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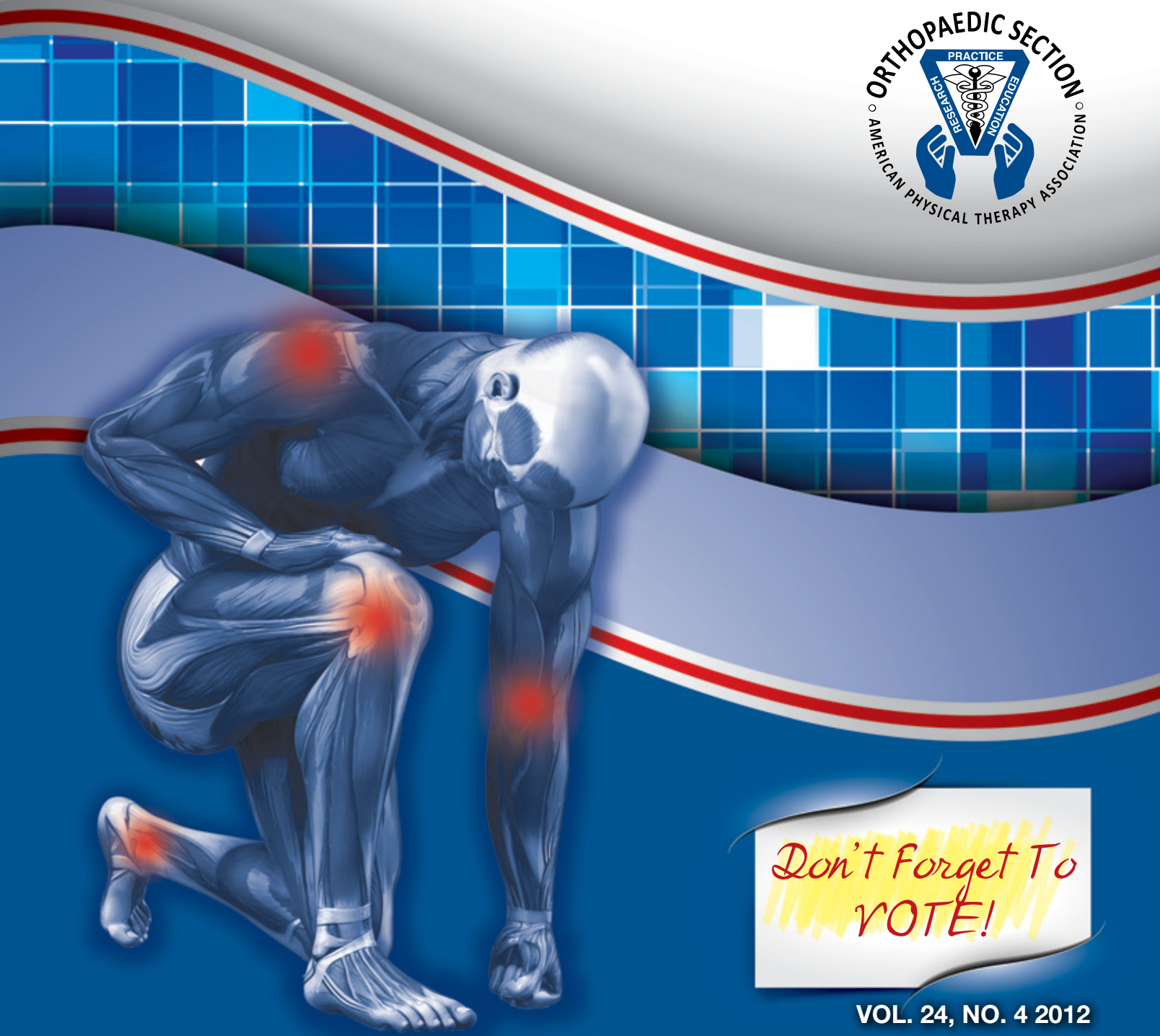

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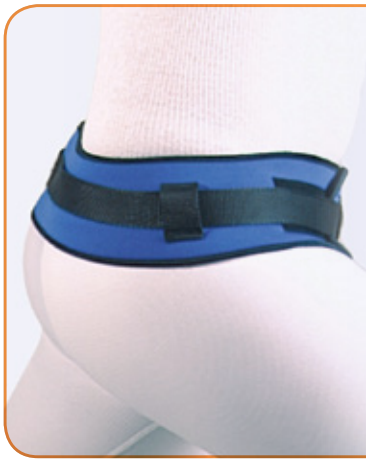

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ORTHOPAEDIC Physical Therapy Practice

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In this issue

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Editor's Note

To Stretch or Not to Stretch…Is This Really The Question?

Christopher Hughes, PT, PhD, OCS

As I was writing this editorial, the Olympics were drawing to a close. One can only be amazed at the high level of athleticism during the games and the beauty of human effort and geometry in motion. I found it most intriguing when the media played back activities in slow motion allowing a full appreciation of the neuromusculoskeletal engine at work!

Around the same time period as the Olympics, I had the pleasure of once again participating in our annual charity community/neighborhood softball tournament. In our minds (the majority of us being between 40-60 years old) we were still young, athletic, and Olympian and now had another chance to relive our sports glory days! Needless to say it didn't take long after the first game to realize that aging muscles and stiff joints have replaced supple young tissue. The brittleness of our bodies responded in an unforgiving manner to the dynamic rigors of softball. Ouch! As one of 3 physical therapists on the team, we were each willingly assigned the role of first aide during the tournament. What was the number one request? *"Hey can I get a stretch?"* As a professional who spends a great deal of time stretching and strengthening patients, it is an easy request to fulfill. After all, the dreaded muscle strain is no doubt the most common injury during these events for us "seasoned" players. As a proponent of stretching, I like to think that all this pregame/postgame stretching leads to more of us being able to get to work on Monday.

Ironically however, despite my empirical rationale, the literature continues to be somewhat divided on the utility of stretching. Some common questions remain. For example:

- Does stretching prevent injury?
- Does stretching improve performance?
- Does stretching decrease strength?

Each of these inquiries strikes at the heart of what we may confidently believe as an effective treatment. After all we often see measurable improvements in range of motion in our patients following injury and postsurgery. However, the interplay between a healing muscle strain and the regaining of normal fiber elongation and stiffness is difficult to monitor and far from an exact science clinically. Anyone who has worked with patients who have had a gastrocnemius or hamstring strain knows that the balance between letting the fibers mend and returning them back to a normal length without scarring and re-tearing is a delicate endeavor. The length tension relationship of multiarticular muscle function overlayed by a sophisticated neurologic input does not make things easy to know when enough is enough or too much is too much.

Past studies do show support that physical performance and injury risk can be altered by the performance of a pre-exercise (warm-up) prior to physical effort but the specific conclusions regarding stretching and defining ideal parameters (dynamic vs static, duration, frequency etc) for stretching remain elusive.[1-3] Some studies argue that stretching can be detrimental to strength or even have concluded that stretching has no bearing on performance.[4,5] In contrast, gastrocnemius stretching has been linked to improved ambulatory functional activities in elderly women.[6] Furthermore throwing athletes with internal impingement demonstrate greater glenohumeral internal rotation deficit and posterior shoulder tightness leading to the conclusion that management should include stretching to restore flexibility to the posterior shoulder.[7] Overall, the heterogeneity and poor quality of the available studies contributes to the lack of definitive conclusions as to the value of stretching for reducing the risk of exercise-related injury, and its effect on strength and performance.[8] One area that requires further research is the influence of stretch on the muscle's ability to withstand eccentric loading.[2]

In the era of evidence-based practice, we not only need to further investigate new types of treatment techniques but also be critical of current fundamental treatment methodologies. One thing I know for certain is that you won't see me flipping a 650-pound tire like swimmer Ryan Lochte! In the meantime, I do know that my teammates and I love the feeling of being stretched. Whether that effort leads to a reduction of injury or improved performance remains to be seen. However, I will continue to stretch not only because it makes me feel a little more "Olympian" but also stretching allows me to contribute annually to a great cause.

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President's Corner

James J. Irrgang,
PT, PhD, ATC, FAPTA

Happy New Year! As I have stated in previous President's messages at this time of year, I view the beginning of the academic year and the start of a new football season as the start of a new year. Refreshed after summer vacation, the new academic year and new football season is filled with excitement and optimism. The Orthopaedic Section Board of Directors had a meeting June 28th to 30th at the Section office in LaCrosse, Wisconsin. The topics of discussion centered on the strategic plans for the upcoming year. Based on these discussions, I have high levels of optimism and excitement for the upcoming year for the Orthopaedic Section.

FIRST ANNUAL ORTHOPAEDIC SECTION MEETING

On May 2nd to 4th, 2013, the Orthopaedic Section will hold its First Annual Meeting at the Marriott World Center in Orlando, Florida. An outstanding faculty has accepted an invitation to participate in this meeting. The meeting will focus on examination and treatment of the low back and lower extremity. In addition to keynote presentations, there will be concurrent sessions that will provide attendees with an option to choose the programming they want to attend. The concurrent sessions will include a combination of didactic lectures and hands on demonstrations with time for participants to improve their hands-on examination and treatment skills. The concurrent sessions for the low back will address manual therapy, exercise, movement systems impairment, and cognitive behavior approach to managing low back pain. For the lower extremity, the concurrent sessions will address hip and knee osteoarthritis, non-arthritic hip pain, ACL rehabilitation, and treatment of the foot and ankle. Attendees will have the opportunity to attend up to 3 concurrent sessions each day. We look forward to having you join us at the First Annual Orthopaedic Section Meeting, which will be an exciting advanced clinical education experience.

EDUCATIONAL OFFERINGS AND THE USE OF TECHNOLOGY

The Independent Study Courses offered by the Orthopaedic Section are an important educational resource for our members and they serve as an important source of non-dues revenue for the Section. These courses have been offered in a paper-based format and provide individuals with the opportunity to acquire continuing education units and to prepare for the Orthopaedic Specialist Certification (OCS) examination. The most popular of these is the Current Concepts of Orthopaedic Physical Therapy, 3rd edition, which many individuals use to prepare for the OCS examination. In the upcoming year, new Independent Study Courses that will be offered by the Section include: Orthopaedic Management of the Runner, Cyclist, and Swimmer; Applications of Regenerative Medicine to Orthopaedic Physical Therapy; and Physical Therapy Evaluation of the Animal Rehabilitation Patient.

While the paper-based educational offerings have been very popular, the Orthopaedic Section leadership believes that it is important to explore other methods to deliver educational opportunities from the Section that incorporate advances in technology and social media. To this end, the Orthopaedic Section has established a Technology Task Force that was charged to develop a comprehensive plan to expand the use of technology to enhance educational offerings and to offer new platforms for communication among Section members. Later this fall, the Task Force will be conducting a survey of Section members to determine their educational needs, the format(s) that are preferred to access educational materials and programs, and to determine how current electronic technology and social media could play a role in enhancing membership in the Section. To assist the Section with this task, you are encouraged to participate in the education and technology survey when it is conducted later this fall.

NATIONAL ORTHOPAEDIC PHYSICAL THERAPY OUTCOMES DATABASE

The Neck Pain Pilot Project for the National Orthopaedic Physical Therapy Outcomes Database (NOPTOD) was launched this past April. One hundred twenty-seven physical therapists from 82 facilities registered to participate in the pilot project. A webinar describing the pilot project including its purpose and procedures for collecting and reporting data was held and can be viewed at https://www.orthopt.org/login.php?forward_url=/content/c/national_orthopaedic_physical_therapy_outcomes_database?

Data collection for the pilot project will continue until the end of October. The results will be summarized and returned to the individuals who participated in the project so that they can review and improve their performance. Information that will be summarized will include compliance with recording of the data elements, clinical outcomes at the start and end of care, change in outcome during care, number of visits, type of procedures provided, accuracy of classification, and matching of treatment to the classification and outcomes of care when the treatment matches the classification compared to the outcome when treatment does not match the classification. After the results have been returned to those that participated in the pilot project, a survey will be conducted to determine the feasibility of data collection and the usefulness of the information in evaluating and improving the clinician's performance.

The results of the pilot project will be used to plan and determine the resources needed for an electronic data capture and analysis system for the NOPTOD. Ultimately, the NOPTOD will be a repository for clinical and process outcomes data for the most common conditions treated by orthopaedic physical therapists. In the upcoming year, we expect to develop a platform to allow for automated submission of outcomes information and to allow clinicians to generate reports that can be used to analyze their clinical performance. Additionally we plan to expand the project to include collection of outcomes data for other conditions commonly treated in an outpatient orthopaedic setting including low back pain, knee osteoarthritis, and shoulder impingement syndrome/rotator cuff tendinopathy.

CLINICAL RESEARCH NETWORK

The Orthopaedic Section has a long standing history of providing financial support for research. This has included the Orthopaedic Section Small Grants Program, which pro-

vides $15,000 to $25,000 grants to Section members to systematically examine orthopaedic practice issues to address the urgent need for clinical research related to orthopaedic physical therapy. To provide an opportunity for more Section members to be engaged in clinical research, this past year the Orthopaedic Section announced a $300,000 grant to support the development of an Orthopaedic Clinical Research Network. An important component to ensure success of the Clinical Research Network is active participation of any Section member who is interested in and committed to participate in the project. This will provide Section members who are interested in research, but do not have the resources to independently conduct a research project with the opportunity to participate in and contribute to important clinical research to advance the practice of orthopaedic physical therapy. The involvement of multiple clinicians and practices in the Clinical Research Network will enable projects to be completed efficiently and will enhance the generalizability of the results to practicing clinicians.

In response to the Request for Proposals, approximately 12 pre-applications were submitted, 3 of which were invited to submit a full proposal. At the time of writing this update, the full proposals are under review and it is expected that the funding decision will be announced later this fall. Once funded, Orthopaedic Section members interested in participating will have the opportunity to learn more about the project and to consider participation in the project.

IMPORTANT SECTION DECISIONS

In January, Bill O'Grady and I will complete our terms as Director and President, respectively. We have greatly enjoyed the opportunity to serve the Section and its members. We hope you agree that our actions have contributed to the success and growth of the Section during our tenure and have positioned the Section to meet the future expectations of its members. It is now time to elect our successors. The Nominating Committee has prepared an exceptional slate of candidates and it is up to you to actively participate in the election process. We encourage you to learn about each of the candidates and to cast your vote during November. For the Orthopaedic Section to continue to be a leader in physical therapy, we need the willingness of well-qualified Section members like you to run for office and participate in the election process to elect the most qualified leaders.

Best wishes for the fall season. I look forward to seeing you at the 2013 Combined Sections Meeting in San Diego, January 21-24, 2013.

Cost of Acute Low Back Pain Management Using the Spinal Manipulation Clinical Prediction Rule with Primary Care Referral to Physical Therapy: A Case Report

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ABSTRACT

Study Design: Case Report. **Background:** Derivation and validation of a clinical prediction rule (CPR) to identify patients who present with low back pain (LBP) and demonstrate short-term improvements with spinal manipulation has been published. However, the effectiveness of manipulation in some randomized trials is controversial. Clinical practice guidelines reflect these conclusions with recommendations for and against manipulation.[13] Many clinical practice guidelines specific to physical therapy (PT) and systematic reviews of practice guidelines developed for primary care providers suggest adherence to an active approach for patients with LBP. Total costs of care for patients with acute LBP that satisfy a CPR have yet to be established. **Case Description:** A 24-year-old female was seen by a student physical therapist at a central Minnesota outpatient clinic for acute LBP lasting 12 days. The patient initially presented to her primary physician's office 10 days after the initial onset where she was immediately referred to PT for follow-up care that included lumbosacral manipulation. **Outcomes:** The patient's Oswestry Disability Index (ODI) score exhibited a significant overall improvement of 93%. The patient's Global Rating of Change (GROC) was reported as "a great deal better," or "6", and the patient's numeric pain rating scale (NPRS) score improved by at least 6 points, or 75%. The total cost for the patient's episode of acute LBP was $832.00. **Discussion:** In relation to clinical practice guidelines, the patient's clinical outcomes were more closely comparable to patients receiving adherent care; however, the patient's total cost was between both adherent and non-adherent care costs reported in the literature. Future research should investigate long-term costs for patients who receive lumbar manipulation for acute LBP in relation to lost time at work, need for medication, number of treatments, and costs related to imaging in comparison to clinical practice guidelines reported.

Key Words: acute, clinical practice guidelines, financial

BACKGROUND

Low back pain (LBP) is a common musculoskeletal complaint with an individual lifetime prevalence of 60% to 80%.[1] The complaint of back pain challenges the common cold for the frequent reason that individuals visit a physician's office.[2] In the United States, a 2002 survey found that 26% of adults reported LBP lasting at least one day in the past 3 months.[3] In 1998, patients with LBP in the United States were estimated to have incurred $90 billion in health care expenditures, with the majority of costs related to prescription medications, outpatient care, and office-based services.[4] This is 60% higher than patients without LBP.[4] Recently, there has been a push to manage these costs through clinical practice guidelines for physicians and other health care providers including physical therapists.[5-8] Physicians and physical therapists should be familiar with these clinical practice guidelines because individuals seeking care for their acute LBP are most often managed by primary care[2] and many receive physical therapy (PT).[9]

One common PT treatment for LBP is manipulation, although effectiveness in randomized trials is controversial.[10-12] Clinical practice guidelines reflect these conclusions with recommendations for and against manipulation.[13] Additionally, derivation and validation of a clinical prediction rule (CPR) to identify patients who present with LBP and demonstrate successful outcomes in short-term improvements with spinal manipulation has been published.[14,15] However, clinical practice guidelines specific to PT[16,17] and systematic reviews of practice guidelines developed for primary care providers[13,18,19] suggest an active approach for patients with LBP, including maintaining activity, promoting exercise, self-management education, and avoiding passive interventions such as bed rest or physical methods (heat/cold, ultrasound, electrotherapy, massage, etc),[20] to improve PT outcomes (fewer visits & lower cost of care).[21] Spinal manipulation, a passive intervention, for patients who satisfy a CPR has not been analyzed thoroughly for cost-effectiveness.

Although total costs for patients with acute LBP has been reported with use of clinical practice guidelines,[21,22] total costs for patients with acute LBP that satisfy a CPR has yet to be established. Therefore, the purpose of this case report was to examine practice patterns, outcomes of care, and report cost related to spinal manipulation for a patient with LBP who satisfied the criteria for a CPR. The secondary focus of this case report was to compare costs of a multimodal approach, including active and passive interventions, to clinical practice guidelines reported in the literature.

CASE DESCRIPTION

Patient History

A 24-year-old female was seen by a student physical therapist at an outpatient clinic for acute LBP of insidious onset lasting 12 days. The patient initially presented to her primary physician's office 10 days after the initial onset where she was immediately referred to PT. Both the outpatient clinic and the patient's primary physician are within a large central Minnesota health care system. The patient reported no history of LBP, and did not recall a specific event that

triggered the episode. The physician's examination revealed the patient's weight as 65.8 kg (145 lbs), height 1.7 m (66 in), BMI 23.4 (normal weight), blood pressure as 109/71, heart rate as 84 bpm, and pain to be 10/10 on the NPRS. With no direct spinal tenderness, negative straight leg raise, and sensation/range of motion (ROM) intact, the only significant finding in the physician's report was bilateral para-lumbar tenderness.

The physician identified the patient as an ideal candidate for the health care system's acute LBP protocol, which requires patients to meet 3 criteria that a task force identified through available evidence.[14,15,23,24] The patient must be between the ages of 18 and 65 years old, have no pain/radicular symptoms below the knee, and have an initial onset of less than 16 days in order to be immediately referred to PT. In the meantime, the patient was given Flexeril (Cyclobenzaprine) to use at bedtime for relaxation and Vicodin as needed for pain.

Upon arrival to the PT department, the patient completed a standard subjective history form, an Oswestry Disability Index (ODI), a Fear Avoidance Beliefs Questionnaire (FABQ), and a numeric pain rating scale (NPRS). The history form revealed the patient had difficulty with bending, driving, running, sit-to-stand, sitting, stairs, and getting into bed/turning over in bed, with pain mostly in the morning and pain at rest. She wanted to return to exercise including Pilates and running. The patient scored 58% on the ODI (severe disability), 40/96 on the FABQ, and 16/42 on the FABQ Work (FABQW) subscale. Here the FABQW score indicates she is not at an increased risk for not returning to work because she scored less than 25/42.[25]

The patient was alert, oriented, and sitting supported in a chair upon initial evaluation. Her history was consistent with the report of the referring physician, and she noted that the Vicodin and Flexeril provided some relief since seeing her physician two days prior. The patient rated her current pain in the central lumbar region as 8/10 on the NPRS. Following PT intervention, the patient wanted to decrease her pain, increase her mobility and return to exercise/work without pain.

