Diagnose Cam-type Femoro-acetabular Impingement (FAI) in a Professional Basketball Player

Alexis Ortiz, PT, PhD, SCS, CSCS[1], Toni Roddey, PT, PhD, OCS, FAAOMPT[1], Luis Rivas, PT[2]

[1]School of Physical Therapy, Texas Woman's University, Houston, TX
[2]Parker University, Dallas, TX

A 29-year old male professional basketball player (200.6 cm; 106.1 kg) was referred to physical therapy due to complaints of right anterior hip pain, which began two weeks prior to his physical therapy evaluation. His pain had worsened with any kind of physical activity, including basketball training. He initially noticed pain in his right hip at the end of the previous season, but was able to finish his season despite pain. He started changing his pre-season conditioning due to pain. He began yoga and hip stretches in an attempt to relieve symptoms. He also reported the inability to perform his main leg strengthening exercises, such as leg press and squats, due to pain and he felt this was limiting his performance. He also experienced pain and a "clicking sensation" during right hip flexion from a hyperextended position, and sharp pain radiating to his right knee after landing from a jump and during twisting/cutting maneuvers. His primary care physician prescribed pain medications, with no relief noted.

During examination, hip strength was normal without tenderness to palpation. During passive hip internal rotation range of motion in supine with the hip flexed to 90˚, he exhibited exquisite pain and decreased hip motion, compared to the unaffected side. Other hip impingement tests such as flexion-adduction internal rotation (FADIR) were also positive. Due to pain severity and restricted motion in internal rotation, the referring physician was consulted to discuss the potential for imaging. Subsequently, magnetic resonance imaging (MRI) was completed, which revealed effusion of the right hip joint, a mild gluteus maximus tear, but negative for a labral tear.

His symptoms continued to worsen making him unable to perform basketball drills and jumping/landing maneuvers. The physical therapist conferred again with the referring physician, and a magnetic resonance arthrogram (MRA) was ordered. Through the use of dye, MRA imaging demonstrates greater sensitivity in detecting intraarticular pathology in the hip.[1] Although MRI of the hip provides good information regarding soft tissue injuries, it does not provide secondary information concerning hip joint pathology.[2] The MRA has been shown to provide reliable and valid information for multiple hip pathologies with sensitivity and specificity values of 100% for the diagnosis of cam deformities when compared against arthroscopic exploration.[3]

In this particular case, the patient underwent an injection of 15 cc solution of gadolinium, saline, and 2% lidocaine under fluoroscopic guidance. Multiplanar and multisequential images were obtained with a 1.5 Tesla GE HDe Signa Magnet using an 8-channel, phase-array coil, including T1W and T2 fat sat sequences in tri-orthogonal planes, gradient echo 3-D with 1 mm spacing between slides. The MRA results revealed a subtle bump at the right femoral head/neck junction (Figure 1 and Figure 2), compatible with cam-type FAI. This condition is caused by an abnormal femoral head-neck junction, leading to abnormal abutment of the irregular femoral head against the normal acetabular rim, especially during the combination of hip flexion, adduction, and internal rotation.[4] Femoro-acetabular impingement can lead to the development of labral tears and degenerative changes such as osteoarthritis.[1,4] His conservative treatment included non-aggravating hip joint mobilizations, self-mobilizations, and hip stretching exercises. A multimodal approach including mobilizations, strengthening, and neuromuscular control exercises appears to be far superior than any one treatment technique leading to full return to sport participation an average of 4.5 weeks sooner.[5] Other studies have demonstrated the positive relationship between improving global and local muscle control in lower limb kinematics in this population.[6,7] Modifications to his training included limiting hip flexion to ≤ 90˚ in exercises such as squats and lunges. Modifications to basketball drills comprised primarily of dynamic warm-up exercises such as the warrior's pose to encourage dynamic mobility of the hip. After modifying aggravating activities, the patient was able to complete two seasons of basketball with minimal symptoms.