Examination

The patient was alert and oriented to person, place, time, and situation. Other than her slight forward head posture, her biomechanical alignment while standing was unremarkable as viewed in the three primary planes. The patient's lumbar flexion was limited to the extent that she could not touch her toes due to significant pain in the left central lumbar region, whereas she could touch her toes prior to onset. Side bending and extension movements were uninhibited, with less intense pain noted in the same location. Single leg stance, used as a balance screening measure, was negative as the patient was able to maintain balance on one leg for 30 seconds bilaterally. Seated forward flexion testing revealed a malaligned sacrum, which was evaluated as a left on right backward sacral torsion.

The patient's biomechanical alignment while supine was also unremarkable with bony landmarks level from left to right and lower extremities even in length. The straight leg raise, iliac spring test, hip scour test, sacroiliac (SI) thigh thrust, SI distraction, Gaenslen's test, and Faber's test were negative bilaterally while in supine. On observation and with palpation, the patient exhibited difficulty with transverse abdominis activation and bridging from supine that indicated a lack of core stability. The patient had greater than 45° of hip internal rotation bilaterally. The sidelying SI compression test was negative for SI pathology. The patient was very guarded in her movements while moving from supine to sidelying to prone.

While in prone, the femoral nerve stretch and the sacral thrust were negative. The patient's lower extremities were even in length and bony landmarks were level from left to right. Posterior-anterior (PA) glides were positive for hypomobility at L2–5 and pain reproduction at L4-S1. Piriformis and left lumbar paraspinal tenderness was identified through myofascial assessment techniques.

Evaluation

The primary physician referred the patient to PT in accordance with the health systems acute LBP protocol. The patient was screened for lumbar manipulation using a previously published CPR.[15] According to Flynn,[15] the CPR consists of 5 variables presented in Table 1, duration of symptoms < 16 days, at least one hip with >45° of internal rotation, lumbar hypomobility, no symptoms distal to the knee, and an FABQW < 19. Her FABQ score of 40/96 and 16/42 on the FABQW are under the cut-offs for increased fear avoidance beliefs. The patient met all 5 variables for lumbar manipulation (see Table 1); although, the patient also had pain with S1 posterior to anterior glides and presented with a left on right backward sacral torsion.

Although seated forward flexion testing has a high specificity to rule in sacral torsion (0.93, 95% confidence interval), it is not highly associated with the source of a patient's low back pain (9.9% frequency & 1.52 odds ratio [0.63, 3.64]).[26] As a result, SI pathology was ruled out. Sacroiliac joint pathology was further ruled out as the cause of LBP in conjunction with Laslett's diagnostic algorithm for SI joint pain using SI joint provocation tests.[27] The sensitivity to rule out SI joint pathology with 5 negative tests was not reported in the study; however, even if the patient had tested positive on one of the 5 tests, the sensitivity to rule out SI joint pathology would have been 1.00 (95% confidence interval).

Delitto's Treatment Based Classification for LBP[28] was used to evaluate the patient's presentation and to direct the patient's course of treatment. Since the patient's pain location did not change with movement, and she had painful, restricted flexion during lumbar motion testing, the patient fell into the category of noncapsular restriction without lateral shift. The patient's flexion was restricted to a greater degree than her extension. This finding, alongside the lumbar manipulation CPR, and her lack of stability, suggested that an opening manipulation of the lumbar facets followed with a stabiliza-

Table 1. Clinical Prediction Rule Criteria Compared to the Patient's Examination

Criteria	Patient
<16 days	12 days
>45° Internal rotation in one hip	>45°
Lumbar hypomobility	L2-L5*
No symptoms distal to the knee	none
FABQW <19	16

FABQW – fear avoidance belief questionnaire work subscale, *Posterior-anterior glides positive for hypomobility at L2-L5

tion program might be helpful during the course of treatment.

Diagnosis

The International Classification of Functioning, Disability and Health (ICF) is a useful tool to assist with understanding the patient's impairments, activity limitations, and participation restrictions.[29] The patient's impairments consisted of decreased lumbar mobility, increased pain, and decreased abdominal recruitment including the transverse abdominis. Her functional limitations included difficulty with sleeping, sitting, negotiating stairs, sit-to-stand transfer, and running. These functional limitations affected her participation as she reported self-restricting herself from Pilates exercise classes and running for exercise. The patient had difficulty driving to get to school/work and found alternative forms of travel necessary. Additionally, the patient reported that pain had restricted her social life and that her normal night's sleep was reduced by less than one-half.

Overall, the patient's clinical findings were consistent with her referring diagnosis. The patient had impaired lumbar ROM and lumbar pain resulting in the inability to sit or perform a sit-to-stand transfer without pain, negotiate stairs, or run. The *Guide for Physical Therapist Practice (Guide)* classifies a patient with lumbago (ICD-9 724.2) into practice pattern 4E, "Impaired Joint Mobility, Motor Function, Muscle Performance, and ROM Associated With Localized Inflammation."[30] The major criteria for inclusion in practice pattern 4E is the patient's "abnormal response to provocation"[28] with pain reproduction during posterior to anterior glides at L4-S1. According to both the Treatment Based Classification for LBP[28] and the CPR,[15] the patient was classified as a candidate for lumbar manipulation.

Prognosis

Flynn et al[15] suggests that patients meeting 4/5 or 5/5 of the variables for the CPR increase the likelihood of success (defined as > 50% improvement in ODI from initial to final) with manipulation from 45% to 95%. According to the *Guide*, practice pattern 4E suggests a course of treatment lasting up to 2 to 4 months with 6 to 24 visits;[29] however, when considering this particular patient's increased likelihood of success, a shorter course of care was more realistic.

The patient's plan of care consisted of an opening manipulation of the lumbar facets, instruction in supine abdominal bracing exercises, supine ROM exercises including knees to chest stretch and piriformis stretch, and instruction to maintain usual activity level within the limits of pain. The proposed frequency/duration of the plan of care consisted of 2 to 4 sessions total, 1 to 2 sessions per week, for 30 days. Anticipated goals and expected outcomes were a collaborative effort of the therapist and patient including: (1) resume previous sleep pattern without awakening due to symptoms in one week, (2) able to sit with minimal to no symptoms for any period of time during school/work in two weeks, and (3) initiate return to sport specific activities including Pilates/exercise with minimal to no symptoms in 4 weeks.

Figure 1. Position prior to regional SI thrust technique to lumbosacral spine also described in both the lumbar CPR derivation and validation studies.[14,15]

Intervention

The patient was informed that she met 5/5 criteria for the lumbar manipulation CPR. After educating the patient on her condition, planned therapy intervention, expectations from treatment, and relatively low risk of complications, the patient consented to treatment. During the patient's initial session, a high-velocity, low-amplitude thrust technique to the lumbosacral spine (two repetitions each direction while supine) was performed in accordance with the health care system's acute LBP protocol (Figure 1). Although not indicative of success,[31] cavitation was noted on the last attempt bilaterally. It should be noted that although an opening manipulation was indicated, the CPR described using the regional SI manipulation, and that an opening manipulation would have been chosen had the regional SI manipulation not produced the intended effects. The patient was then instructed in exercises appropriate for a home exercise program (HEP) for her condition[32,33] (Table 2).

A lumbosacral manipulation was performed during two follow-up sessions. No cavitations were noted during the second session, and multiple cavitations were noted during the third session. The patient's HEP was advanced during the second and third sessions (see Table 2). During each follow-up session, the patient was also asked to demonstrate the previous session's home exercise recommendations to test adherence to her HEP.

When determining the need for further lumbar manipulation during follow-up sessions, Flynn and colleagues used an ODI score of > 50% improvement to categorize patients as a success.[15,16] The patient was manipulated during the second session of PT because her ODI score improved by only 38%. The patient described in this case report was "successful" after the second treatment when she reported a 62% overall improvement on her ODI.

OUTCOMES

Outcome measures are presented in Table 3. The patients ODI score, categorized as a participation measure when using the ICF model, trended well during clinical management and exhibited an overall improvement of 93%. Additionally, the patient completed the GROC during the last session and stated that her overall condition is "a great deal better," or "6" when using the numerical listings. In relation to the patient's anticipated goals and expected outcomes, the patient partially met our first goal of resuming her

Table 2. Daily Home Exercise Program (Completed twice a day)

Exercise	Following Treatment 1	Following Treatment 2	Following Treatment 3
Knees to Chest Stretch	3 repetitions, 30 seconds each	3 repetitions, 30 seconds each	3 repetitions, 30 seconds each
Piriformis Stretch	3 repetitions, 30 seconds each	3 repetitions, 30 seconds each	3 repetitions, 30 seconds each
Abdominal Bracing	15 repetitions	Discontinued	N/A
Leg Fold Exercises With Abdominal Bracing	N/A	15 repetitions	Discontinued
Bridging With Abdominal Bracing	N/A	15 repetitions	15 repetitions
Quadruped With Unilateral Arm or Leg Lift With Abdominal Bracing	N/A	N/A	15 repetitions

previous sleep pattern without awakening due to symptoms in one week. She stated that her back would occasionally get "tense" while sleeping. The patient fully met both our second and third goals including being able to sit with minimal to no symptoms for any period of time during school/work in two weeks and initiating return to sport specific activities including Pilates/exercise with minimal to no symptoms in 4 weeks. Changes in the patient's impairments, functional limitations, and participation restrictions are summarized in Figure 2.

The total cost of the patient's episode of acute LBP is summarized in Table 4. The patient's episode of back pain used a physician's office visit, a PT evaluation, 3 units of manual therapy, and 4 units of therapeutic exercise. Charges for the aforementioned CPT codes were retrieved from the health care system's billing department. Since the patient had private insurance, average private insurance reimbursement was also retrieved.

Table 3. Outcome Measures

Outcome Measure	Initial Evaluation (Day 1)	Day 7	Day 12	Day 15
Oswestry Disability Index	58%	36%	22%	4%
Numeric Pain Scale	8/10	6/10	1-4/10	0-2/10
Global Rating of Change	N/A	N/A	N/A	+6 ("a great deal better")

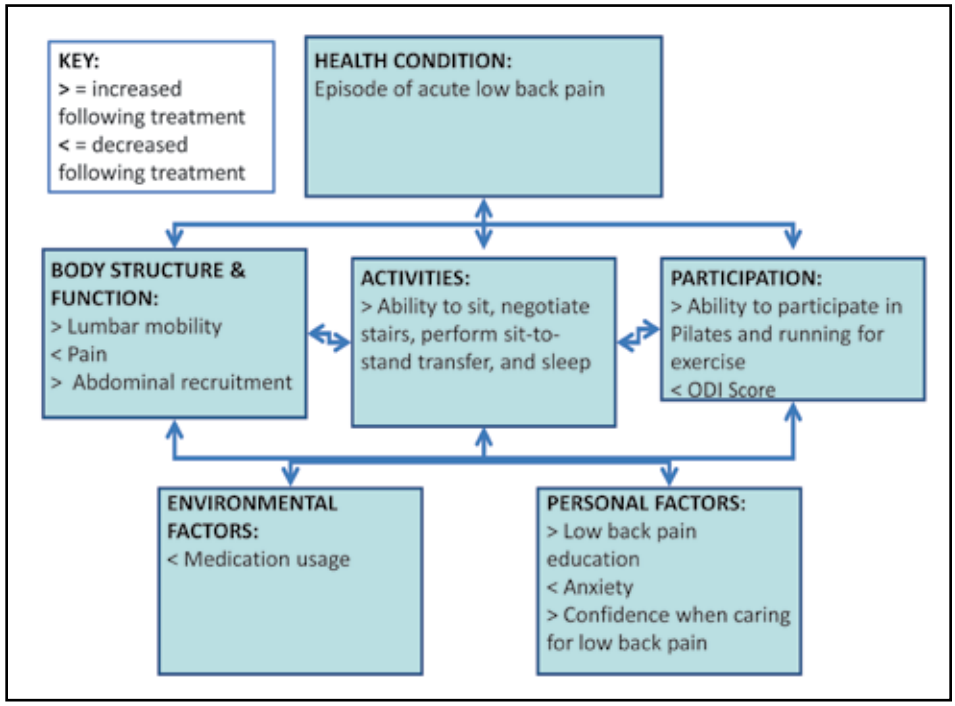

Figure 2. International Classification of Functioning, Disability and Health (ICF) Model changes with clinical management.

DISCUSSION & CONCLUSION

Manipulation for patients with acute LBP who satisfy a CPR has improved short-term outcomes;[15,16,21] however, total costs have yet to be established. Use of the CPR for the patient described in this case report follows evidence-based guidelines for patients with acute LBP. Based on the outcome measures used, the patient demonstrated improvements over the course of PT intervention.

The health care system's evidenced-based acute LBP protocol advocates for immediate referral to PT if a patient meets the 3 specific criteria previously mentioned.[15,16,23,24] Having an initial onset of < 16 days was an essential criteria for the patient's immediate referral to PT as it is the most accurate individual variable in the CPR, with a positive likelihood ratio for successful outcome of 4.4.[16] Jaesche et al[34] reports that positive likelihood ratios greater than 10 generate large conclusive shifts in probability, whereas values between 5.0 and 10.0 generate moderate shifts, and values between 2.0 and 5.0 generate small shifts in probability. Similar to how the patient's initial onset time was essential for referral, the fact that the patient met 5/5 criteria of the CPR was essential to the clinical reasoning behind manipulation. When a patient presents with 4/5 or 5/5 of the variables within the CPR at baseline, research indicates a positive likelihood ratio for successful outcome of 24.38.[15] This means that the probability of success with manipulation goes up dramatically, and further emphasizes the need for early access to PT.

The patient demonstrated clinically significant improvements over the course of PT intervention with all three outcome measures. Minimum detectable change (MDC) is defined as the amount of change required to be 90% confident that an observed change in score reflects a real change in the underlying variable.[35] The ODI's MDC has been reported in the literature as 10.5%, and possibly as much as 15%.[36] In addi-

Table 4. Health Care System's CPT Charges & Average Private Insurance Reimbursement

CPT Code	Name of CPT Code	Health Care System Charge	Average Private Insurance Reimbursement
99213	Physician's Office Visit	$144.00	$134.00
97001	PT Evaluation	$185.00	$133.47
97140	Manual Therapy (x3)	$207.00	$176.82
97110	Therapeutic Exercise (x4)	$296.00	$317.92
	TOTAL COST	$832.00	$762.21

tion, the ODI's reliability has been reported as r = .89 for a same-day test-retest.[37] The patient's overall change on the ODI went from 58% to 4%, which surpasses the MDC and thus indicates true improvement. Additionally, the patient's overall improvement of 93% from baseline using the ODI surpasses the successful outcome measure of 50% improvement from baseline on the ODI reported in the literature.[15,16] The GROC was another measure used to establish a successful outcome. Scores of +6 and +7 have been reported in the literature to indicate large changes in patient status.[38] The patient reported +6 "a great deal better," which indicates a significant improvement in the patient's status. Lastly, the MDC for the NPRS has been reported as two points;[39] the patient reported a change of at least 6 points, or a 75% improvement, which indicates a true reduction in pain.

Total costs for patients with acute LBP who satisfy a CPR has yet to be reported in the literature. The health care system's total charge to the patient for her episode of acute LBP was $832, including her physician's office visit and all PT related charges. On average, the health care system is reimbursed $762.21 by private insurance companies for these charges. The discrepancy of $69.79 is either charged to the patient as an "out of pocket" cost or eaten by the health care system for the patient's episode of acute LBP.

In the validation study of the lumbar manipulation CPR, the researchers report some health care utilization improvements, but do not report total cost.[16] The researchers concluded that health care use among those receiving lumbar manipulation was decreased at 6 months posttreatment.[16] Additionally, a statistically significantly smaller proportion of individuals that met the CPR criteria, and received manipulation were seeking additional health care for LBP when compared to individuals who did not meet CPR criteria and did not receive manipulation. Although it would have been informative, it was not possible to collect 6-month outcome measures for this patient case report.

Clinical and financial outcomes can be discussed in comparison with clinical practice guidelines to realize how the patient in this case report builds on current literature. Fritz et al retrospectively collected clinical outcomes and financial data for patients with LBP who received two types of care within the Rehabilitation Agency of Intermountain Healthcare (IHC), a Salt Lake City based health care delivery system.[22] Patients who received care adherent to clinical practice guidelines were compared to patients who received non-adherent care. As mentioned, the clinical practice guidelines recommend an active approach including maintaining activity, promoting exercise, self-management education, and avoiding passive interventions such as bed rest or physical methods (heat/cold, ultrasound, electrotherapy, massage, etc),[20] to improve PT outcomes (fewer visits & lower cost of care).[22] The study defined adherent care as having a 3:1 ratio of active to passive codes for each phase (phase I – first two weeks, phase II – beyond two weeks).[22] Our patient's phase I ratio was 1:1 with 3 units of therapeutic exercise, and 3 units of manual therapy (spinal manipulation), while phase II was 1:0 with 1 unit of therapeutic exercise only. Patients who received adherent care had statistically significant fewer PT visits, lower charges, and greater improvement in pain and disability.[22] A comparison of outcomes among patients receiving adherent versus non-adherent care[22] and the patient reported in this case report is summarized in Table 5.

In comparison to the article published by Fritz et al,[22] our patient's care was relatively non-adherent to clinical practice guidelines, but included a multimodal approach of active and passive interventions. The pain and disability outcomes far surpass the averages of both groups however. Based on the above date, our patient's clinical outcomes were more closely comparable to patients receiving adherent care; however, the patient's total cost for her episode of LBP was between the two groups, and fell within the standard deviation of both groups.

If the reported low end for one episode of LBP with adherent care is on average $562.00, and the patient is seen on average for 4.6 sessions, it can be calculated that it costs $122.00 per session, whereas our patient's cost per session was $172.00 per session. Researchers found variation in average total expenses per episode and average number of visits based on geographic characteristics.[40] The mean expenditures per visit per episode for the Midwest was $151 while for the West, $113. This difference, although not statistically significant, may exemplify an underlying factor of higher costs per visit per episode of care in the Midwest. One factor that was statistically significant in the study was the type of setting; mean expenditures per visit per episode for an office-based setting (including the outpatient clinic) was only $118 while a hospital outpatient setting was $188. This suggests that hospital outpatient PT is more costly than office-based PT.

Another factor worth mentioning is manipulation of the patient on the third visit after she reached a >50% improvement following the second PT session. The day prior to the third session, the patient worked a 9-hour shift, and reported during the third session, "I could not move last night." She believed she did too many exercises after her 9-hour shift, but also reported that overall she was improving, as exhibited by her score on the ODI. A third session of lumbar manipulation was discussed with the patient as an option for her condition along with exercise intensity following a 9-hour shift, but undoubtedly added additional costs ($69 manual therapy charge & $74 therapeutic exercise charge at follow-up) to the patient's episode of care.

The purpose of this case report was to examine practice patterns, outcomes of care, and report cost related to spinal manipulation for a patient with LBP who satisfied the criteria for a CPR. It cannot be deduced that the patient's care was cost-effective or effective long-term, only that the patient's clinical and financial outcomes were discussed in comparison to similar patients with acute LBP reported in the literature. Although it has been reported in the literature that there is decreased health care utilization at 6 months with individuals that receive lumbar manipulation for acute LBP,[16,22] this case report is limited because long-term outcome

Table 5. Comparison of Outcomes between Patients Receiving Adherent versus Non-adherent Care[22] and the Patient Reported in this Case Report

	Visits to PT	Duration of Care (days)	ODI Improvement	NPRS Improvement	Total PT Charges
Current Patient	**4**	**15**	**93%**	**75%**	**$688**
Adherent Care	**4.6**	**25.4**	**53.7%**	**49.1%**	**$562**
Non-adherent Care	**5.9**	**29.7**	**37.5%**	**39.2%**	**$729**

measures were not reported.

In conclusion, the patient in this case report showed clinically significant improvements with the lumbar manipulation CPR for her acute LBP. Costs of a multimodal approach, including active and passive interventions, were compared to clinical practice guidelines reported in the literature. Future research should investigate long-term costs for patients who receive lumbar manipulation for acute LBP in relation to lost time at work, need for medication, number of treatments, and costs related to imaging in comparison to clinical practice guidelines reported.

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Differential Diagnosis of Medial Groin Pain

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ABSTRACT

Background and Purpose: This case report describes a 60-year-old male who presented with insidious onset of right medial groin pain for 4 weeks. The authors describe an interregional approach to resolving the hip pain by describing a clinical decision making approach to recognizing and treating referred pain from the lumbar spine. **Methods:** The patient was treated with a combination of repeated lumbar spine movements into extension, core stabilization, gluteal activation, and manual therapy. **Findings:** The patient's symptoms in the right groin were abolished and a hypothesis of referred pain from the lumbar spine to the right proximal adductor attachment was confirmed. **Clinical Relevance:** Since groin pain is a common complaint, physical therapists must study interregional relationships, continually looking beyond the immediate location where symptoms are reported to be most significant, in order to accurately determine the source and cause of patients' symptoms.

Key Words: clinical reasoning, differential diagnosis, groin pain, hip pain, lumbar spine

INTRODUCTION

Groin pain is a common orthopaedic problem accounting for approximately 10% of all sports medicine clinic visits.[1] The differential diagnosis of groin pain can be extremely challenging due to the complex anatomy surrounding this region.[1] A multitude of structures and conditions are potential sources of groin pain.[2] Among them are pathologies involving the hip joint (eg, osteoarthritis, labral tears, impingement, and avascular necrosis), pubic symphysis (eg, osteitis pubis), hip musculature (eg, flexor and adductor strains), abdominal musculature (eg, rectus abdominis strains), bursa (eg, greater trochanteric bursitis), and bone (eg, fractures of femoral neck and pubic ramus).[3] A majority of patients undergoing physical therapy for groin pain suffer from one of the aforementioned hip/pelvic conditions.[4,5] Recent studies have shown the prevalence of hip degenerative joint disease to be as high as 27%,[4] hip labral tears between 22% and 55%,[6-8] and trochanteric bursitis near 15%.[5]

Less common causes of groin pain include nerve compression (eg, obturator or lateral femoral cutaneous nerve entrapments), sports hernias, referred pain from abdominal viscera (eg, bladder, ureters, and kidneys), and referred pain from the lumbar spine.[2] Although rare, groin pain referred from the lumbar spine typically involves the L1 or L2 nerve roots, but may involve any of the first 3 lumbar spinal levels.[9] Compression of these nerve roots as a result of a disc herniation occurs in the majority of patients exhibiting groin pain of lumbar spine origin.[9] The point prevalence of symptomatic lumbar disc herniations among all levels is quite low, estimated between 1% and 3%.[10,11] Furthermore, the percentage of persons with "upper" lumbar disc herniations (ie, L1-2, L2-3, and L3-4) is even smaller, making up less than 5% of all people with lumbar disc herniations.[12,13] Focusing even more specifically on the upper two lumbar levels most consistent with groin pain, a study by Albert et al[12] found that 24 out of 140 patients with "upper" lumbar disc herniations exhibited the disc pathology at either L1-2 or L2-3. Additionally, a 2007 study[14] showed only 4 of 41 patients who had undergone surgery for single level disc herniations at either L1-2 or L2-3 had prior symptoms to the groin highlighting the rarity of lumbar referred groin pain.

Lumbar spine referral to the groin is often difficult to ascertain. Clinical signs and symptoms associated with referred lumbar pain to the groin region are highly variable and can even be misleading.[12] The clinical evaluation for possible neural involvement from the lumbar spine relies on a thorough patient interview and a comprehensive, yet detailed physical examination. The purpose of this case report is to discuss a patient with an insidious onset of groin pain combined with discrete clinical examination findings ultimately leading to a diagnosis of lumbar spine referred pain.

CASE DESCRIPTION

Patient Characteristics and History

A 60-year-old male was referred to physical therapy in 2010 with a groin strain. At the time of the physical therapy evaluation, the patient reported pain in the right proximal adductor region radiating slightly to the right medial groin (Figure 1). The pain was of insidious onset beginning approximately 4 weeks earlier with a similar prior episode of symptoms occurring 9 months prior. The patient rated his pain at worst as 6/10 and 0/10 at its least on a visual analog scale. He denied having pain while sleeping at night, but noted stiffness in the groin region during the morning. He complained of pain with sitting, standing, bending, squatting, walking, and lifting. Functionally he reported the pain limited his ability to pivot on his right leg, ascend/descend stairs, stretch the right hip into abduction, golf, and complete his workout regimen, especially repeated sit ups. Further questioning regarding the specifics of his workout regimen revealed the patient performed a primarily flexion based abdominal-lower back "core" routine. Previous treatment for the similar episode occurring 9 months earlier included nonsteroidal anti-inflammatory drugs and physical therapy focusing on hip adductor stretching and gluteus medius strengthening. Although he reported the prior bout of physical therapy

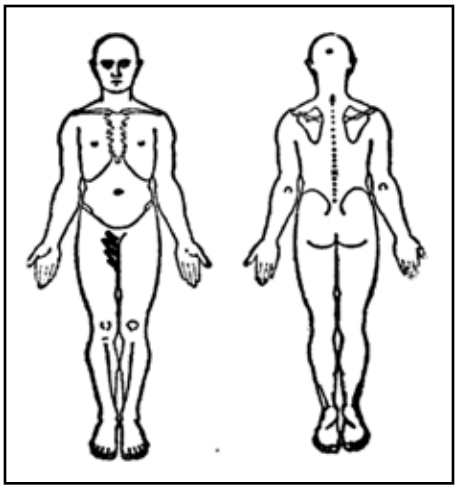

Figure 1. Patient's body chart from intake form.

was moderately successful, it did not fully resolve his symptoms. He subsequently had plain film radiographs taken of the right hip that revealed no significant bony abnormalities. Past medical history was significant for a lumbar discectomy at L4-5 in 2005 with post-surgical intermittent low back pain as well as ongoing paresthesia and weakness of the left gastrocnemius. The patient reported his left sided lower extremity symptoms were not related to his current right sided groin pain. An intake form was used to rule out non-neuromusculoskeletal pathologies as well as verbally clarifying any responses of concern.

Hypothesis

At the completion of the patient interview, a leading hypothesis of a possible lumbar nerve root compression linked to the past lumbar dysfunction and/or surgery was developed to explain all lower extremity symptoms. Our alternate hypothesis was that an internal derangement of the hip coexisted with a lumbar nerve root compression. Incorporating the SINSS model (Severity, Irritability, Nature of the complaint, Stage of pathology, and Stability) by Maitland,[15] the patient's symptom severity was deemed "low" since he continued to perform all ADLs and recreational activities, although with pain. Irritability was rated as "moderate" due to pain in the morning, increased pain intensity during routine activities, and symptom provocation with specific movements including spinal flexion and hip abduction. The nature of the complaint encompassed symptom location and the intermittent quality of the pain. The stage of the pathology was termed "acute on chronic" (flare up of a chronic condition) because the patient's 9-month episode and past lumbar surgical history preceded the current 4-week presentation. The patient's condition was deemed "stable" secondary to baseline symptoms consistently being reproduced to the same degree with specific activities.

The SINSS model has also been shown to help guide the sequence and length of the objective examination based on patient response.[15] For example, if the symptoms are very severe or tissues appear easily irritated with low level testing, then the remainder of the examination can be limited to only those few essential tests and measures necessary to provide a probable diagnosis. Similarly, if the early stages of assessment indicate low symptom severity and tissue irritability, the examination can be expanded to include all tests and measures needed to confirm a suspected diagnosis.

Table 1. Lower Quarter Neurological Screening Results

Screening Component	Element Tested	Right	Left
Myotome	Hip Flexion (L1-3)	5/5	5/5
	Knee Extension (L3)	5/5	5/5
	Ankle Dorsiflexion (L4)	5/5	4-/5
	Great Toe Extension (L5)	5/5	4-/5
	Ankle Plantar Flexion (S1)	5/5	3-/5
Sensation	Light touch	Intact	Decrease posterolateral calf/plantar aspect foot
Reflexes	Quadriceps (L3)	2+	2+
	Achilles (S1)	2+	0

Table 2. Sahrmann Lower Abdominal Testing[17]

Level	Position
Level 0	Supine with knees bent and feet on floor; spine stabilized with "navel to spine" (Base Position)
Level 0.3	Base position with 1 foot lifted
Level 0.4	Base position with 1 knee held to chest and other foot lifted
Level 0.5	Base position with 1 knee held lightly to chest and other foot lifted
Level 1A	Knee to chest (>90° of hip flexion) held actively and other foot lifted
Level 1B	Knee to chest (at 90° of hip flexion) held actively and other foot lifted
Level 2	Knee to chest (at 90° of hip flexion) held actively and other foot lifted and slid on ground
Level 3	Knee to chest (at 90° of hip flexion) held actively and other foot lifted and slid not on ground
Level 4	Bilateral heel slides
Level 5	Bilateral leg lifts to 90°

Physical Examination

Observation in standing revealed a well-healed postsurgical midline lumbar incision, a flattened lumbar spine, a horizontally oriented skin crease at the mid-lumbar spine termed a "transition zone" by Janda,[16] decreased gluteal tone bilaterally, and marked decrease of left calf muscle tone. A transition zone is defined as a "focal area of stress within the spine in which neighboring vertebrae change in morphology" and is commonly identified by a visible skin crease at a particular spinal segment.[16] Other postural findings included a 120° rib angle along with a poor, upper chest breathing respiratory pattern. A comprehensive neurological screen was completed to rule out the lumbar spine neuromuscular components as symptom generators even though according to Albert et al,[12] sensory, motor, and reflex testing can be variable and potentially misleading in suggesting a level of disc herniation (Table 1). During Sahrmann lower abdominal testing, the patient exhibited poor core activation as evidenced by his inability to complete level 1A abdominals[17] (Table 2). The patient's gait assessment revealed decreased bilateral hip extension and adduction range of motion, as well as a positive left Trendelenburg hip drop. All screening techniques were well tolerated by the patient (ie, low symptom irritability). The screening findings supported the initial hypothesis that the patient's left sided symptoms were of neuromuscular origin and possibly linked to past lumbar pathology/surgery; however, these same findings could not confirm the suspicion of lumbar referral to the right groin. To help rule out the hip and rule in the lumbar spine as the origin of symptoms, bilateral hip joints and the lumbar spine were screened (Table 3). A hip Scour test followed by an Anterior Hip Impingement test, placing the hip in combined flexion, adduction, and internal rotation (FADIR), was performed bilaterally yielding no greater pain than end range hip flexion alone. Posterior-to-anterior (PA) spring testing over the lumbar spine elicited pain at each segment and revealed global hypomobility. Straight leg raise testing was positive at 66° on the left producing left sided low back pain, whereas hamstring tightness was elicited on the right at 46°, but resolved with right ankle plantarflexion. Repeated movement testing of the lumbar

Table 3. Physical Examination Range of Motion Measurements at Initial Evaluation

Movement	Measurement	
Lumbar spine flexion AROM	22° *	
Lumbar spine extension AROM	15°	
	Right	**Left**
Hip flexion PROM	85° *	88°
Hip abduction PROM	15° *	24°
Hip internal rotation PROM	15°	25°
Hip external rotation PROM	22°	25°

Abbreviations: AROM, active range of motion; PROM, passive range of motion.

*Provocative of groin pain.

Note: Lumbar spine AROM was measured in standing using an inclinometer. Hip flexion and abduction PROM was measured in supine using a goniometer. Hip internal and external PROM was measured in supine at end range hip flexion using a goniometer.

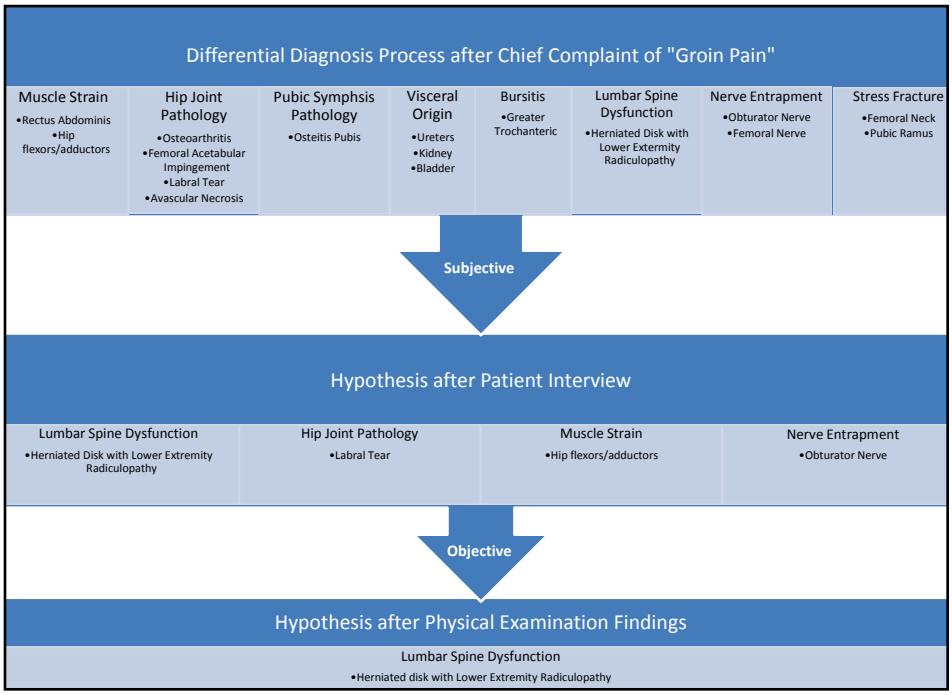

Figure 2. Differential diagnosis decision pathway (diagnoses ranked highest to lowest from left to right).

spine was then implemented following the standard McKenzie based progression to determine symptom peripheralization versus centralization. Centralization is defined as the process by which pain radiating from the spine to the extremities is sequentially abolished, distal to proximal in response to a particular movement pattern. The opposite symptom directional response is termed peripheralization. The McKenzie system was first recognized in the 1950s and has been well described in the literature.[18] Repeated standing lumbar flexion for 10 repetitions followed by a trial of 3 sit-ups (feet secured, flexion in supine) aggravated the patient's groin pain. Due to the patient's increased symptom irritability and intensity per the SINSS model criteria, the examination was curtailed allowing for one additional test. Repeated lumbar extension testing in prone was chosen and revealed significant limitation. After 10 consecutive active prone press-ups (PPUs) to lumbar extension end range were performed by the patient per the McKenzie method, lumbar and hip flexion were reassessed revealing complete abolition of groin pain. The elimination of the groin symptoms following the extension specific repeated movements of the lumbar spine in conjunction with the negative imaging and hip special test findings supported the hypothesis that the medial groin pain was referred from the lumbar spine rather than the hip (Figure 2).

Intervention

Since flexion biased motions were provocative and repeated lumbar extensions resolved all symptoms, an extension oriented treatment approach was initiated at the initial visit. In order to improve lumbar spine extension, this treatment approach incorporated PPUs with overpressure and PA grade III lumbar spinal mobilizations at levels L1-L5. As part of his home exercise program, the patient was instructed in PPUs and the McKenzie progression into greater degrees of lumbar extension. The patient reported improved symptom control throughout the day as well as abolition of the morning groin pain. Consistent with the centralization phenomenon, the patient reported developing lower back pain despite distal lower extremity relief. Core exercises to improve transverse abdominis control and stability in a neutral plane were implemented and progressed over the first two weeks as part of the comprehensive treatment plan (Table 4). These exercises included abdominal breathing, bent knee fall outs (Figures 3 & 4), and motor control heel slide progression (Figures 5-8). A sidelying clam exercise (Figures 9 & 10) was also initiated to improve gluteal muscle strength and coordination.

Although considerably improved, the patient reported intermittent right groin pain particularly during activities requiring hip flexion with a flexed spine. Such activities included placing his foot on a step in order to tie his shoes or stepping over a ledge while getting into his boat. Due to pain with active hip flexion, the psoas muscle was considered a possible contributing structure to the patient's groin pain. The psoas muscle originates from the lumbar vertebrae and is known to be a source of compression and anterior shear force production at the lumbar spine.[19] A Thomas test stretch combined with soft tissue mobilization to the psoas muscle was initiated to decrease tone and resultant lumbar spine shearing forces. Using this technique at home, the patient was able to eliminate his symptoms independently.

After 8 visits, the patient reported a significant reduction in the frequency of his groin pain, as well as improved tolerance to walking and bending. However, he continued to present with pain during lifting activities and sitting and standing greater than one hour. He also complained of pain in the proximal adductor region and medial groin with active hip flexion while sitting. Objectively, lumbar spine, hip abduction, and hip external rotation range of motion

Table 4. Specific Interventions During Course of Treatment

Intervention	Week 1-2	Week 3	Weeks 4-6	Weeks 7-9
ROM	PPU PPU with sag	Continue with PPU	Continue with PPU Added: AAROM hip flexion with towel Hand Heel Rocks	Continue with PPU Added: AROM hip flexion Progressed to seated hip flexion
Core Activation	Abdominal Breathing Pullovers BKFO Motor Control Heel slides	Added: Standing Thera-Band rows Standing Thera-Band extension Hook lying perturbations	Added: Standing crossovers Scaption on foam Thera-Band chest press on foam	Added: Bodyblade® with core Hip Hinging with cane Thera-Band rows with unilateral rotation
Gluteal Activation	Sidelying Clams	Continue with Sidelying clams	Added: Gluteus maximus over table	Addition: Leg press
Manual Treatment	Lumbar extension mobilization Grade III L1-L3	Continued mobilizations; Added Thomas test stretch	Continued prior manual treatment	Continued prior manual treatment

PPU=prone press-ups, BKFO=bent knee fall outs

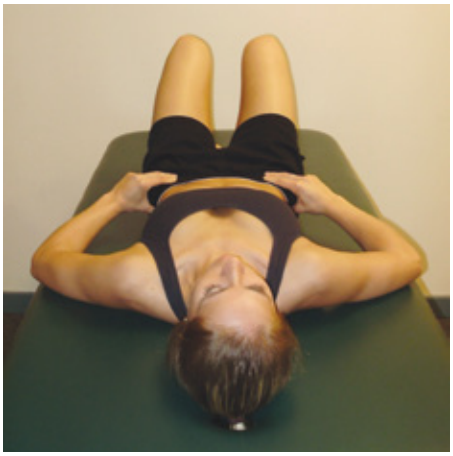

Figure 3. Bent knee fall out start position.

Figure 4. Bent knee fall out finish position.

improved (Table 5). Also, improvements in hip extension, rib angle, and subsequent gains in trunk motor control were observed.

Over the next 4 weeks, the patient continued to improve with walking tolerance, experiencing only two isolated symptom exacerbations. The first exacerbation of groin pain occurred while he attempted golfing. It was hypothesized that the flexion and rotational shearing at the lumbar spine during a typical golf swing may have caused him to reinjure his low back. The second exacerbation occurred when he stepped into his boat. This too may have been related to the lumbar flexion movement that had also produced similar symptoms in the clinic. Education on regularly performing PPUs was given and the patient was again able to completely abolish symptoms. At discharge, the patient rated his pain as 0 out of 10 at worst on the visual analog scale and he was able to ambulate without pain. He returned to golf without restriction and returned to full gym activities with modifications to his core program (ie, maintained pelvic neutral position and prevented loaded lumbar flexion).

DISCUSSION

Although there are many causes to hip pain, a focused hypothesis was garnered by taking a detailed subjective history as well as completing a comprehensive, but focused physical examination. Systemic and bony involvement such as hip osteoarthritis, femoral acetabular impingement, and avascular necrosis were ruled out on the basis of negative imaging, negative Scour test, current symptom description, and a past medical history significant only for spinal dysfunction. However, it is interesting to note that the patient met 3 of 5 hip osteoarthritis clinical prediction rule criteria: self-reported squatting as an aggravating factor, active hip extension causing pain, and PROM hip IR ≤ 25° increasing the probability of hip osteoarthritis being present from 29% to 68%.[20] Also, contrary to what both radiographic imaging and special testing revealed, hip PROM restriction in 3 planes has a 0.93 specificity for mild to moderate hip osteoarthritis being present.[21]

Muscular causes were initially ruled out by the subjective report of morning pain as well as negative symptom provocation with manual muscle testing. Therefore, the list of probable diagnoses was reduced to a hip internal derangement such as a labral tear, peripheral nerve entrapment, or lumbar referral. Internal derangement of the hip was deemed unlikely based on negative Anterior Hip Impingement testing, denial of clicking or popping which is the most consistent clinical symptom,[6,8] and the location of symptoms primarily over the proximal adductor muscle attachment. Although obturator nerve entrapment could not be completely ruled out, the patient's medial thigh symptoms were proximal to the area typically supplied by this nerve and the overall clinical picture provided stronger support for lumbar pathology. After correlating the patient's subjective complaints with the objective examination findings, it was concluded that lumbar spine referral to the groin was the most likely diagnosis.

The tests and measures in the objective examination were selected because of the specificity and/or sensitivity. Hip impingement and labral pathology were confidently ruled out because the Anterior Hip Impinge-

Figure 5. Motor control heel slide progression (level 0).

Figure 6. Motor control heel slide progression (level 0.3).

Figure 7. Motor control heel slide progression (level 2).

Figure 8. Motor control heel slide progression (level 5).

ment (FADIR) test's sensitivity ranges from 0.95 to 1.00.[22-25] But, rarely do special tests demonstrate both high sensitivity and high specificity so it is often necessary to use a combination of tests to improve the clinical diagnostic utility. For example, the straight leg raise has been shown to have relatively high sensitivity range of .72 to .97 yet a low specificity range of .11 to .66. The sensitivity of an observed motor deficit ranges widely from .10 to .70 but has a better specificity ranging from .54 to .99. A detected sensory deficit is more sensitive than specific, .66 compared to .51, respectively.[26,27] The variable sensitivity and specificity of these tests prevented us from ruling out the lumbar spine with confidence or confirming that the lumbar spine was the source of pain.