(Continued on page 212)

Figure 1. T1 axial magnetic resonance arthrogram of the patient's right hip, showing a subtle prominence of the femoral head/neck junction (white arrow), compatible with cam-type femoro-acetabular impingement.

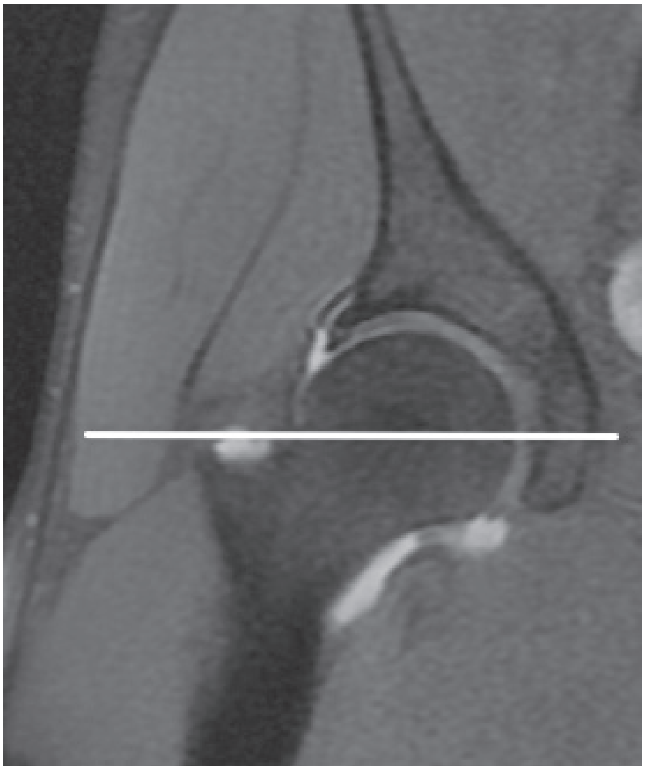

Figure 2. T1 coronal magnetic resonance arthrogram of the patient's right hip, demonstrating the location of the axial slice in Figure 1 (white line); the subtle prominence is not visible on the coronal slices.

ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

President's Message

Kirk Peck, PT, PhD, CSCS, CCRT

Continuing Education Reminder:

I am going to put this out there front and center…PLEASE consider attending the IAVRPT- 8th International Symposium. As mentioned previously the ARSIG is a **Silver Sponsor** for the *International Veterinary Rehabilitation Symposium* being held in Corvallis, Oregon, August 4-8, 2014, and the agenda looks great. Details about the Symposium may be found at the following: www.isvr2014.com.

ARSIG Updates

Recent activities by ARSIG Officers:

1. Revised content on the ARSIG web site, including goals.
2. Finalized details for the "special" 2-day canine rehabilitation CE course to be held in Springfield, MA, September 6-7, 2014.
3. Preparation for the ARSIG involvement in the Orthopaedic Section Strategic Planning Meeting to be held, October 15-17, 2014.
4. Continued discussions regarding a "new" practice analysis survey for distribution among all SIG members.
5. Generation of ideas for a "special" graphic logo to represent the ARSIG.

OPTP Submissions

I realize I sound like a broken record here but once again, I request all SIG members to please consider submitting articles for publication in OPTP. A key role of the SIG is to promote and advance the practice of animal rehabilitation, and by sharing clinical wisdom and knowledge, all SIG members can contribute to the cause.

At a minimum, a short paragraph or two on a clinical pearl related to evaluation or treatment techniques would be a wonderful way to share with others. Writing a brief critique or review of an interesting journal article or new book publication is another option. A little more extensive work ensues with writing case study reports or randomized controlled experiments, but I know some of you are directly involved in such work and your willingness to share with the SIG would be greatly appreciated. So please, I encourage everyone to consider adding to the body of knowledge in support of the SIG, and more importantly, to help "advance" the science of animal rehabilitation.