However according to two studies by Laslett et al,[26,27] 3 signs (eg, centralization phenomenon, presence of a directional preference, and moderate to major lumbar extension range of motion loss) exist that can help rule in lumbar spine involvement with a high degree of confidence. The centralization phenomenon has a specificity of .94 despite having a sensitivity of only .40 and likewise the presence of a directional preference has a specificity of .91 with a sensitivity of .41.[26,27] Furthermore, moderate to major lumbar extension range of motion loss is shown to have a specificity of .87 even though its sensitivity is only .27.[26,27] When combined, the centralization phenomenon and extension range of motion loss yield a positive likelihood ratio of 6.5.[26] The cluster of these 3 signs in conjunction with subjective reports of minimal pain irritability with hip testing, guided the hypothesis of lumbar spine referral.

The McKenzie progression was considered an important component of this patient's program. Based on a repeated movement assessment and positive findings for directional preference, an extension based progression was critical to successful management of the patient's symptoms. The McKenzie system has been shown to be a reliable system since the early 1990s.[18] Centralization, the hallmark feature of the McKenzie system, is not only a common occurrence, but predictive of good outcomes.[18,28] A literature review by Wetzel and Robinson[28] concluded that patients who demonstrated directional preference and who also experienced centralization of lower extremity symptoms to the lumbar spine had a high likelihood of success from conservative care, even when neurological deficits were present. Furthermore, a systematic review by Clare et al[29] revealed that the McKenzie method produces a greater decrease in short term pain and disability when compared to a variety of other treatments. However, limited data exists on long term disability levels when employing the McKenzie method alone.[29] Since the patient exhibited the two prognostic signs highlighted by Wetzel and Robinson,[28] the treatment based progression of exercises recommended by Delitto et al[30] was employed to relieve pain and restore full range of motion. Since 1997, the importance of identifying subgroups of patients with low back pain has been a top priority in low back pain research. Classification of patients exhibiting "non-specific" low back pain into distinct subgroups is essential to deliver specific and effective treatment. The patient in this case fit the extension oriented treatment approach criteria by demonstrating symptoms that peripheralized with lumbar flexion, symptoms that centralized with lumbar extension, and signs and symptoms consistent with nerve root compression.[30]

Due to intermittent recurrences of pain, a biomechanical assessment of motor control was completed, and it was discovered that the psoas major muscle contributed to the symptom generation. It is well known that the lumbar spine and hip are closely linked through muscle and ligamentous attachments. Because the psoas major muscle originates from the transverse processes of all lumbar vertebrae, this muscle can contribute to mechanical low back pain. Based on anatomic studies by Bogduk et al,[19] the psoas major muscle exerts an extensor moment at the upper lumbar spine and a flexor moment on the lower segments during erect standing posture resulting in an anterior shear and compression force. Also, the psoas major muscle is the prime mover of the hip into flexion. The relationship between the hip and lumbar spine is termed "regional interdependence" and can be defined as "the concept that seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with the patient's primary complaint."[31] By restoring normal lumbar flexibility and decreasing psoas

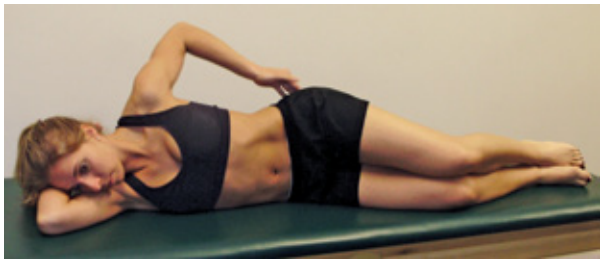

Figure 9. Sidelying clam exercise start position.

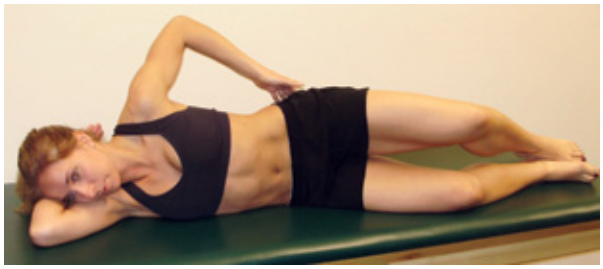

Figure 10. Sidelying clam exercise finish position.

major muscle tone, full pain free lumbar extension was restored.

Abdominal and deep paraspinal musculature activation exercises were implemented and progressed throughout the plan of care in order to regain optimal spinal stability, reduce synergistic hip flexor dominance, and reduce the potentially excessive resultant spinal load. In asymptomatic individuals the transverse abdominis (TrA) functions like a corset to stabilize the lumbar spine.[32] Two randomized control trials (RCTs) have validated the effects of core stabilization demonstrating that multifidus and TrA activation is delayed in patients suffering with low back pain.[33,34] Grade III L1-3 extension mobilizations along with other non-core exercises were initiated since motor control exercises have not been shown to be clinically superior to either manual therapy techniques or other exercise for low back pain.[35] However, motor control exercises for low back pain are more beneficial than minimal intervention or the typical care provided by a general practitioner.[35,36]

CONCLUSION

The patient in this case had failed prior conservative management aimed at the hip joint. Although the information gleaned from the patient interview was typical of 'groin pain,' a battery of selective physical examination tests and measures combined with a strict adherence to a systematic differential diagnosis process, allowed the authors to determine that the lumbar spine was the origin of the patient's groin pain. Conservative treatment of this patient required a transition from repeated movements to lumbar stabilization and manual therapy. Comprehensive management focusing upon pain relieving strategies, techniques designed to improve both lumbar and hip mobility, and improving core stability were implemented with success. Restoring full, painless range of motion to the spine and restoring full strength to the core musculature proved vital, thus allowing the patient to return to full activity without symptoms or restriction. The examination, evaluation, diagnosis, and treatment progression were all guided by an acute understanding of the regional interdependence of lower extremity, spinal biomechanics, and the pertinent neural anatomy. It is imperative that physical therapists study these relationships and continually look beyond the location where symptoms appear to be most significant.

ACKNOWLEDGMENT

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Table 5. Physical Examination Range of Motion Measurements after 8 Visits

Movement	Measurement	
Lumbar spine flexion AROM	40°	
Lumbar spine extension AROM	17°	
	Right	**Left**
Hip flexion PROM	85°	90°
Hip abduction PROM	22° *	30°
Hip internal rotation PROM	15°	27°
Hip external rotation PROM	30°	30°

AROM=active range of motion, PROM=passive range of motion.

*Provocative of groin pain.

Note: Lumbar spine AROM was measured in standing using an inclinometer. Hip flexion and abduction PROM was measured in supine using a goniometer. Hip internal and external PROM was measured in supine at end range hip flexion using a goniometer.

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Differential Diagnosis of Psoriatic Arthritis in a Patient Referred for Carpal Tunnel Syndrome

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ABSTRACT

Study Design: Case Report. **Background:** Psoriatic arthritis (PsA) is a form of seronegative spondyloarthritis and is thought to be underdiagnosed in patients with psoriasis. **Purpose:** To describe a 38-year-old male patient with bilateral hand/finger pain diagnosed and referred by a neurologist for carpal tunnel syndrome. **Method:** Based on the patient's subjective and objective findings, a research review was conducted to correlate his symptoms to other pathologies. **Findings:** After reviewing the research, a referral to a rheumatologist was recommended. Blood analysis along with confirming symptoms provided the full diagnosis of psoriatic arthritis. **Clinical Relevance:** In the era of direct access to physical therapy, it is vital that a physical therapist is able to recognize abnormal symptoms and appropriately refer to other health professionals in order to best serve the patient.

Key Words: carpal tunnel syndrome, physical therapy, psoriatic arthritis

BACKGROUND

Psoriatic arthritis (PsA) is a form of seronegative spondyloarthritis associated with arthritis.[1,2] The typical presentation of PsA is an asymmetrical, peripheral distribution of joint pain and stiffness, which more often than not presents in the morning (a.m.). The patient's presentation and pain provocation can be similar to many other arthritic conditions such as rheumatoid arthritis and osteoarthritis. Its pain distribution and a.m. severity can also be mistaken for symptoms consistent with carpal tunnel syndrome. In addition, PsA may be associated with other conditions such as Achilles tendonitis, plantar fasciitis, and various other distal tendonopathies. However, this article will focus primarily on the upper extremity differential diagnosis.

The current prevalence of the PsA is as low as .04% to 2% of the general population.[3] The prevalence is estimated to range between 11% and 45% in persons with an established diagnosis of psoriasis.[3-5] In 2009, Radtke et al[5] performed a multicenter observational study on patients with psoriasis who were seen in dermatological hospitals and private practices. The authors created a questionnaire and received 4078 copies that were completed by patients and physicians determining the potential presence of PsA. Of the data collected 19% were confirmed to have PsA. This research highlights the value of implementing simple screening criteria that can provide an accurate diagnosis of PsA.

The most frequently referenced diagnosis of psoriatic arthritis was established by Moll and Wright in 1973,[6] which used 3 simple criteria. They were (1) inflammatory arthritis, peripheral, and/or sacroiliitis or spondylitis; (2) the presence of psoriasis; and (3) the absence of a rheumatoid factor.[3,6,7] Additionally, Moll and Wright[6] described 5 clinical patterns that assisted in the diagnosis of PsA. These patterns are:

- Distal interphalangeal joint (predominant affected area)
- Asymmetrical oligoarticular
- Symmetrical polyarticular
- Spondylitis and sacroiliitis
- Arthritis mutilans

In 2006 Taylor and the CASPAR (ClASsification criteria for Psoriatic ARthritis) Study Group,[8] refined Moll and Wright's criteria. To meet the new classification criteria for PsA, a patient must have an inflammatory articular disease with 3 or more of the following 5 criteria:

1. Evidence of psoriasis, either through personal history or a family history.
2. Psoriatic nail dystrophy including onycholysis, pitting, and hyperkeratosis observed on current physical examination.
3. Negative presence of rheumatoid factor.
4. Current or history of dactylitis (swelling of an entire digit).
5. Radiographic evidence of the hand showing juxtaarticular new bone formation, appearing as ill-defined ossification near joint margins, excluding osteophyte formation.

Based on this new classification schema, the authors demonstrated 91.4% sensitivity and 98.7% specificity in the diagnosis of PsA. Although the current research shows that the criteria for signs and symptoms have remained, there has been the addition of enthesitis as additional criteria due to its prevalence with PsA. Enthesitis is defined as the inflammation at the site of the tendon, ligament, or joint capsule fiber insertion.[8] Though the sensitivity and specificity of the classification criteria are very high, it is important to note that the population studied had symptoms of PsA averaging for more than a decade. The authors concluded that the classification criteria may not be as sensitive or specific for the general population, though the authors were confident that the criteria would likely perform well if used for the general population.[8]

The need to differentially diagnose patient conditions is an essential clinical decision making process that physical therapists perform prior to selecting and administering the appropriate care. With the expansion of direct access to physical therapy, it is critical that the physical therapist be aware of all potential physiologic and systemic causes of orthopaedic dysfunctions. The purpose of this case study is to illustrate the unique features of psoriatic arthritis, and how to differentiate the disorder from other conditions that could mimic its symptoms.

CASE DESCRIPTION

The patient was a 38-year-old male, who was referred to physical therapy by his neurologist with the diagnosis of carpal tunnel syndrome in late June 2009. The pain started in January of that year with the discomfort and disability predominantly limiting morning activities. After two months the patient went to his primary care physi-

cian who referred him to a neurologist and he was evaluated in April. The neurologist ordered electromyography and nerve conduction velocity (EMG/NCV) testing of bilateral upper extremities, as well as blood analysis, which were performed in mid-May. The EMG/NCV displayed bilateral normal median sensory nerve action potentials (SNAP) across the wrists. Additionally both sides demonstrated prolonged SNAPs across the palm with the right median nerve greater than left with preserved amplitudes and decreased conduction velocities. The ulnar nerve data was within normal limits bilaterally. Bilateral median nerve compound muscle action potential showed slightly prolonged distal latency with preserved amplitude and conduction velocity across the wrist. The same was found for the left ulnar nerve, but not the right. Blood analysis found the patient to have a negative rheumatoid factor.

Physical Therapy Examination

At the time of referral, the patient's chief complaint was bilateral hand pain, right worse than left, with the majority of his pain located in the right 3rd phalanx and left 4th phalanx that was limiting his productivity at work. The patient, who is right handed, works as a chief of staff on Capitol Hill, and needs to frequently type and write information or sign documents, which was almost impossible for the patient to perform secondary to pain and stiffness in his right 3rd phalanx. The month prior to his initial physical therapy evaluation, the patient was wearing bilateral neutral wrist splints, with minimal to no change in symptoms. Using the verbal numeric pain scale, the patient reported his pain to be an 8-9/10, (with 0 = no pain and 10 = worst imaginable pain) especially in the mornings. The patient reported only mild and occasional numbness and tingling in the right palm, typically occurring in the morning. As a result, the patient delayed his work activities until 11 a.m. to allow for a decrease in pain to a tolerable level (rated as a 5-6/10). Additionally, the patient had to discontinue weight training exercises and kitchen duties, secondary to a lack of range and pain with gripping objects.

The patient's past medical history included status post right lateral epicondylitis in 2005, diverticulitis and plantar fasciitis in 2008, and currently was experiencing "ankle pain" that was being addressed by a podiatrist who prescribed the use of foot orthoses, with minimal to moderate decrease in pain and improved function. Most notable previous medical finding was the diagnosis of psoriasis as a child, which the patient mentioned on the second visit and not during the initial evaluation.

The physical examination revealed entire 3rd phalanx swelling, which was correlated with the symptomatic area of the patient's right hand. The left hand presented similarly on the 4th phalanx, though the swelling was considerably less. Visual inspection noted the right 3rd and the left 4th phalanx were larger in size and girth than the other digits. There was no thenar atrophy observed in either hand or any tenderness to palpation. All ranges of motion of bilateral elbow, forearm, and wrist were within normal limits, exhibiting no pain with end range overpressures. Although the left phalangeal joints were within normal limits, the 4th metacarpal phalangeal joint (MCP), proximal interphalangeal joint (PIP), and distal interphalangeal joint (DIP) displayed pain with overpressures. Similarly the right phalangeal joints were within normal limits, except the right 3rd DIP joint, limiting flexion motion to 65° due to pain, along with painful MCP and PIP joints with overpressure at end of extension and flexion. The right 3rd DIP was the most symptomatic area on the patient's right hand, followed by the PIP and MCP joints. These impairments led to an inability to make a full fist. Although subjectively the patient did report palmar pain near the heads of the metacarpals; the pain was not reproduced with range of motion and overpressure testing of the wrist and hand.

The patient's right grip was severely hindered secondary to pain and stiffness. Dynamometer testing revealed the right grip strength to be 42 pounds while the left was 100 pounds. Manual muscle testing of forearm supination and pronation, as well as wrist extension and flexion was 5/5 bilaterally. However, there was mild pain in the respective digits during both left and right wrist muscle testing.

Tinel testing was performed bilaterally for the median and ulnar nerves. The patient presented with a positive median nerve Tinel sign bilaterally as evidenced by a change in sensation along the right 3rd and the left 4th phalanx but this testing did not reproduce the patient's symptoms.[21] Ulnar nerve Tinel testing was negative bilaterally. The Phalen's test was positive on the right while negative on the left.[9] However, the patient did experience mild tingling in the 3rd phalanx, but no pain or sensation elsewhere on the hand or wrist. Upper limb tension tests (ULTT) were positive bilaterally for median, ulnar, and radial nerves, but did not reproduce the symptoms in either the patient's hands or fingers. Provocation of symptoms was elicited with use of compressive, varus, and valgus forces of the identified MCP, PIP, and DIP joints. Finally, the patient reported pain relief with manual distraction of the joints.

Clinical Impression

Although the patient was referred to physical therapy with a medical diagnosis of carpal tunnel syndrome (CTS), the patient's primary symptoms were not entirely consistent with that diagnosis. The patient did have some mild symptoms that were consistent with CTS, eg, his positive Tinel and Phalen's test. Also, the EMG/NCV testing indicated neural signs consistent with CTS. However the symptoms elicited during the CTS special testing were not consistent with the patient's chief complaint. The primary symptoms were elicited through compression of the DIP, PIP, and MCP joints during active and passive movements. This was the primary reason the patient was unable to grip fully and without pain. Weak and painful grip is a symptom associated with CTS, but single joint swelling without any history of trauma is rare and suggests a possible systemic origin.[10]

Physical Therapy Plan of Care

Given the patient's right DIP flexion impairment, soft tissue mobilization (STM) of the extensor digitorum tendons and muscles was the primary intervention used to address this impairment. In addition, the patient was instructed in gentle wrist extensor and flexor stretching for therapeutic exercise and use of a cold pack to the swollen phalanx in order to decrease swelling. This plan of care provided positive relief with increased right DIP flexion range of motion to 80°.

At the second visit the patient reported relief through the weekend, with pain at a level of 6/10, but a resumption of the pain and stiffness had returned Monday morning. To address the possibility of CTS, the patient was treated using a carpal tunnel protocol similar to what was described by Baysal et al.[11] The protocol includes use of pulsed ultrasound to the carpal tunnel (duration 15 minutes), tendon glides, and median nerve gliding. To address the patient's primary symptoms, the patient received joint distraction (grade III-IV) of the right 3rd and left 4th DIP and PIP and grade III anterior-posterior and posterior-anterior mobilizations. Grade IV medial glide of the pisiform

with the wrist in full supination were also performed. The plan of care continued to include soft tissue mobilization to the extensor digitorum and wrist and finger flexors prior to the tendon gliding exercises that consisted of straight, hook fist, flat fist, and lumbrical grips each maintained for 5 seconds, 10 times each. Therapeutic exercises included gentle towel crunches, wrist flexor stretching, and an alternative tendon gliding exercise consisting of 6 different positions, going from fist to wrist extension, supination, and thumb extension overpressure. The treatment session concluded with the use of ice applied to the 3rd and 4th digits. The patient was able to achieve some relief post-treatment as evidenced by a visual decrease in joint/digit swelling and increases in ROM of right DIP to approximately 90% of normal limits.

On the second visit, the patient informed the PT about his history of psoriasis. After being provided this new information, the PT performed a literature search to determine if there was a possibility of the patient having PsA. The research revealed a strong possibility for the patient's symptoms to be associated with PsA. The patient's past medical history included ankle pathology, suggestive of enthesitis, which in PsA patients affects the plantar fascia and Achilles tendon.[2,3,12,13] The patient also had a current history of psoriasis, and presented with dactylitis and pain mostly in the DIP.[3,6,7,8,11,13] These signs and symptoms were more consistent with PsA than with CTS. Since the patient had a scheduled appointment with his neurologist, he and the physical therapist discussed the change in diagnosis with the neurologist who concurred. Based on the change in diagnosis to PsA, the patient was referred to a rheumatologist who confirmed the diagnosis via blood analysis. The patient was prescribed Indocin, 75 mg two times per day, which reduced the severity and irritability of his symptoms while improving the duration of relief provided by the physical therapy. Prior to the patient visiting the rheumatologist, his right hand was an estimated 90% to a full fist; with grip on the right improving to 75 lbs and right 3rd DIP flexion 85°. Upper limb tension tests were negative for the right median and ulnar nerves and slightly positive for the radial nerve. The left ULTT was positive for ulnar nerve only. Median nerve Tinel testing remained positive bilaterally, whereas the Phalen's test was negative bilaterally.[9] Although it took less time to obtain relief from his morning stiffness and pain, his function continued to be impaired.

Over the next two and a half weeks, the patient's symptoms slowly diminished in intensity. This was illustrated by a marked decrease in finger swelling, and significantly less pain with DIP, PIP, MCP stress tests (2/10 at worst). Left hand pain and stiffness were reduced and minimal throughout the day, with very little flare-ups. The patient was able to start resuming weight training with machines at the beginning of August, 7 weeks post-initial evaluation. Pain level on the VAS was 1-2/10 during the morning.

At this point, cervical mobilization was added to the plan of care and performed prior to nerve gliding. The change in plan of care led to enhanced outcomes as noted by patient report of consistent improvement in range of motion and decreased pain (1/10 VAS) in the mornings between appointments.[14,15]

Unfortunately the patient had a setback in progress at 9 weeks post initial evaluation. This was in part due to his decision to wean off of the night splints and increase his activity level. He presented with right DIP pain, especially with flexion and compression, as his primary chief complaint. The patient reported relief with the distraction, and mobilization of the DIP, along with STM of the extensor tendons.

The patient continued in physical therapy 1-2x/week and displayed occasional flare-ups of symptoms in the right 3rd and left 4th phalanx. By the third and fourth month, the patient's pain was again at a low level 1/10 for the digits with the ability to make a full fist and only mild disruption in function in the mornings, lasting less than an hour. The patient was discharged early October 2009, 14 weeks from his initial evaluation. Upon discharge the patient was to continue his home exercise program to manage his impairments.

The patient was seen later in 2009 for other musculoskeletal injuries related to ankle pain and plantar fasciitis. During those sessions he would present with an occasional exacerbation of his finger symptoms, requiring brief intervention in order to relieve pain and increase range. By the end of the year, the patient had reduced the medication and was using night splints as needed.

At the time of his discharge in October, the patient had largely achieved his goals by reducing pain in his fingers during the morning to a manageable 1/10, with mild stiffness and no swelling noted during the a.m. This allowed the patient to type, write, and perform all work duties without limitation. The patient was able to return to recreational exercise and weight training 3x/week with no limitation from either hand. One year post-discharge, the patient was continuing full activity with no restrictions at any point in his day. He reported 0/10 pain, with no impairments noted on either hand. He was now taking medication less than 2x/week to manage the PsA.

DISCUSSION

According to the CASPAR,[8] the patient in this case presented with many of the classic signs and symptoms of PsA. He had been diagnosed with psoriasis, tested negative for rheumatoid factor, and had current dactylitis. Other factors that distinguished his PsA from other medical conditions were his subjective complaints of morning stiffness, having DIP involvement, polyarticular involvement, and a history of Achilles tendonitis and plantar fasciitis. The only other signs that the patient did not exhibit were asymmetrical sacroiliitis, and prominent psoriatic nail dystrophy.[3,6,7,8,11,16]

In retrospect it would have been beneficial for the patient's medical workup to include radiographic imaging of his DIP joints to determine the amount of ill-defined ossification, but at the time his physicians deemed this testing unnecessary. Radiographs can display the magnitude of osteolysis or joint erosion of the affected area. Advance erosion is typically seen in the phalangeal joints and would be viewed as the classic "pencil in cup" deformation, with the projection of one end of the joint into a broader area of the other end.[17] In the case of this patient, a radiograph could have led to an earlier diagnosis of PsA and determined the appropriate plan of care based on the severity of the joint space. Severity would also have given an indication of prognosis, and establish a baseline measurement as progressive radiographs are taken in the future.

Recently studies have shown that the use of Doppler ultrasound can provide a detailed assessment of enthesitis in tendons of the lower limbs.[18,19,20] This type of imaging modality is being incorporated into physical therapist practice and could evaluate the potential of enthesitis in a patient with PsA. This diagnostic imaging study would provide the physical therapist greater insight into the patient's tendon integrity enabling the clinician to select the most appropriate interventions and/or the need to refer back to the physician for additional medical management.

Diagnosis of CTS and its Similarity to PsA

Based on the patient's clinical presentation, the neurologist's diagnosis of CTS was appropriate. The patient did present with symptoms characteristic of CTS. Studies have shown that pain in the middle finger can be considered a classic form of CTS.[21,22] Nora et al[23] conducted an analysis of 1039 patients with carpal tunnel syndrome. They found 47.8% presented with pain in the 3rd digit, with an additional 5.7% of the pain restricted to the fingers. Paresthesia was identified in the 3rd digit (80.8%) and 21.3% in the fingers. This patient's EMG/NCV demonstrated latency across the wrist, which is a gold standard for confirming the diagnosis of CTS. However, the additional history of psoriasis, plantar fasciitis, foot/ankle pain, distal polyarticular pain with presentation of severe dactylitis required consideration of PsA as differential diagnosis and further medical work up to confirm this diagnosis. Although the patient was negative for rheumatoid factor (RF), the presence of RF positive does not completely rule out PsA. Studies have shown 4% to 13% of patients with PsA are RF-positive as well.[2,3,8]

The challenge in diagnosing PsA is identifying the presentation early and treating the patient before the symptoms become too severe to become debilitating. As stated earlier, the CASPAR criteria have not been used in the general population, though it was speculated to perform well especially in those individuals who have the presence of an inflammatory articular feature. The current diagnostic classification has a very high sensitivity and specificity, but the mean duration of symptoms was 12.5 years. Early detection of PsA is currently and vigorously being researched. D'Angleo et al[24] categorized 44 patients with PsA whose duration was less than 12 months using the CASPAR criteria. Their results showed the sensitivity decrease from 91.4% to 77.3%. Psoriasis and negative RF were the most prominent criteria, with juxtaarticular bone formation viewed by radiograph the least sensitive criteria (2 out of 44). Therefore it is unlikely that the use of radiographs to determine the extent of bone abnormalities in the early months of PsA will detect any changes.[24,25]

Prognosis and Role of Physical Therapy

The long-term prognosis for patients with PsA is poor; with studies reporting quality of life and functional capacity less than healthy age matched controls.[3,25] Additionally if the onset of the PsA is in a polyarticular pattern, the erosive damage is likely to be higher further impacting a patient's prognosis.[26] Gladman et al[27] assessed the mortality of patients with PsA and concluded an increased risk of death existed for those with prior use of medication, a high erythrocyte sedimentation rate at presentation, the absence of nail changes at first visit, and evidence of radiologic damage at presentation are prognostic factors associated with an increased mortality. In addition their data suggests the absence of nail lesions is associated with a better prognosis once the radiologic changes have been considered. This was seen with this patient, where he did not have any nail dystrophy.

Physical therapy can provide relief and/or management of symptoms and improve quality of life for patients with PsA. Currently there are no studies assessing the effects of physical therapy in this patient population. To the authors' knowledge the only study that has mentioned physical therapy was by Lubrano et al[28] that identified physical therapy as a "when necessary" intervention. They concluded that there is very little evidence available to assess the efficacy of rehabilitation. Clearly more research needs to be done on the short-term and long-term effects of physical therapy for patients with PsA.

A limitation to this case study was the lack of inclusion of a standardized outcome measure. Outcome measures are valuable because they guide clinical care by revealing limitations experienced by the patient, and allow the practitioner to assess and document the status of the patient and the effects of the current treatment. Validated outcome measures for patients who have psoriatic arthritis include the Psoriatic Arthritis Response Criteria, American College of Rheumatology Core Data Set, Disease Activity Score and Psoriasis Area and Severity Index.[29,30] Additionally the Disabilities of Arm Shoulder and Hand could have also been used. The use of an outcome measure with this patient would have assisted in determining when the patient reached his maximum potential and when to appropriately discharge him from physical therapy.

This case illustrates the need for early diagnosis in this population in order to achieve better outcomes and improve function. The case also highlights the importance of combining physical therapy with the appropriate medication, for patients with systemic inflammatory diseases. Continued communication and collaboration with all members of the patient's health care team is also essential.

Finally this case study facilitated many clinical questions regarding the examination and management of patients with PsA, including the role of physical therapy, the duration of treatment given the exacerbation and remission pattern of symptom presentation and the impact of pharmacologic management have on the patient's outcome.

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Differential Diagnosis of a Patient Referred to Physical Therapy with Neck and Shoulder Pain: Brachial Plexus Neuropathy

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ABSTRACT

Background and Purpose: This case report describes a 52-year-old-right-handed female secretary who was referred to physical therapy by her primary care physician with the diagnosis of neck and shoulder pain. The patient presented with gross right upper extremity weakness. **Findings:** After completion of initial evaluation and diagnostic testing, the patient's diagnosis was confirmed as idiopathic brachial neuropathy. **Clinical Relevance:** By being familiar with the clinical signs and symptoms of brachial plexus neuropathy, health care costs can be reduced and a proper diagnosis obtained. A patient with brachial plexus neuropathy will initially report a sharp intense pain in the upper extremity followed by residual weakness. Recovery from brachial plexus neuropathy can take several months to years to regain full strength of the upper extremity.

Key Words: cervical spine, residual weakness, The Penn Shoulder Score

BACKGROUND

Brachial plexus neuropathy, also known as neuralgic amyotrophy, idiopathic brachial neuritis, acute shoulder neuritis, or Parsonage-Turner syndrome, is a disorder of unknown cause that affects the brachial plexus.[1,2] Brachial plexus neuropathy is often missed by health care professionals as a possible diagnosis, secondary to having a similar clinical presentation to other pathologies such as cervical radiculopathy, rotator cuff tears, shoulder impingement, calcific tendinitis, and adhesive capsulitis.[3-5] A detailed history and clinical examination can help a clinician to differentiate brachial plexus neuropathy from other possible cervical and shoulder pathologies.[3]

The clinical presentation of brachial plexus neuropathy is an acute onset of sharp severe pain in the upper extremity.[3-7] The pain often awakens the patient at night and lasts for a few days to weeks.[8] After the pain lessens in intensity, weakness and atrophy is noted in the involved extremity.[7] With strength testing, moderate weakness to total paralysis of the shoulder girdle may be present.[5,9] The weakness may persist for several weeks to months.[10] Eighty to 90% of patients with brachial plexus neuropathy can expect a full recovery in 3 years.[5]

There was very little published on brachial plexus neuropathy prior to 1942. It was during the war years, 1941-1945, that Parsonage and Turner saw 136 cases of severe pain starting at the shoulder blade radiating down the upper extremity followed by a period of weakness.[2] The subjects with the onset of pain were absent of any constitutional symptoms, prior to the onset of pain.[2] During this time, treatment was similar to that of poliomyelitis including, analgesics, range of motion exercise, splinting, and strengthening.[2]

Seventy years later, treatment of brachial plexus neuropathy remains almost the same. In the acute stages of pain control, a nonsteroidal anti-inflammatory drug (NSAID) and opiate have been shown to be effective.[11] The use of an over-the counter NSAID does not provide adequate relief and should not be advised.[11] In the later phase of sharp shooting pain, a co-analgesic may be helpful.[11,12] As the pain subsides, physical therapy is recommended to maintain full range of motion and to regain strength.[1,12] van Alfen[11] also suggests the use of a foam rubber sling to support the weight of the arm when sitting, standing, and walking to relieve the scapula-stabilizing muscles of the arm weight.

Without taking a detailed history and clinical examination, a misdiagnosis may occur and lead to unnecessary diagnostic and therapeutic interventions.[1] Diagnostic testing may include electromyography, nerve conduction studies, magnetic resonance imaging (MRI), and cerebrospinal fluid examination. These diagnostic tests are not necessary to confirm the diagnosis of brachial plexus neuropathy, if a detailed history and examination was conducted, however, they can be useful in supporting the diagnosis and ruling out other conditions.[1,13,14]

The purpose of this case study is to present a description of a patient referred to physical therapy with the diagnosis of neck and shoulder pain. The physical therapist's history and examination findings raised concern that there was involvement of the brachial plexus. This case will make health care providers aware of brachial plexus neuropathy when a patient presents with initial sharp intense pain followed by residual weakness. The prevalence is not high, 2 to 3 per 100,000 persons per year; however, clinicians should be aware of this condition as a possible diagnosis.[12]

DIAGNOSIS

Patient History

The patient, a 52-year-old-right-handed female secretary, was referred to physical therapy by her primary care physician with the diagnosis of neck and shoulder pain. The patient's chief presenting complaints were pain and weakness in her right upper extremity that was progressively getting worse over the past 5 months. She had stated quitting her bowling league due to upper extremity weakness and pain. She was also unable to pick up and hold her 3-year-old granddaughter. Prior to the onset of symptoms, she was able to complete all daily, work, and recreational activities without any difficulty.

The patient related her onset of pain to a mammogram that she had approximately 5 months ago. She stated the pain was initially a sharp shooting pain down the right upper extremity. The pain limited her ability to sleep throughout the night. She rated her initial onset of pain a 10/10 on the numeric pain scale. At the time of the initial evaluation (5 months after the onset), her pain was a dull ache, rated a 5/10, with use of the right upper extremity. She also stated having a sensation of fullness and swelling in the right axilla.

Prior to beginning physical therapy, the patient had blood work, radiographs, and a cortisone injection. The results of the blood work showed a deficiency of vitamin D. The patient was advised by her primary care physician to take a vitamin D supplement secondary to her deficiency. The radiographs of her cervical spine and right shoulder were reviewed as normal. The cortisone injection was administered to her right shoulder complex. The patient stated no relief of pain from the injection. She continued to take Motrin every 5 to 6 hours for pain control, since the onset of symptoms.

Physical Examination

After completing the patient's history, further examination of the cardiovascular, musculoskeletal, and neurologic systems were completed (Table 1). The patient had hypertension listed on the past medical history form that was being controlled with medication. Her blood pressure was taken, prior to examining the musculoskeletal and neurologic systems, to assure that her blood pressure was well controlled. After taking the blood pressure, it appeared that her hypertension was controlled with the medication and dosage she was currently taking.

During patient observation, a forward head and rounded shoulder posture was noted. There was notable inflammation located in the anterior aspect of chest wall, surrounding the pectoralis major. This clinical finding was consistent with her complaint of "fullness and swelling" within the anterior chest wall. Palpation of the pectoralis major, revealed mild tenderness. She was also tender to palpation in the right bicep, supraspinatus, infraspinatus, rhomboids, and right axilla. Trigger points were palpated in the biceps and supraspinatus.

A movement analysis was first completed for the cervical spine. The patient exhibited full range of motion in the cervical spine. No pain or symptoms were elicited with passive overpressure of the cervical spine. Joint play was assessed on the cervical spine using posterior to anterior glides. Once again no pain or reproducible symptoms were reported.

Range of motion was then assessed for both upper extremities. The patient had full range of motion; however, the motion was very slow and challenging for the patient to complete the range. With the observed active motion of the upper extremities, it was apparent that there was weakness in the upper extremities, specifically the right upper extremity.

Strength was then assessed in the upper extremities and significant weakness was noted in her right upper extremity as compared to the left extremity (Table 1). She had the greatest weakness with right shoulder flexion, abduction, and shoulder extension, elbow flexion, and grip. Secondary to the weakness on the examination, the patient's reflexes and sensation was assessed. The patient had normal (2+) reflexes bilaterally for the biceps, triceps, and brachioradialis. Her sensation was also intact to sharp and dull touch.

Table 1. Examination Findings During the Initial Evaluation

Test and Measures	Clinical Findings		
Pain Level	At onset, 10/10 Right Upper extremity from the shoulder to digits		
Posture/Observation	Forward head/rounded shoulders, inflammation noted in right axilla and pectoralis major		
Palpation	Tenderness noted in the supraspinatus, infraspinatus, rhomboids bicep, and pectoralis major		
Sensation	Intact to sharp and dull		
Neurologic	Reflexes:		
	Triceps 2+,		
	Biceps 2+, Brachioradialis 2+		
Myotome Testing	Shoulder:		
		R	L
	Abduction	4-/5	4+/5
	Flexion	3+/5	4+/5
	External Rotation	4/5	4+/5
	Internal Rotation	4/5	4+/5
	Extension	4-/5	4+/5
	Elbow:		
	Extension	5/5	5/5
	Flexion	3+/5	4+/5
	Hand:		
	Grip	30lbs	58lbs
Muscle Strength	Serratus Anterior: 4/5		
	Infraspinatus: 4/5		
	Teres Minor: 4-/5		
	Subscapularis: 4/5		
	Teres Major: 4+/5		
	Pectoralis Major: 4-/5		
	Deltoid: 4-/5		
	Latissimus Dorsi: 4-/5		
	Tricep Brachii: 5/5		
	Biceps Brachii: 3+/5		
	Brachialis: 3/5		
	Brachioradialis: 4-/5		
Range of Motion	Cervical: No limitation or pain provocation		
	Right Upper Extremity: Full range but decreased speed noted with the motion		

Abbreviations: R, right; L, left

Diagnosis

Based on the clinical examination, the patient had significant right upper extremity weakness following a complaint of 5 months earlier of 10/10 intense pain. The weakness was associated with multiple nerve root levels correlating with the brachial plexus and cervical spine. She did not have any findings related to the cervical spine, other than multiple nerve root involvement. The clinical findings were more closely associated with brachial plexus neuropathy, because of the nerve root involvement and the pain presentation. The referring physi-

cian was contacted regarding the examination findings. The primary care physician and therapist decided to refer the patient to a neurologist and for an MRI of the brachial plexus to confirm the diagnosis of brachial plexus neuropathy.

The referring physician first scheduled an MRI of the cervical spine that showed mild degenerative changes. The MRI of the brachial plexus identified a small cyst in the region of the right spinoglenoid notch. Since the cyst was located in the spinoglenoid notch represented in the brachial plexus MRI, an additional MRI of the right shoulder complex was conducted. The referring physician advised the patient to see an orthopaedic surgeon regarding the cyst. The surgeon felt that the cyst was not a cause of the present symptoms and no surgical intervention was necessary. The referral to the neurosurgeon led to an EMG and nerve conduction velocity testing. At the conclusion of the neurologic assessment, the neurologist confirmed the therapist's suspicion of idiopathic brachial plexus neuropathy.

The patient entered physical therapy for muscle weakness (*ICD*-9-CM diagnosis code 728.87) and right shoulder pain (*ICD*-9-CM diagnosis code 719.41), over a 3-month period. At the conclusion of diagnostic testing, the patient would fit under the Practice Pattern 5F (Impaired Peripheral Nerve Integrity and Muscle Performance Associated with Peripheral Nerve Injury). The overall goal with physical therapy was to increase strength in the right upper extremity to allow the patient to return back to recreational bowling and allow her to hold her grandchild. Once the patient was able to independently progress her strengthening program, she was discharged to manage her condition independently with an instructed home exercise program. According to a review of the peer-reviewed literature, improvements in strength can take a period of 3 months to 3 years.[5]

Outcome Assessment Tools

Two outcome assessment tools, the Oswestry Disability Index and the Penn Shoulder Score, were used throughout the course of patient treatment (Table 2). The Oswestry Disability Index is one of the principal condition-specific outcome measures used in the management of spinal disorders.[15] The tool was initially used for lumbar and cervical spine assessment.[16,17] Recently, the Neck Disability Index, which is a modification of the Oswestry Disability Index, has been shown to be a reliable and valid measure in patients with acute or chronic neck pain with symptoms of musculoskeletal or neurogenic origin.[18] The Penn Shoulder Score is a reliable and valid measure for reporting outcomes in patients with various shoulder disorders. In a study by Leggin et al, test-retest was 0.94, which indicates excellent reliability.[19]

The tools were administered 3 times during the treatment (initial evaluation, after one month of treatment, and at discharge). The patient scored moderate disability (28%) on the Oswestry Disability Index on her initial visit and improved to minimal disability (6%) at the time of discharge. The patient improved by 22% through the course of treatment and exceeded the minimal detectable change score.[15] In addition to the Oswestry Disability Index, she also improved by 56 points on the Penn Shoulder Score, again exceeding the minimal detectable change score at discharge.[1]

DISCUSSION

The patient in the case study was referred to physical therapy for neck and shoulder pain. Without a thorough history, systems review, and examination, the diagnosis of brachial plexus neuropathy may have been missed. It is essential that health care providers be aware of the signs and symptoms of brachial plexus neuropathy. If a patient presents with intense shooting pain along an upper extremity, followed by residual weakness of multiple neurologic levels, it is important to examine the brachial plexus, cervical spine, and shoulder prior to confirming the diagnosis.

It is also valuable to know that the recovery period with brachial plexus neuropathy can take several months to years.[5] After the initial period of pain is subsiding, the patient can be seen in physical therapy to help with pain management initially and then progress in physical therapy to a strengthening program. Once the patient reaches his/her goals in therapy he/she can be discharged to independently manage the condition to alleviate the financial burden of co-pays for the patient.

Additional diagnostic testing can also be used to confirm the diagnosis of brachial plexus neuropathy, but the cost of using diagnostic testing to confirm the diagnosis outweighs the benefits for confirming brachial plexus neuropathy.[1,13] If an in-depth history and evaluation is conducted, one can conclude the diagnosis of brachial plexus neuropathy without additional diagnostic testing. Table 3 outlines the distinguishing findings to aid in the differential diagnosis of brachial plexus neuropathy versus cervical radiculopathy as well as the key findings in this case. The additional testing may be useful for ruling out additional pathologies that may present with the similar symptoms of brachial plexus neuropathy.

The patient in this case had many diagnostic tests and additional health care visits. The course of physical therapy was carried out until the patient had all testing ordered by the referring physician and showed independence with her home exercise program. The total cost for the insurance company, in this case, was $5,205.60 (Table 4). If there was increased knowledge about the treatment of brachial plexus neuropathy, there could have been a decreased cost on the health care system.