State Legislative Questions

The number of questions I receive pertaining to state laws and PT practice on animals throughout the country continue to grow. The following examples represent a few key issues I have personally responded to over the past several weeks.

1. *Question:* If state laws are "silent" on non-Vets performing animal rehabilitation, is it legal for PTs and PTAs to practice on animals?

   Answer: It depends on how legal authorities in state jurisdictions interpret scope of practice when language is non-existent. Some states might ignore the "silence" in legal language while other states have taken action, generally declaring that it is not legal for PTs and PTAs to practice without presence of explicit language.

2. *Question:* How can I tell if it is legal for a PT or PTA to practice on animals in my state?

   Answer: There are several sources to consult in answering this question. The first and most obvious resources are state practice acts for both physical therapy and veterinary medicine. Second, is to review regulatory language corresponding to statutory law. Regulatory language is generally where the details have been ironed out by professional boards and state health departments. Third is to check if there have been any official opinions rendered on the issue of animal rehabilitation by professional health boards or the state Attorney General. In addition, state Departments of Health might also have something on record in relation to animal rehabilitation. Finally, at the very least consult your state PT Association to see what they have on record. Minutes from many of the organizations and departments just mentioned can be found online…but you will have to do a little digging if you are not familiar with web searches for legal and regulatory documents. However, I urge everyone to explore state laws and know your legal limits before you get too invested.

3. *Question:* How do I go about legalizing animal rehabilitation for PTs and PTAs if the current scope of practice does not allow for treatment of animals?*

   Answer: First and foremost, you absolutely must consult your state PT Association to see where they stand on the issue. Support from Chapter Components is essential if state laws or regulations need to be changed. Second, determine exactly what laws or regulations need changed before taking action. You may also consult APTA State Government Affairs to discuss the laws in your state.

4. **Question:* What states have successfully implemented or drafted proposals to implement explicit statutory or regulatory language?
   a) Colorado/Utah/New Hampshire - PT Practice Acts.
   b) Nevada/Nebraska/Louisiana - Vet Practice Acts and Regulations.
   c) New Jersey/Kansas/Alabama - Bills or regulations have been proposed but not enacted upon to date.
   d) Arizona, Wisconsin, Florida, Oregon, Michigan, New York, West Virginia - States where no language exists, but inquiries about legal practice on animals have been received by the ARSIG President.

* *If you serve as a state legislative SIG liaison, or simply stay in touch with current state laws, please notify the SIG President of any updates that are not represented in the list of states above.*

California Veterinary Medical Board

The California Veterinary Medical Board (VMB) has tentatively rescheduled the public hearing on the proposed regulatory language to mandate "direct supervision" over all non-vets treating animals for October 21-22, San Diego, CA. The PTs and PTAs practicing in California may need your support to oppose the VMB language. Representatives from the ARSIG are planning to attend the Vet Board meeting to provide testimony.

All SIG Members

The SIG officers always welcome input from members. If you have any ideas or creative thoughts on how the SIG can better serve your needs, please do not hesitate to contact any of the officers listed on the website.

Summer is here; enjoy the moment!!

Contact: Kirk Peck (President ARSIG): (402) 280-5633 Office; Email: kpeck@creighton.edu

Numerical Lameness Score Intrarater Reliability, Interrater Reliability, and Validity in Canine Gait Assessment

Tammy Wolfe, DPT, PT, CCRP, GCFP

BACKGROUND AND PURPOSE

Among the types of canine gait assessment tools available, use of the force plate is clearly the "gold standard." However, because of financial, time, and space constraints, most veterinary and animal physical therapy professionals do not have the luxury of using a force plate to analyze the majority of their patients' gait patterns. In an attempt to create both more objective and universal communication between medical providers and to document progress in rehabilitation, several lameness scales have been created and used. The visual analogue score (VAS), the 0 to 5 lameness scale, and the 0 to 4 lameness scale are a few of the more frequently used scales to describe lameness and changes in gait of canine patients. The purpose of this study was to evaluate the intrareliability, interreliability, and validity of veterinarians and physical therapists using a numerical 0 to 5 lameness scale to assess lameness in dogs.