CONCLUSION

Although not commonly seen, brachial plexus neuropathy is a diagnosis that affects

Table 2. Outcome Assessment Tools Used During Patient Care

Assessment Tool	Initial Evaluation	1 Month with Therapy	Discharge	Minimal Detectable Change
The Penn Shoulder Score: Overall	30/100	70/100	86/100	Total score 90% confidence interval = 12.1points
The Penn Shoulder Score: Pain	6/30	22/30	26/30	5.2 points
The Penn Shoulder Score: Satisfactory	1/10	7/10	9/10	1.8 points
The Penn Shoulder Score: Function	23/60	41/60	51/60	8.6 points
Oswestry Disability Index	28%	18%	6%	MDC 90% confidence interval = 10% points
Abbreviation: MDC, minimal detectable change				

Table 3. Differential Diagnosis

	Cervical Radiculopathy	Brachial Plexus Neuropathy	Case Findings
Pain	Sharp, burning pain in affected dermatomes	Initially a sharp burning pain in all or most of the upper extremity. Progresses to a dull ache in most of the upper extremity after the sharp pain subsides	Initially had a sharp burning pain which progressed to a dull ache in the upper extremity
Palpation	Tenderness over affected area of the posterior cervical spine	Tenderness over the affected area of the brachial plexus	Tenderness was present in the axilla and the region of the brachial plexus
Strength	Segmental weakness	Multi-segmental weakness	Multi-segmental weakness in the upper extremity
Deep Tendon Reflexes	Affected nerve root maybe depressed	Upper extremity reflexes maybe initially depressed	Normal reflexes were present
Range of Motion	May have reduced range in the cervical spine	Full upper extremity and cervical range of motion	No range of motion limitation

Table 4. The Total Cost of Patient's Episode of Care

Cost of Patient's Total Care	
Physician/Treatment	Cost (Paid by Patient's Insurance Company)
Primary Care Physician Visits	$306.00
Physical Therapy	$1,557.50
Neurologist	$182.00
Orthopedist	$88.00
Nerve Conduction Velocity/EMG	$950.00
Cervical Spine MRI	$496.00
Brachial Plexus MRI	$511.50
Right Shoulder MRI	$1,114.60
Total Cost	$5,205.60

multiple nerve root levels. If a patient presents with an acute, intense onset of pain followed by residual weakness associated with many nerve root levels, one must consider brachial plexus neuropathy as a possible diagnosis. The treatment of brachial plexus neuropathy involves medication and an upper extremity strengthening program. Diagnostic testing may be used to confirm the diagnosis, but with a comprehensive and detailed history and examination, diagnostic testing may not be necessary and can ultimately reduce health care costs. Lastly, patients need to be aware that recovery from brachial plexus neuropathy can take several months to years to return back to their previous level of function.

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Rehabilitation Following Simultaneous Bilateral Quadriceps Tendon Rupture and Repair

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ABSTRACT

Background: This case report describes the rehabilitation of a patient who suffered a bilateral quadriceps tendon rupture and subsequent surgical repair. **Case Description:** A 56-year-old male sustained a simultaneous bilateral quadriceps tendon rupture due to a fall. After diagnosis and surgical repair, the patient was immobilized for 6 weeks. He moved from inpatient physical therapy to inpatient rehabilitation unit stay, to home health and then onto outpatient physical therapy over a 9-week period. Outpatient physical therapy focused on gait, balance, strengthening, and functional retraining. **Outcomes:** Following rehabilitation the patient regained greater than 125° flexion range of motion bilaterally, increased quadriceps strength with a residual deficit, and ambulated with a walking stick. Functionally, the patient returned to work at prior to injury level, he resumed outdoor home maintenance and hunting activities, and reduced his fall risk. **Discussion:** Identification of a quadriceps tendon rupture is done by interview of mechanism of injury (fall) and clinical inspection for swelling and ecchymosis, palpable suprapatellar gap, and inability to actively extend the knee or straight leg raise. Early detection and treatment of bilateral simultaneous quadriceps tendon rupture is important as early repair improves outcomes. The rehabilitation process should focus on maintaining neuromuscular firing patterns during periods of immobilization, functional lower extremity strengthening, and incorporate balance and motor control activities.

Key Words: exercise therapy, quadriceps tendon, rehabilitation

BACKGROUND

The simultaneous rupture of both quadriceps tendons has been reported in the literature as a relatively rare occurrence.[1-4] Shah[4] reported in 2002 in a review of 66 cases that the injury was more likely to occur in males, over 50 years of age, and a result of a fall. Younger patients were more likely to have an underlying medical condition that could contribute to the likelihood. These include chronic renal failure, gout, hyperparathyroidism, diabetes, steroid use due to systemic disease, and steroid abuse.[3,4] These injuries are commonly misdiagnosed.[4,5] The diagnosis is made based on mechanism of injury, a fall, appearance, bilateral swelling and suprapatellar gaps, and lack of function, inability to actively extend the knee, and/or perform a straight leg lift.[1,3,4,6] Preferred course of treatment is surgical repair with postoperative immobilization. Physical therapy following immobilization is also recommended.[1,3,4]

Few comprehensive studies are reported in the literature. Case studies and retrospective analyses are the predominant reporting format. In addition these case studies have rarely described the rehabilitation aspects following surgery and immobilization. The purpose of this case presentation is to detail the course of physical therapy governing postoperative care following the repair of bilateral quadriceps tendons.

CASE DESCRIPTION

Patient

A 56-year-old white male presented in the clinic 9 weeks after operative repair of bilateral quadriceps tendon ruptures. The patient injured himself in a slip and fall onto flexed knees on stairs. He was transported via ambulance to the emergency department where he was admitted for an orthopaedic consult as he was unable to bear weight. Standard knee 3 view x-ray films found prominent joint effusion bilaterally with concern for quadriceps tendon injury right greater than left. Bilateral simultaneous quadriceps tendon rupture was determined by orthopaedic consult in conjunction with radiographic findings. He was taken to surgery within 24 hours of injury for repair. The patient was placed in long leg immobilizers with a "weight bearing as tolerated in immobilizers only" restriction. Acute physical therapy focused on stand pivot transfer training and bed mobility. He was transferred to a rehabilitation unit after a 5-day stay. His 8-day rehabilitation unit stay focused on ambulation with wheeled walker, wheel chair mobility, transfers, and activities of daily living (ADLs). Exercise included hip strengthening in standing, supine, and sitting for all muscle groups. Isometric setting of the quadriceps was not emphasized at this time. The patient was released from the rehabilitation unit with the ability to ambulate using wheeled walker, assistance with some bathing and dressing activities, and an order of no stairs. He was referred to home health services for anticoagulant monitoring, occupational therapy, and physical therapy for continued ADL work, mobility, strength, and gait. At 6 weeks post repair, he was able to begin range of motion work and knee strengthening including quadriceps setting. The patient was required to use immobilizers on his knees for 8½ weeks postop when in weight bearing.

Evaluation

The patient presented to outpatient therapy in a wheel chair with wheeled walker. He was released from immobilizers for gait two days prior to this visit. At the initial visit, the patient reported 2/10 pain using a verbal 0-10 pain scale with a range of 2-4/10 based on movement. Visual Analog Scale was measured at 6.5 cm. The patient reported that his goal was to "walk normal" and "drive independently."

A review of social history, past medical history, and current systems screening was performed. The patient was a full time employee at a plumbing warehouse prior to his injury. His occupation required computer and phone work from a desk, walking in the warehouse, and accessing his building from the parking lot. He reported being an avid hunter and fisherman, which was important for him to resume. Functional complaints included still needing assistance with bathing due to slick surfaces in the bathroom, ambulating at home in a wheeled walker, using his wheelchair for

activities outside the home, and that he had not resumed sleeping in his own bedroom or driving independently. The patient's medical history included a family history of diabetes, intermittent gastroesophageal reflux disease (GERD), asthma, and sleep apnea which were managed with a continuous positive airway pressure device. Review of systems revealed continued asthmatic care, bilateral edematous legs with pitting, well healed scars from distal third of quadriceps extending to below patella bilaterally, obvious quadriceps and gastrocnemius atrophy (unable to quantify due to bilateral nature of injury), and an intact neurological screen. Current medications which had been taken for over 3 years included Advair and Proventil for asthma, Prevacid for GERD, and Vantage was being used as a sleep aid. He reported discontinuation of pain medication.

Evaluation findings are presented in Table 1. Results of functional testing findings are shown in Table 2. All evaluation procedures were performed according to accepted standards.[7-12]

The patient presented with near normal strength in isolated testing, but functionally demonstrated weakness, muscle control issues, and less coordinated movement patterns. Impairments identified included pain, decreased ROM compared to normal, decreased functional strength, inefficient postures, muscle imbalances, impaired motor control, gait and balance deficiencies, and a high risk for falls. Functional limitations included limited standing and walking tolerance, difficulty with personal care and home ADLs, difficulty with lifting objects, difficulty with transitional movements, and difficulty with stair use.

Table 1. Objective Measures from Initial Evaluation

Test	Result	
Active Range of Motion	L (0°-93°)	R (1°-98°)
Passive Range of Motion	L (2°-0-95°)	R (1°-0°-100°)
Passive Straight Leg Raise	L 55°	R 60°
Manual Muscle Testing	5-/5 bilaterally gross myotomal testing of lower extremities	
Joint Mobility	Bilaterally negative for ligamentous instability with drawer and collateral ligament testing	
Patellar mobility testing	Bilaterally appropriate glide available in medial- lateral and superior- inferior planes	
Joint Clearing	Hip and ankle joint clearing negative bilaterally	
Care Connections[25]	34/50	
Visual Analog Pain Scale	6.5 cm	

Table 2. Functional Testing Results from Initial Evaluation

Test	Observation
Gait	Use of wheeled walker with moderate hand support, slow with gait cycle, stiff legged, no heel strike, immediate foot flat when loading at heel strike.
Standing Posture	Slight flexion at hips over walker with hands for support. Bilateral knee hyperextension "locking" knees straight.
Squat	Hand assist to rise and lower from chair, unable to perform a squat without maximal weight bearing through hands.
Anterior Lunge	Increased valgus, lacks medial/ lateral control, moderate hand weight bearing for balance (bilateral finding).
3 inch Step Down	Lacks eccentric control to lower, moderate hand weight bearing to perform (bilateral finding).
8 inch Step Down	Unable to perform.
Single Leg Balance	Trendelenburg present, unable to perform without moderate hand weight bearing (bilateral finding).
Bilateral Heel Raise	Able to perform with moderate weight bearing through hands.
Single Leg Heel Raise	Unable to perform any clearance of heel.
Stand on Heels	Partial lift of toes, less than 2 sec hold with moderate hand weight bearing.
Tinetti	Balance, 4/16 Gait, 8/12 Total, 12/28 (high risk for fall)

Clinical Decision Making

Based on the evaluation, this patient would be classified into Musculoskeletal Practice Pattern I- Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Bony or Soft Tissue Surgery (4I).[13] Secondary patterns include Neuromuscular Practice Pattern A: Primary Prevention/Risk Reduction for Loss of Balance and Falling (5A).[13]

The initial plan of care was to introduce closed chain and functional strengthening, progressive general leg strengthening, gait training, mobility training, balance and postural training, and manual therapy as alleviate restrictions in soft tissue and scar mobility. The surgeon gave a directive of no extensive loading in deep flexion or deep squatting. Prognosis based on current status was determined to be good for meeting goals and resuming lifestyle.

Interventions

The initial treatment focused on neuromuscular retraining, active range of motion, and functional strengthening related to gait and ADLs. The next portion of treatment shifted focus to general strengthening and balance work. Finally, the emphasis shifted to higher level functional strengthening with set up of a terminal general strengthening program for home use.

The initial 6 weeks the patient used Schwinn® *Airdyne* Upright Exercise bike and NuStep TRS 4000 T4 Cross Trainer reciprocal lower extremity exercisers to allow a degree of control to perform self ROM. The Airdyne cycle provides 360° cyclic motion with accommodating resistance provided by wind (drag). The harder the patient pedals, the more resistance. The handles also allow the patient a means of control not only for speed but to self regulate the amount of rotation in a pedal attempt. The NuStep provides reciprocal stepping motion with fixed resistance. The adjustment of the seat allows for reciprocal muscle activation and strengthening within a ROM tolerated by the patient. Initiation of medial/lateral balance in stance on a single plane wobble board was chosen to initiate perturbation reactions in the neuromuscular pathways. Gait training progressed from wheeled walker to walking stick (patient preference versus cane use) in 3 weeks. Initial eccentric strengthening began with lowering to a 66 cm chair height surface then progressing lower to a chair height in a squat position

without the use of hands. Basic closed chain leg press (single and double), chair squats, and continued 4 direction straight leg raise activities for strengthening were also prescribed. Repetitions were subjectively based on level of fatigue. If the patient was unable to perform any exercise with good form, then the exercise set was terminated. After 4 weeks, he progressed to concentric strengthening on stairs and increased balance board single plane work in medial/lateral and anterior/posterior directions including ball tosses and manual perturbation. At the end of 10 visits, the patient was able to ambulate with a walking stick, return to work at his desk with access to the warehouse as needed, independently driving, dressing independently, carry 10 lbs, and returned to sleeping in his own bedroom with the ability to climb stairs with a lateral step-to gait pattern. Range of motion was measured 0°-115° actively bilaterally and his Tinetti score improved to 20/28, which still is categorized as being at risk for falls. Single leg stand had improved to 5 seconds with hand touch for balance with a compensated trendelenburg position.

The rehabilitation focus shifted to weight training including leg extension, leg flexion, 4 directional walks in tubing loop, and 4 way hip strengthening in weight bearing with tubing for resistance. Balance work was completed in single leg stance, on balance board, closed chain step ups in forward, lateral and retro positions emphasizing eccentric control. The repetitions continued to be based on fatigue and mechanical changes. The home program reinforced functional strengthening with the chair squats, walking program, home biking, knee and hip strengthening.

At 24 weeks, the patient was seen by the physician. At that time, active ROM was 0°-126° bilaterally, a straight leg raise with no extensor lag was noted except when held longer than 20 seconds. Single leg standing was performed for 8 to 10 second hold with hand touch and hip strategy to assist with balance. There was no compensated Trendelenburg noted. Functional strength showed normal ability to lower into and rise from a standard height chair without hand support. It was observed that eccentric control was deficient after closed chain descent past 30° characterized by increased speed in descents. Standard manual muscle tests remaining at 5-/5. An isokinetic test at 60°/sec revealed peak torque at 65.5 Nm with a 16.1% peak torque to bodyweight ratio on the right quadriceps and 64.0 Nm with a 15.7% ratio on the left. The quadriceps to hamstring ratios were 83% and 85%, respectively. This verified the therapist's assumption that there was still weakness that was not measured using manual muscle testing procedures, but could be observed.

Due to reimbursement coverage limits at this time, the patient was not authorized to receive care for one month. Upon return to the clinic, the patient had lost control of terminal knee extension in gait with resultant hyperextension moments in midstance. The patient performed a straight leg raise with a lag of 30° on the right, 15° on the left despite passive hyperextension to 5° bilaterally. Tinetti had dropped to 15/28. The patient reported he had not been completing his home program. Based on his current set of problems, attention was focused on home program compliance, total leg strengthening, balance, and gait.

The elliptical machine was used to gain knee control and to prevent hyperextension. The weight bearing nature in upright combined with manual cueing performed by the therapist helped to reduce knee hyperextension in both forward and backward movement patterns. This translated into controlled activity in terminal knee extension for stance in gait. Lateral hip and calf strengthening was performed to perceived patient fatigue. Balance board activities and open chain terminal knee extension PREs with weight were used. Concentric and eccentric mechanical work on isokinetic equipment was used to allow the patient to become more familiar with isokinetic exercise. A terminal home exercise program was set up using the isotonic equipment, elastic tubing, and general aerobic conditioning of daily walking or biking for 30 minutes daily was prescribed.

OUTCOMES

Patient was discharged from care 39 weeks after surgical repair. At the time of discharge, the patient reported intermittent "shots" of pain with aching and stiffness within the knee joint and quadriceps muscles in the mornings rated at 2/10. The patient reported perceived "gives" (loss of control) in his knees intermittently without an identifiable pattern of onset. However he did not have any incidences of "buckling." He returned to work at full duty including overtime, as well as hunting. He returned to all house upkeep activities including brush clearing and ladder climbing. Overall he resumed his active lifestyle with minimal limitations and intermittent, low level pain. Tables 3 and 4 summarize the outcomes data.

DISCUSSION

This is a unique case report. This patient met 3 risk factors for quadriceps tendon rupture: age range, obesity, and gender. The literature reports steroid use as another risk factor. The presence of long-term inhaled steroids may have increased his risk. It has been reported that with corticosteroid use, there is a higher risk for tendinopathy.[14] In a 2005 review by Blanco, Krähenbühl, and Schlienger,[14] 7 tendinopathies were reported to have underlying asthma issues with inhaled steroid use, including two spontaneous ruptures of tendons (site not specified). The authors admitted that this may be an under-reported phenomenon that warrants further research and monitoring.

This patient continued to have residual weakness of the knees, hips, and gastrocnemius. The patient did report near normal function with respect to his previous activity level. This is a common finding in the literature.[15-18] The quantification of strength is poorly reported in the literature. In single leg ruptures, restoration of strength measured by peak torque of the involved leg has been reported to within 60%-80% of peak torque of the uninvolved leg tested at 60°/sec.[17-21] This residual weakness is reported at 2 years postinjury.[22] In 2001, Kelly et al[19] used isokinetics for rehabilitation and testing. They reported 11% peak torque to body weight ratio at approximately 29 weeks after surgery at 60°/ sec.[19] A normal finding for males in their fifties is 80% at 60°/sec.[20] The patient in this current case report was able to produce a 20% peak torque to body weight ratio, which is significantly lower than the normal value of 80%. Functional return in this reported patient would indicate that little correlation exists between peak torque and functional activity. Additional effort to increase strength of this patient may have produced eventual higher peak torque values.

The uniqueness of issues presented in a bilateral quadriceps tendon rupture challenges clinical decision making by the physical therapist. Comparison to single extremity tendon ruptures is possible for interventions, but prognosis is difficult. The bilateral lower extremity weakness and soft tissue disruptions require caution when using closed chain activities, correcting for motor control deficits, and balance disturbances. Continuity of care in the treatment team, attention to tissue healing stages, and addressing the functional needs at each stage was a contributor to the patient's success in this case. Despite functional activity restoration, objective evidence of weaknesses con-

Table 3. Objective Measures at Outcome

Test	Result	
Active Range of Motion	L (3°-0°-127°)	R (3°-0°-129°)
Manual Muscle Testing	5/5 quadriceps and hamstrings bilaterally	
Isokinetic Test- (60°/sec): Quadriceps Peak Torque to Body Weight Ratio	L 20%,	R 24%
Isokinetic Test- (60°/sec): Peak Torque Quadriceps	L 82.7 Nm	R 97.6 Nm
Care Connections [25]	14/50	
Visual Analog Pain Scale	1.8 cm	

Table 4. Functional Testing Results at Outcome

Test	Observation
Gait	Long walking stick, normal gait stride with mild bilateral compensated Trendelenburg and intermittent but inconsistent hyperextension moments of the knees in stance phase.
Standing Posture	Upright, intermittent but inconsistent hyperextension lock of knee.
Squat	Able to lower and raise from standard chair with control and no use of arms.
Anterior Lunge	To floor without hand support, and rise with minimal hand weight bearing, 5 reps each leg achieved.
3-inch Step Down	With control, no rail, reciprocal pattern.
8-inch Step Down	With rail to balance, mild eccentric control loss.
Single Leg Balance	5 sec no hands (stepping strategy), 30 sec with finger tip touch (ankle strategy) (Bilateral finding).
Bilateral Heel Raise	20 reps, finger tip touch to maintain balance.
Single Leg Heel Raise	Unable to perform full range of motion.
Stand on Heels	Able to walk on heels 10 feet.
Tinetti	Balance, 15/16 Gait, 11/12 Total, 26/28.

tinues to exist. Some case studies include earlier prescription of quadriceps setting exercise.[16,23,24] This was not done in this patient's case as deemed as a contraindication by the surgeon. Earlier implementation of submaximal quadriceps setting to enhance neuromuscular activation of the quadriceps may be warranted.

This case report has attempted to present an evidence-based rehabilitation approach for this patient population despite its low incident rate. Detailed information on restrictions, when to initiate exercise, phase progressions coincident with healing times, and improved methods to optimize strength with increasing risk of rerupture are all factors that may allow for improved overall care for these patients who have undergone this type of surgery.

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Sonographically Guided Physical Therapy of Achilles Tendinopathy Following Platelet Rich Plasma Injection: A Case Report

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ABSTRACT

Background & Purpose: Optimal management of tendinopathies has been elusive. Recently interest in platelet rich plasma (PRP) injections has been described. Few studies have been published examining the use of PRP for tendinopathies. These studies have wide variations in methodology and have shown mixed results. This case study describes one approach to the management of a patient with chronic Achilles tendinopathy with PRP injection with an emphasis on the post-procedure management. **Methods:** A basketball coach with refractory Achilles tendinopathy underwent a series of 3 ultrasound guided platelet rich plasma injections. The patient then underwent a 10-week course of physical therapy where progression of tendon loading was determined in part by the quality of tendon morphology as determined by periodic sonograms. **Findings:** At the conclusion of physical therapy, the patient was pain free and had resumed his prior level of activity. At a one year follow up he continued to be pain free and a Victorian Institute Sport Assessment-Achilles questionnaire was completed with a score of 96/100. A sonogram taken at one year revealed normalization of tendon morphology. **Clinical Relevance:** This case study describes one approach to the management of chronic Achilles tendinopathy. Many factors could have resulted in the favorable outcome in this case. The use of multiple injections to achieve filling of tendon defects, an individualized assessment of tendon healing clinically and by ultrasound to inform a graduated increase in tendon loading warrant further study.

Key Words: Achilles tendinopathy, sonography, platelet rich plasma, physical therapy

INTRODUCTION

Growing interest in using plasma rich protein (PRP) injection therapy as a treatment approach in chronic tendinopathies.[1,2] Plasma rich protein is an autologous concentration of human platelets in a small volume of plasma. Within the concentration of plasma platelets exists approximately 7 fundamental growth factors that are actively secreted by the platelets to initiate wound healing. When the autologous concentration solution of platelets are formulated and injected into the injury site, the growth factors within the solution bind to the cell membrane at the site of injury via transmembrane receptors. The mechanism of the transmembrane receptors allows activation of an endogenous internal signal protein that begins the process of cellular proliferation, matrix formation, and collagen synthesis. The goal of PRP injection therapy is to promote the synthesis of type I collagen. It has been postulated that concentrated growth factors within PRP injections work in conjunction with the body's natural healing response for the repair of damaged tissue.[3]

Optimal patient selection, injection protocols, post-procedure rehabilitation, and a return to activity following PRP injections have not been defined in the literature. The limited evidence published to date reveals wide methodological variability with all aspects of PRP injection management.[4-8] Absent a well-supported methodological approach, clinical experience has been the main determinate for rehabilitation and activity progression following PRP injections. This has led to a wide variability in treatment approaches and potentially wide variability in outcomes.

CASE DESCRIPTION

A 37-year-old male patient presented to JH with a one year history of chronic Achilles tendon pain following an injury while playing softball. He was previously unresponsive to multiple conservative treatments including; medication, physical therapy (PT), orthotics and immobilization. After a careful physical examination, plain radiographs were obtained that were positive for calcific tendinopathic changes at the distal Achilles tendon insertion. A sonogram by JH[9] (Figure 1) demonstrated an irregular hypoechoic area in the distal Achilles tendon with an estimated 40% disruption of the normal fibrillar pattern. Areas of calcification were noted throughout the distal tendon.

Based on the clinical and imaging findings, he was diagnosed with chronic Achilles tendinopathy. After conferring with JH, the patient elected to proceed with autologous PRP injections.[1,2]

The procedure was completed according to the following protocol: The patient's blood was withdrawn into a 60 mL syringe. To the autologous blood, 5 mL of sodium citrate anticoagulant was added and the resulting solution was injected into the proprietary Harvest Technologies separation cassette. The cassette was placed into centrifuge for 12 minutes. Five milliliters of PRP was then drawn from the cassette into a 10 mL syringe with 2 cc of lidocaine 1%. Using ultrasound guidance, the PRP solution was injected in the distal Achilles tendon. Following injections, the patient was immobilized in a walking boot and was asked to minimize weight-bearing activity. At 6 weeks into a course of physical therapy the boot was discontinued.

After each PRP injection sonograms were performed documenting improvement in tendon echogenicity. Three injections were ultimately necessary to achieve adequate filling of tendon defects. Each of the 3 injections was spaced ~3 weeks apart. Two weeks after receiving his third PRP injec-

tion, the patient was referred for PT. Criteria for PT referral included a marked reduction of the patient's subjective pain complaints, decreased point tenderness over the site of injury, and improved tendon quality demonstrated by sonography.

The initial physical therapy evaluation of the patient yielded the following results:

- Patient was ambulating in a walking boot.
- Pain at the right Achilles tendon was 2/10 at rest, increasing to 5/10 with weight bearing inside the walking boot on a numeric pain rating scale (NPRS).
- Active right ankle dorsiflexion (DF) was 0º and plantarflexion was 25º.
- Palpation revealed focal thickening of the right Achilles tendon as compared to the contralateral side.
- Visible atrophy of the right calf with 4/5 strength on manual muscle testing.

A post PRP treatment sonogram (Figure 2) providing a pre-PT baseline was performed by WS. This baseline examination revealed fusiform swelling and residual small focal hypoechoic areas. When compared to scans taken several weeks prior to PT, there was a visually improved tendon morphology at the injury site.

To establish safe limits of range of motion (ROM) ultrasound-guided motion (Figure 3) was initially used with the goals to protect and promote healing of the PRP injection site. Five degrees of passive ankle DF was determined as the starting upper limit of motion based upon minimal separation of fibers near the enthesopathic ossification as well as accompanying reports of discomfort (Figure 3).

Rehabilitation was divided into 3 phases.

- Phase 1: Goal to restore ROM while protecting the PRP graft. Interventions consisted of mobilization, flexibility exercises, low intensity exercise, and partial weight bearing activities. Dorsiflexion was limited to no more than 5°. Progress to Phase 2 when no sonographically observed gapping of tendon at end ROM DF.
- Phase 2: Progression of exercises to include higher level resistance. Initiate weight bearing activities out of boot. Progress to Phase 3 when repeat sonogram demonstrates healing progression, asymptomatically improved ROM, strength and weight bearing activities.
- Phase 3: Progression of exercises to include eccentric triceps surae and advanced neuromuscular reeducation.

In *Phase 1*, the main goal was to restore normal ROM while protecting the PRP graft. Soft tissue mobilization above the graft site, joint mobilization, controlled motion, and flexibility exercises were employed to improve mobility and assist in collagen organization and synthesis. Isometric, manual rhythmic stabilization and partial weight bearing exercises were used for muscle re-education and to facilitate strengthening.

Once the patient met the clinical goals of *Phase 1*, sonography (Figure 4) was used to assess the outcomes of the initial phase of therapy and to determine the readiness of the patient to implement *Phase 2*. The sonogram taken at the conclusion *of Phase 1* demonstrated continued normalization of tissue with a reduction in focal hypoechoic sites. The patient's ability to sustain end-range stress was also reassessed using sonography.

Phase 2 consisted of a continuation of *Phase 1* interventions with the addition of gradual lengthening of the Achilles tendon through the use of progressive strengthening exercises and the initiation of weight bearing activities out of the boot with an emphasis on balance, and heel to toe gait motion. During this phase, the patient began cycling activities out of the boot.

A third sonogram of the tendon was performed at week 5 as the patient's clinical examination findings continued to improve (Figure 5). The third sonogram revealed decreased tendon thickness and normalization of the tendon structure.

Based on asymptomatic progression of weight bearing activities, increased strength, improved ROM, with sonographic findings of continued tissue normalization, the patient was progressed to the third management phase.

During *Phase 3* triceps surae eccentric exercises[10,11] were initiated as well as plyometric exercises to increase dynamic activities and to improve strength, neuromuscular control, and balance.

OUTCOMES

At the completion of 10 weeks of therapy, the patient improved with respects to pain and disability (Figure 6). Our criteria for measurable improvements were based upon:

- improvement in ankle ROM,
- the ability to ambulate on a treadmill for 10 minutes at 3.5 mph with an NPRS rating of < 1/10,
- return to unrestricted activities of daily
- sonographic finding of normalization of tissue depicted as reduced fusiform enlargement and homogeneity of the Achilles tendon similar to a published report by Ohberg.[12]

The patient was cleared to resume full activities including coaching basketball.

The patient returned one year later and completed the Victorian Institute Sport Assessment-Achilles questionnaire, a self-reported pain and activity outcome survey. His score was 96/100. The Victorian Institute Sport Assessment-Achilles has a score range from 0 to 100, a score 80 or above corresponds with less pain and increased activity.[13] This questionnaire has been shown to be reliable and to have construct validity in patients with Achilles tendinopathy.

DISCUSSION

Optimal management of tendinopathies has been elusive. Treatment methods advocated for patients with partial tears of the Achilles tendon resulting from tendinopathy have included nonsteroidal anti-inflammatory medication, rest, iontophoresis, soft tissue mobilization, exercise programs, heel lifts, steroid injections, immobilization, and surgical intervention all with mixed results. In methodologically robust studies, no one intervention strategy has been demonstrated to have superior results.[14] Historically treatment approaches for tendinopathies in general such as therapeutic ultrasound, iontophoresis, phonophoresis, nonsteroidal anti-inflammatories, corticosteroid injections, and immobilization have not demonstrated long term efficacy and some strategies may be detrimental to tendon healing.[15-19]

The interest in PRP injection therapy has been tempered by a lack of robust evidence supporting its efficacy.[20] A recent study[4] that received widespread attention examined PRP injection in chronic Achilles tendinopathy. In a blinded trial, PRP was compared with saline injection followed by eccentric exercise for both groups and no difference was found between groups. In our opinion post-procedure limitations of this study include a lack of monitoring of tendon healing by sonography that precluded determination if additional PRP injections were needed, and an arbitrary initiation of eccentric exercise. Gaweda[7] in one case series reported favorable outcomes

Figure 1. Sonogram taken at initial presentation.

Figure 2. Baseline sonogram prior to starting physical therapy.

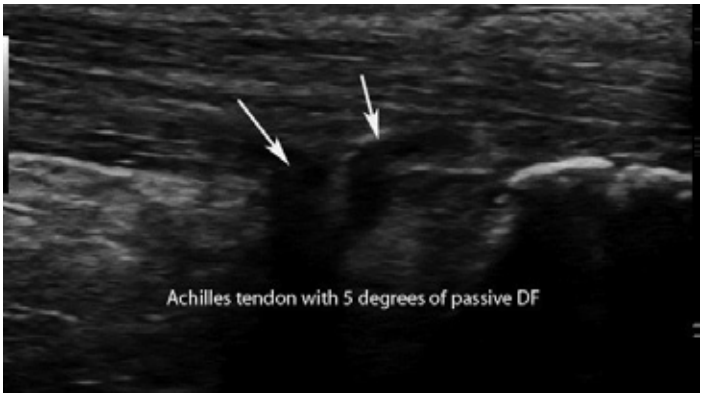

Figure 3. Scan taken with 5º passive DF. Arrows denote minimal separation of fibers at 5º of DF near the enthesopathic ossification establishing the limits of ROM prior to initiation of PT.

Figure 4. Two weeks into PT demonstrates a reduction in focal hypoechoic sites.

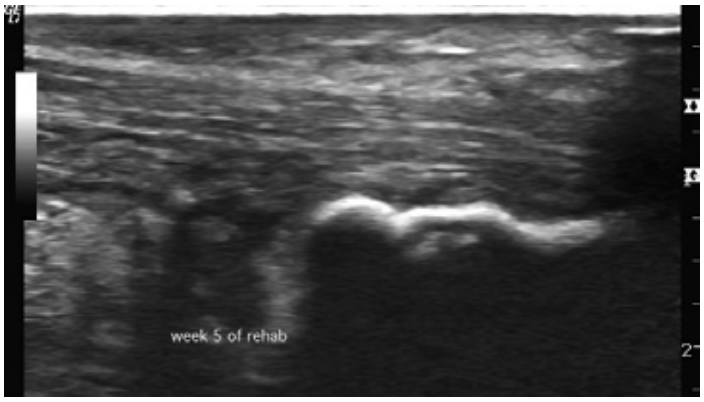

Figure 5. Decreased tendon thickness and improved echogenicity of tendon is noted.

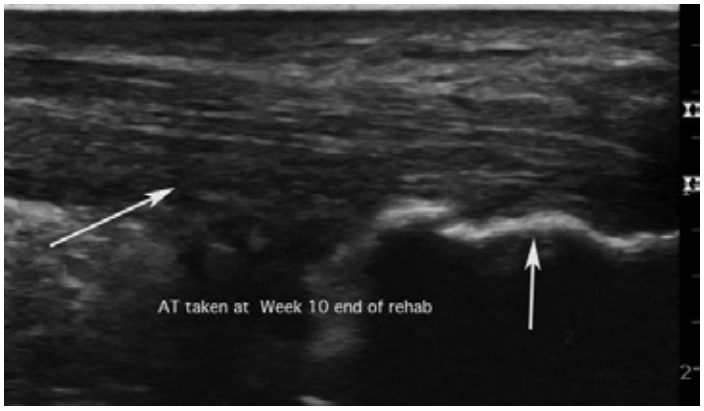

Figure 6. Sonogram after 10 weeks of physical therapy.

using ultrasound guided PRP injection and activity progression once tendon healing was noted by sonography.

Following PRP injection, our goals of PT management are based on avoiding excessive scarring and disruption of the healing process while minimizing disuse atrophy and other associated sequela of immobilization.[21,22] Physical therapy management was guided by careful monitoring of tissue healing using clinical assessment and periodic ultrasound imaging. The knowledge derived, particularly from sonography, enabled the physical therapist to monitor and optimally increase the strain placed on the healing tissue.[10-12] This study has limitations as a retrospective, single subject case study.

This case report describes one use of sonography to guide physical therapy following Achilles tendon PRP injections. The added use of ultrasound guided treatment progression could have been a factor in the favorable outcome for this patient.

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Boston, MA	Yack	Sep 26 - 30
St. Augustine, FL	Viti	Oct 24 - 28
Baltimore, MD	Smith	Nov 8- 12

S2 - Advanced Evaluation & Manipulation of Pelvis, Lumbar & Thoracic Spine Including Thrust
21 Hours, 2.1 CEUs (Prerequisite S1)
$595

St. Augustine, FL	Viti	Sep 14 - 16
Washington, DC	Irwin	Sep 21 - 23
Cincinnati, OH	Irwin	Oct 5 - 7
Atlanta, GA	Irwin	Nov 2 - 4
Chicago, IL	Yack	Nov 16 - 18

S3 - Advanced Evaluation & Manipulation of the Cranio Facial, Cervical & Upper Thoracic Spine
27 Hours, 2.7 CEUs (Prerequisite S1)
$795

Chicago, IL	Smith	Sep 14-17
New York City, NY	Smith	Oct 19 - 22
Las Vegas, NV		Nov 1 - 4
Boston, MA		Nov 8 - 11
St. Augustine, FL	Smith	Dec 7 - 10
San Diego, CA		Dec 13 - 16

S4 - Functional Analysis & Management of Lumbo-Pelvic-Hip Complex
15 Hours, 1.5 CEUs (Prerequisite S1)
$545

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St. Augustine, FL	Grant Roys	Oct 6 - 7
Atlanta, GA	Nyberg	Oct 20 - 21
Cincinnati, OH	Lonnemann	Nov 3 - 4
Ft. Lauderdale, FL	Grant Roys	Nov 10 - 11
Chicago, IL	Nyberg	Dec 8 - 9

E1 - Extremity Evaluation and Manipulation
30 Hours, 3.0 CEUs (No Prerequisite)
Also Available to OTs
$745

Louisville, KY	Naas	Sep 20 - 23
Orlando, FL	Busby	Oct 25 - 28
Houston, TX	Turner	Oct 18 - 21
Virginia Beach, VA	Naas	Nov 8 - 11
Birmingham, AL	Busby	Dec 6 - 9
Las Vegas, NV	Turner	Dec 6 - 9
Scranton, PA	Naas	Dec 6 - 9

E2 - Extremity Integration
21 Hours, 2.1 CEUs (Prerequisite E1)
$595

Austin, TX	Patla	Sep 21 - 23
New York City, NY	Patla	Oct 12 - 14
Little Rock, AR	Conrad	Oct 26 - 28
Chicago, IL	Conrad	Nov 2 - 4
St. Augustine, FL	Patla/Conrad	Nov 30 - Dec 2
Denver, CO	Patla	Dec 7 - 9

Advanced Manipulation Including Thrust of the Spine & Extremities
20 Hours, 2.0 CEUs (Prerequisite: Completion of MTC Certification)
$775

Denver, CO	Yack	Nov 9 - 11

MF1 - Myofascial Manipulation
20 Hours, 2.0 CEUs (No Prerequisite)
$595

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Gulf Port, MS	Cantu	Oct 12 - 14
Washington, DC	Grodin	Oct 12 - 14
Charleston, SC	Cantu	Nov 2 - 4
San Francisco, CA	Grodin	Nov 9-11
Houston, TX	Grodin	Dec 1 - 3
St. Augustine, FL	Stanborough	Dec 14 - 16

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32 Hours, 3.2 CEUs
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$995

St. Augustine, FL		Oct 29 - Nov 3

CRANIO-MANDIBULAR, HEAD, NECK & FACIAL PAIN CERTIFICATION Preparation and Examination
32 Hours, 3.2 CEUs
(Prerequisites: S1, S3, CF1, CF2, CF3, CF4)
$995

St. Augustine, FL		Oct 27 - 31

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Applied Musculoskeletal Imaging for Physical Therapists
21 Hours, 2.1 CEUs (No Prerequisite)
$545

Grand Rapids, MI	Agustsson	Sep 14 - 16
New York City, NY	Agustsson	Nov 2 - 4

Animal-Assisted Therapy: Improving Treatment Outcomes
15 Hours, 1.5 CEUs (No Prerequisite)
$545

St. Augustine, FL	Redner/Schefke/ Schuitema	Nov 17 - 18

Caregiver Training 1: Assessment and Treatment of Dementia
12 Hours, 1.2 CEUs (No Prerequisite)
Open to OTs, PTs, COTAs, PTAs and other health professionals
$445

St. Augustine, FL	Hubbard	Sep 29 - 30

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Book Reviews

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

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

Muscle and Sensory Testing, 3rd Edition, Elsevier, 2012, $83.95
ISBN: 9781437716115, 605 pages, Spiral Cover

Editor: Reese, Nancy Berryman, PhD, PT

Description: This book represents a single source for muscle strength assessment and neurologic examination. A companion website uses video clips to demonstrate the techniques and offers related web links and references. The previous edition was published in 2010. **Purpose:** The purpose is to provide students and healthcare professionals with accurate assessment techniques for the neuromusculoskeletal system. This edition places more emphasis on published evidence for the procedures it describes. It also expands on functional testing for more active individuals, and for pediatric hand-held dynamometry. The techniques it presents are essential skills that will enable clinicians to accurately assess patients and help guide them in their clinical decision making. **Audience:** The target audience includes students and professionals in healthcare disciplines. It is an excellent resource for students, and also would be useful as a quick reference in the clinic. **Features:** The beginning chapters cover manual muscle testing of the upper and lower extremities, head, neck, and trunk for pediatric patients through adults. Subsequent chapters cover functional muscle testing, hand-held dynamometry, the neurological screening examination, and using observational gait as a screening tool. Chapters are clearly organized using the same format throughout, allowing readers to quickly look up specific tests by muscle action. The well-done illustrations and photos provide clarity for patient position, stabilization, and patient and examiner action. Red arrows indicating direction of patient movement and examiner direction of resistance are especially useful for students. "Evidence for Practice" boxes following techniques offer the most up-to-date published research, and chapters conclude with case studies. The appendixes provide a concise reference for average joint ranges of motion, muscle innervation by spinal cord level and by peripheral nerve. The companion website, a great tool to enhance learning, is divided into two sections: student learning and instructor resources. **Assessment:** This is a good update, with the change from DVD to learning system website, the addition of "Evidence for Practice" boxes, and the expansion of chapters to include functional testing for more active individuals and a greater variety of sensory testing techniques. The techniques of manual muscle testing and neurological assessment have not changed significantly through the years. That said, this book is useful for students and seasoned clinicians, as it provides the most recent research and at-a-glance access to tests.

Lauren Y Perrone, MPT, OCS
Head 2 Toe Physical Therapy

Geriatric Physical Therapy, 3rd Edition, Elsevier, 2012, $91.95
ISBN: 9780323029483, 611 pages, Hard Cover

Editors: Guccione, Andrew A., PT, PhD, DPT, FAPTA; Wong, Rita, EdD, PT; Avers, Dale, PT, DPT, PhD

Description: An update of a 2000 edition, this book provides a thorough foundation in geriatric physical therapy, from basic science applications in aging to intervention strategies for specialty populations. **Purpose:** The stated purpose is to assist the development of therapists who can use available evidence and objective measures to integrate health and functional status with components of the physical therapy exam, formulate a diagnosis, and design effective interventions through the continuum of care across varying settings to achieve the best outcomes. The book also aims to help practitioners be informed advocates for older adults. The book describes the differences in geriatric physical therapy and promotes advancing geriatric practice through the use of best available evidence. As our profession continues to elevate the practice of physical therapy through the incorporation of new research in practice, it is important to make the best available evidence accessible to busy, practicing clinicians. This book does just that for clinicians working with older adults. **Audience:** Intended for both students and practicing clinicians, the book is well suited for students interested in specializing in geriatric care and is a complete reference for practicing clinicians or for aspiring geriatric certified specialists. The editorial team is headed by a leader in physical therapy research in the area of geriatrics and functional outcomes. **Features:** Topics range from the physiology of aging, examination, evaluation, special problems older adults face in different settings, to nonclinical patient management related to reimbursement and patient advocacy. Chapters on the physiology of aging provide a well-written review with a section on evidence-based manual intervention. Management of hip fracture in the cognitively impaired is helpful for acute and outpatient therapists and includes a discussion of environmental concerns. Many tables help organize concepts and serve as quick references, particularly in the section on functional outcome norms. Chapters on special populations cover a wide spectrum of practice, from the senior athlete to older adults with developmental disabilities to end-of-life care. References are available only on the accompanying Evolve website, which requires creation of an account, but also provides links to the Medline abstracts of the references as well as other helpful website links. **Assessment:** This is a great reference for geriatric practice, and a useful resource for clinicians who would like to remain current on the evidence relating to geriatric practice. This edition adds more contributors specializing in this field, reflecting the advances of this area of physical therapy practice.