Previous reliability and validity studies have compared various aspects of lameness and various types of scales. One study compared clinician and owner VAS to force plate analysis in 9 dogs with a diagnosis of fragmented medial coronoid process and found that there was a minimal correlation between owner VAS and force plate analysis and no correlation between clinician VAS and force plate analysis when taken at one, two, 6, and 12 months postdiagnosis.[1] Another study assessed the validity of a VAS questionnaire for use in assessing pain and lameness in dogs. Forty-eight dogs with mild to moderate lameness were assessed by the owners using an analogue questionnaire with 39 questions. Only 19 of the questions showed moderate repeatability of > .6.[2]

A third study evaluated the agreement between numerical rating scales (NRS), VAS, and force plate gait analysis in dogs. In this study, 3 veterinarians with orthopaedic training rated lameness using the NRS and VAS before surgery, at 4 weeks, and at 8 weeks postsurgery. Interreliability was low with no significant relationships between any observer's scores and force plate data except in extreme lameness.[3] A fourth study comparing numerical gait analysis with force plate analysis before and after induced lameness in normal dogs showed a low correlation between scores obtained from vets with orthopaedic training and veterinary students and the force plate analysis.[4]

METHODS

In this study, 19 consecutive dogs arriving at a canine physical therapy office on a randomly selected day were videotaped by a third year physical therapy student with no canine experience. This was a double blind process, where neither the student nor the clients were aware of why they were being filmed. Two videos were recorded. The first video was from a lateral viewpoint and the second video was from a cranial/caudal viewpoint. Each video filmed the dogs walking 140 to 150 feet on a smooth surface.

Each video was numbered, transferred to a CD, and sent to 5 canine-certified physical therapists and 5 general practice veterinarians with the scale described as below:

0/5 = Normal gait pattern
1/5 = Mild lameness, needing a trained eye to see
2/5 = Moderate lameness with a normal stride length and partial weight bearing
3/5 = Moderate lameness with shorter stride length and partial weight bearing
4/5 = Severe lameness with toe touch weight bearing and minimal use of the limb
5/5 = Nonweight bearing

The physical therapists and veterinarians returned the score sheet. In 6 to 8 weeks, they received another CD with identical videos in a different order. They scored each video again and returned the score sheets.

RESULTS

Intrarater reliability and interrater reliability were zero to moderate. The highest intrarater correlation was .84 and the lowest was .26. And the median was .47 when all 10 evaluators were considered. The physical therapist group intrarater reliability was a moderate .58 and score correlation in the veterinarian group was a low .37 correlation. Interrater reliability was based on the number of dogs that everyone in the group scored identically. Among the physical therapists, the score correlation was a low .16, and among the veterinarians, the correlation was zero.

DISCUSSION

In previous studies, several types of lameness scales were compared over a period of time and the lameness score of each dog in the study could have changed. In an attempt to limit variables, this study did not compare different gait samples over a period of time and did not attempt to compare different types of lameness scales to each other. The idea behind the study was that, even if lameness scoring varied from person to person, if the intrarater reliability scores were high, at least documentation of a single medical professional would be reliable in showing changes in lameness over time. This hypothesis proved to be false in this study. It is possible that orthopaedic-trained veterinarians may have scored higher in both intrarater and interrater reliability than general practice veterinarians. It is also possible that additional training in scoring may have increased the intra- and interreliability scores for all participants.

In conclusion, the veterinary profession continues to be primarily subjective in analysis of canine gait and lameness. The 0 to 5 scale does not appear to be a valid form of gait analysis for most individuals to use to show changes in gait or to use as an outcome measure. It can be, however, moderately valid to use when charting progress of an individual dog by one practitioner. A more valid universal, objective lameness analysis scale would be beneficial so that physical therapists and veterinary professionals can accurately document changes in lameness with confidence in the objectivity of their observations.

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