Monique Serpas, DPT
HealthReach Rehabilitation Services

Functional Movement Development: Across the Life Span, 3rd Edition, Elsevier, 2012, $64.95
ISBN: 9781416049784, 370 pages, Soft Cover

Authors: Cech, Donna J., DHS, PT, PCS; Martin, Suzanne Tink, MACT, PT

Description: This book reviews the development and changes in the human body throughout the lifespan in terms of psychosocial growth, body systems, body structure, and functional mobility. This update of the 2002 edition includes the most current evidence-based concepts and additional clinical examples. **Purpose:** The authors are successful in providing an understanding of the impact that changes to the human body's multiple systems have on functional movement throughout the lifespan, from conception to death. Covering all aspects of normal development in one book makes this work unique. **Audience:** The primary audience is physical therapy and occupational therapy students as well as other healthcare professional students who treat clients for impaired functional movement. The book is most suitable for undergraduate physical therapy students studying human development and physical therapy assistant students. **Features:** The book is conveniently divided into three sections that address basic concepts of functional movement, body system development and changes, and functional movement outcomes. The first section reviews the basic concepts of functional movement in order to help readers develop a conceptual foundation for the remainder of the book. The second section reviews how body systems develop and change throughout the lifespan, and the impact these changes have on functional movement. The final section is the most detailed and informative, particularly the chapters discussing posture and balance, locomotion, and prehension. **Assessment:** The level of detail of the function and development of the body systems and the overall content of the book as a general review make the book most suitable for undergraduate students or students pursuing an associate healthcare degree. For practitioners, this serves as a review of the body's multiple systems and their effects on functional movement, but it does not include advanced theories or specific techniques to treat functional movement dysfunctions in a clinical setting. Nonetheless, the review of neonatal development of each body system is uncommonly useful to practitioners and a rare find in such books.

Jennifer C. Hoffman, PT, DPT, OCS
Private Practice

Introduction to Pathology for the Physical Therapist Assistant, Jones & Bartlett Learning, 2013, $82.95
ISBN: 9781449630584, 502 pages, Soft Cover

Author: Moini, Jahangir, MD, MPH

Description: This book provides an introduction to health and disease; the pathology of the cell; infection, inflammation, and repair; pathology of the body systems; and environmental hazards. Extensive illustrations, charts, graphs, and a substantial glossary supplement the text. **Purpose:** The purpose is to provide thorough, entry level information about pathology for physical therapist assistants. The topics were chosen to reflect areas which physical therapist assistants are likely to encounter on a day-to-day basis. The author does an excellent job of covering a wealth of material, and presenting it in an organized and easy-to-understand manner. Each chapter is outlined with specific learning objectives and includes a glossary of terms, review questions, and case studies. **Audience:** Although written specifically for physical therapist assistants, the book also can be used by other clinicians wanting to expand their knowledge of pathology. The author has written many textbooks in the fields of pathology, anatomy and physiology, and pharmacology. **Features:** Each of the five units contains multiple chapters that provide more specific detail on topics in that unit. The book presents the material clearly and concisely without too much medical terminology. Each chapter has clearly defined key terms with an informative glossary. One weakness is that, other than small sections labeled "red flag," the book does not specifically correlate the condition being discussed to clinical implications for the therapist. Another weakness is the lack of references other than a few web pages listed at the end of each chapter. **Assessment:** Overall, this is a useful book that can be used by students or clinicians wishing to improve their knowledge in the field of pathology. It can easily be used as a quick reference or an educational tool. It is well written, easy to read, and uses numerous helpful pictures, graphs, charts, and diagrams. Its only shortcoming is it does not specifically note implications for the physical therapist assistant for the pathology or condition being discussed.

Daniel Higgins, DPT, OCS, ATC
Orthopedic & Sports Physical Therapy Associates

Manual Therapy Seminars: Needs of the Complex Patient

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"Visceral Manipulation enables one to gain awareness of relatively ignored structures." - M. Nicholson, PT

"Fellow colleagues at Memorial Sloan Kettering Cancer Center can't stop talking about how helpful your course has been in their treatment of our patients." - T. Fitzpatrick, PT, MBA

Visceral Manipulation: Organ-Specific Fascial Mobilization; Abdomen 1 (VM1)

Toronto, ON	Nov 1 - 4, 2012
Big Sur, CA	Nov 4 - 9, 2012
Green Bay, WI	Nov 15 - 18, 2012
Tampa Bay, FL	Nov 29 - 2, 2012
Vancouver, BC	Dec 6 - 9, 2012
Tucson, AZ	Dec 6 - 9, 2012
Houston, TX	Dec 13 - 16, 2012
Washington, DC	Jan 17 - 20, 2013
Dallas/Ft. Worth, TX	Jan 24 - 27, 2013
Denver, CO	Feb 21 - 24, 2013
Palm Beach, FL	Mar 7 - 10, 2013
Edmonton, AB	Mar 21-24, 2013

Neural Manipulation: Neuromeningeal Manipulation; An Integrative Approach to Trauma (NM1)

Chicago, IL	Dec 7 - 9, 2012
Minneapolis, MN	Jun 21 - 23, 2013

TIME magazine named Jean-Pierre Barral, DO, MRO(F), RPT, "one of the Top Healing Innovators to watch in the new millennium."

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OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

Greetings OHSIG Members!

A FEW EXCITING UPDATES FROM THE OCCUPATIONAL HEALTH SIG

Opportunity for Member Participation

We hope some of you responded to the survey that was sent asking for participation for authors with expertise in occupational health and an interest in writing a monograph to be included as part of an independent study course produced by the Orthopedic Section, APTA. The course will be comprised of a total of 6 monographs.

A survey was sent to all OHSIG members. We hope this was of interest to some of you. Responses were to be sent to OHSIG VP/Ed Chair, Lorena Pettet Payne, lpettet@aol.com.

Thank you to Rick Wickstrom, PT, DPT, CPE, CDMS

A huge thank you to Rick Wickstrom, OHSIG, for his passion and involvement with the OIDAP over the past several months. The OIDAP provided a summary report in light of the disbandment of the task force. Rick has attended meetings on our behalf and has played a key role with many stakeholders. In addition Rick provided feedback on behalf of the OHSIG to APTA related to the inclusion of work information in the electronic health record (EHR). The NIOSH, CDC, and HHS are requesting public comments on the potential inclusion of work information in the electronic health record (EHR). Karen Jost reached out to the OHSIG and feedback was provided.

Are you able to attend the First International FCE Research Meeting in the Netherlands?

The First International FCE Research Meeting will be in Haren, The Netherlands and will take place October, 25, 2012. This is a great opportunity to participate with top researchers and others in the area of FCE and a great opportunity to collaborate with colleagues from around the world.

A brief look at the agenda and speakers:

- New research
  1. Does test evaluator's fear of injury influence maximal lifting capacity? A triple blind RCT. Sandra Jorna-Lakke
  2. Cost-benefit of work-related multidisciplinary rehabilitation for patients with MSDs: Does employment status matter? Marco Streibelt
  3. Can submaximal physical and functional capacity be detected in patients with chronic pain? A systematic review. Suzan van der Meer
  4. Reliability, agreement and safety of FCE in patients with WAD. Maurizio Trippolini
- Pros/Cons for normative values for FCE. A debate Remko Soer and Paul Kuijer
- FCE as outcome
  1. Gender differences in capacity ratings predicting RTW for patients with MSDs. Marco Streibelt
  2. Decline of functional capacity in healthy aging workers. Remko Soer
  3. Longitude assessment of physical capacity in a cohort study on early osteoarthritis of the hip and the knee. Andre Bieleman
  4. Does the performance of an FCE lifting test differ between employees on sick leave due to MSDs in physically demanding work and their health counterparts? Paul Kuijer
  5. Deconditioning in workers with chronic MSD pain: does work matter? Remko Soer
  6. Client's perspective on the utility of FCE for the assessment of physical work ability, prognosis for work participation and advice on RTW. Willemijin Pas
- Pre-employment FCE
  1. Pre-employment functional assessments predict MSD injury risk associated with manual handling in coal miners. Jenny Legge
  2. Job-specific FCE protocols for household waste collectors: development and reproducibility. Vincent Gouttebarge
- One for all, or all for one?
  1. Debate
  2. Generic or specific FCE protocols? Vincent Gouttebarge and Doug Gross
- Where do we go from here?
  1. Open discussion
  2. FCE research agenda. Doug Gross and Michiel Reneman

Note: Details on the program, directions to our rehab center, and dinner are posted on our website: http://www.umcg.nl/NL/UMCG/AFDELINGEN/CENTRUMVOORREVALIDATIE/RESEARCHONDERWIJS/POSTWDPIMEETING-FCE/Pages/default.aspx

Announcing Second Scientific Conference on Work Disability Prevention and Integration; Healthy Aging in a Working Society

October 22-24, University Medical Center Groningen, The Netherlands

The FCE Research Meeting will follow the WDPI meeting. For more information on WDPI, go to the following: http://wencke4.housing.rug.nl/documenten/medici/Internationale_Conferenties/WDPI%202012/WDPI_2012.htm

Announcing Human Factors and Ergonomics Society Annual Meeting

The Human Factors and Ergonomics Society announce the 56th Annual Meeting to be held October 22-26, 2012 at the Westin Boston Waterfront in Boston, MA. Additional details are at http://www.hfes.org//Web/HFESMeetings/2012annualmeeting.html.

OHSIG Election

The office of President is up for election later this fall. The term is 2013-2016. If you are interested in running, contact Jill Galper, Nominating Committee Chair at Jill.Galper@imxmed.com.

Thank you to John Levene, DPT, OCS, CMT, MS, for his article in this issue of OPTP on pre-placement testing.

In his article John discusses the evidence that supports a pre-placement functional testing program. Pre-placement testing has been shown to reduce injury rates and employment costs for employees performing heavy physical demanding jobs. Thanks to John for a look at the benefits of such a program.

OHSIG BOD Members

As always, your BOD members are listed on the Orthopaedic Section Web site. We welcome your feedback!

Professional Regards,
Margot Miller PT
OHSIG President

The Effects of Functional Pre-employment Testing on Work Injuries and Workers' Compensation Costs

John Levene, MS, PT, OCS, CMT
SVP, National Therapy Director, Concentra, Brookfield, WI

INTRODUCTION

In order to remain competitive in today's global marketplace, United States employers must manage all aspects of their expenses including employment related costs such as workers' compensation. Workers' compensation costs have increased at an alarming rate in the past 20 years.[1] Multiple strategies have been adopted in order to control costs such as aggressive case management of medical expenses and lost time related to workers' compensation cases. Ergonomic programs have been implemented to abate potential job hazards and reduce injuries. Such ergonomic programs have been successful in making jobs safer; however, it is not possible to engineer out the physical requirements of many jobs. In order to better match employees to the physical requirements of a job, employers have implemented pre-placement functional testing based on the concept that employees who are physically matched to their job are less likely to experience a job-related injury. In theory, employees may benefit from such pre-placement tests as they will have less risk of harm, improved job satisfaction, and career longevity.

Programs to test job applicants' strength to perform a specific job were first reported by Chaffin et al[2] and Keyserling et al[3] who reported that the incidence of musculoskeletal injuries reduced as employees' isometric strength exceeded the requirements of the job. This led some employers to adopt discriminatory hiring practices by setting artificially high applicant strength qualifications that far exceeded the actual requirements of the job. In 1991 the Americans with Disabilities Act (ADA) established guidelines for employers on nondiscriminatory practices in screening individuals for jobs. The ADA requires that employers must hire applicants with or without impairments or functional deficits who are otherwise qualified if they can perform the essential functions of the job. Employers may not perform tests that tend to screen out certain individuals and tests must be a valid representation of the physical essential job functions and consistent with business necessity. As a result of the ADA, pre-employment tests must be job specific and test for the applicant's ability to perform the essential job functions.[4]

To date, scientific data to support the effectiveness of pre-employment tests is minimal. Controlled studies on employers implementing pre-employment testing programs is rare because employers are most often implementing multiple cost control strategies simultaneously, consequently confounding the effects of a pre-employment test alone. Employment issues and work environment limit the ability to have a true control group and therefore limit the possibility of a randomized controlled trial. Employment and cost data collection is challenging due to multiple parties involved. Employment data resides with human resources departments and workers' compensation cost data often reside with third party payers. Extracting costs related to subjects involved in a study from workers' compensation cases is an administrative burden. As a result, most evidence to support pre-placement testing is in the form of quasi-experimental or case studies. The purpose of this analysis is to review the evidence that supports the effectiveness of pre-placement functional testing programs on reducing work place injuries and employment related costs.

METHODS

The initial search was conducted on 11-1-08 using PubMed at the College of St Scholastica's academic library. Search terms used were "pre-placement or pre-work and testing AND functional." Limits used were English language and human. The search yielded 61 related articles. Inclusion criteria consisted of: (1) studies conducted after 1991; (2) test methods were ADA compliant; (3) test methods screened for the ability to perform the essential job functions with specific pass and fail criteria; (4) tests were not dependent upon specific commercial equipment and could be replicated in multiple locations. Eight articles were selected for review by scanning the titles and abstracts. Two articles by Reimer et al[5] and Rosenblum et al[6] used isokinetic equipment to measure strength and predict function; they were both excluded because they did not test essential job functions. One article by Scott[7] was actually a descriptive article with a case study and not a scientific investigation, and therefore excluded as well. The remaining 5 studies met the inclusion criteria and were included in this analysis.

REVIEW OF THE LITERATURE

Littelton M. Cost effectiveness of a pre-work screening program for the University of Chicago physical plant. *Work*. 2003; 21(3): 243-250.

Littelton[8] conducted a study to examine the effect of a post-offer pre-placement physical screen test on the frequency and severity of work related musculoskeletal injuries and overall workers' compensation costs. Subjects were 712 new hire employees grouped into 18 separate job classifications at the physical operations department for the University of Illinois Chicago between 3-1-98 and 2-28-01. Subject demographics

were not disclosed. A job site analysis was performed by a physical or occupational therapist to identify the key essential job functions and critical physical demands. Functional physical screens were developed for each job classification based on the Physical Work Performance Evaluation developed by Lechner et al.[9] Each physical screen consisted of 5 to 7 functional tasks with specific pass or fail criteria. Subjects were required to pass all functional tasks components of the screen in order to be eligible for employment.

A quasi-experimental, retrospective design was used to analyze the cost effectiveness of the screening program. Three job classifications comprising 87% of the total screens completed were used for data analysis. The number of subjects screened for each of the remaining job classifications was too small for analysis. The study compared the incidence rate of injury and workers' compensation costs for a control group of all new employees hired into the same job classifications without completing the physical screen from 3-1-95 to 2-28-98 to the experimental group who completed the physical screen from 3-1-98 to 2-28-01.

The authors noted an 18.5% reduction in the incidence of injury for the experimental group. They determined that the incidence reduction was not significant but did not disclose their statistical analysis. Workers' compensation costs were reduced by 79% for the experimental group which was considered statistically significant, but again no statistical analysis was disclosed other than data tables. Failure rate was 22% for the most physically demanding job but much lower percentage in lesser physically demanding positions. The authors concluded that the pre-placement physical screen was effective in reducing the incidence of injuries, mean cost per injury, and a cost benefit ratio of $18 saved for each dollar expended on the screening program.

Although the cost reduction appeared profound, not all of the reduction may be accounted for by the physical screen. In 2001 there was a change in approach by the university for handling workers' compensation claims that may have deemed some cases noncompensable, where similar cases may have been compensable prior to 2001. The authors also excluded certain "outlier" high dollar workers' compensation cases from the experimental group, but not the control group which certainly would affect the cost difference between the groups. Despite these limitations, the reduction in injuries and costs between the groups was impressive and support the effectiveness of pre-placement physical screens, particularly for jobs with high physical demands. A more in depth statistical analysis would have made the study more credible.

Harbin G, Olson J. Post offer, pre-placement testing in industry. *American Journal of Industrial Medicine.* 2005;47:296-307.

The purpose of this two-part study by Harbin et al[10] was to determine if a pre-placement functional screen test could be used to predict the incidence of work injury and to evaluate the effectiveness of a pre-placement functional screen in reducing employment related costs. The first phase of the study included 1435 male and 1038 female working age subjects who were tested in the order they were hired during a 3-year period from 1989 to 1991 in a food manufacturing plant. Jobs at the plant were analyzed for physical demands and categorized into one of 5 Dictionary of Occupational Titles (DOT) job classifications ranging from sedentary to very heavy work.[11] The screen consisted of 20 different anthropometric, fitness, strength, and lifting tests as outlined by the American Physical Therapy Association Functional Capacity Evaluation guideline. Results of the screen indicated which level of DOT job classifications each subject had the physical capacity to perform. Subjects were monitored for incidence of injury and job performance for a 3-year period post hire. For data analysis subjects were divided into strong, above mean strength, and weak, below mean strength groups based on results of dynamic lifting and isometric strength tests. A two sample t-test yielded no significant difference in injury incidence between the strong and weak groups indicating that strength or physical capacity alone cannot be used to predict injury. Subjects were then divided into matched and mismatched groups based on their assessed DOT classification level as matched to the DOT classification of their job. The odds ratio of injury was much higher for the mismatch group ranging from 15.6 for the lumbar spine to 58.0 for the wrist. Chi Square analysis for difference between matched and mismatched groups was significant at P equal to less than .0001.

The second phase of the study implemented a post-offer pre-placement physical screen based on results of the first study. All new hires from 1993 to 1998 were required to complete and pass a screen that demonstrated that they had the physical ability to perform the job requirements based on the DOT classification system and were monitored for injury until 2002. Neither the number of subjects hired during this period nor was a statistical analysis disclosed. The authors reported that the overall injury rate did not appear to decline, but severity of injury as measured by the cost of medical care reduced from $70,000 to $10,000 annually, and lost work days reduced from 700 to 7 annually.

The authors concluded that strength tests alone cannot be used as a sole predictor of workplace injury, however the incidence rate of injury increases for subjects who cannot demonstrate the physical ability to perform the essential functions of a job. It was further concluded that a pre-placement physical screen, which is matched to the essential job functions, is effective in reducing workers' compensation costs and lost work days and that the effectiveness increases for jobs that are more physically demanding.

When analyzing strength as a predictor of injury, dividing the subject population into two strong and weak groups based on the mean may not have been sensitive enough. Perhaps stratifying the subjects by quartile or percentile rank would have allowed for more detailed analysis of difference in injury between subjects at the high and low end of the strength spectrum. The study took place over a 13-year period in which many other cost control, employment, economic, or environmental factors may have influenced change in medical costs and lost work days. The study did not account for specific physical demand variances of different jobs that may be performed within the food plant but rather classified jobs into one of 5 physical demand levels based on the DOT. Twenty test components can be time consuming and costly to administer. The study could have evaluated which test components had the best predicative value or no predictive value in order to streamline the screen for future use. Results of this study provide evidence that a physical pre-placement

screen can be effective in reducing employment related costs but cannot be used to predict work injuries.

Gassoway J, Flory V. Pre-work screen: Is it helpful in reducing injuries and cost. *Work*. 2000;15(2):101-106.

The purpose of the study by Gassoway et al[12] was to determine the effectiveness of pre-work screening on reducing incidence of injury, workers' compensation costs, and turnover rate for nursing assistants at a regional health system. The authors implemented Isernhagen Work Systems to perform job site analysis and develop a pre-work screen based on identified physical essential job functions.[13] Test components consisted of various lifts, push/pull, simulated transfers, and dexterity and coordination tasks. The study compared 144 subjects who were hired between May 1996 and May 1997 without completing the pre-work screen, to 163 subjects hired between May 1997 and May 1998 who successfully completed the pre-work screen. Subjects were monitored for one year after their hire date for work related musculoskeletal injuries and employment status.

Results for the unscreened versus screened group respectively were as follows: Injury rate reduced from 18.1% to 13.5% , workers' compensation costs reduced from $377 to $320 per employee and turnover rate reduced from 60.4% to 41.7%. Approximately 20% of the applicants in the screened group failed a test component and were denied employment. No other statistical data was provided. The authors concluded that the pre-work screen was effective in reducing the incidence of injury, workers' compensation costs, and nursing assistant job turnover rate.

Subjects were monitored for only one year of employment which may not be a sufficient time for musculoskeletal injuries to manifest. No subject demographic information was disclosed other than the subjects were nursing assistants. The study suggests that the pre-work screen was effective in reducing injuries, controlling costs, and reducing employment turnover; however, more scientific statistical analysis would lend more credibility to the study.

Anderson C, Briggs J. A study on the effectiveness of ergonomically-based functional screening tests and their relationship to reducing workers' compensation injuries. *Work*. 2008;31(1):27-37.

The purpose of this study by Anderson et al[14] was to evaluate if an ergonomically-based functional post offer screening program was effective in reducing workers' compensation costs for physically demanding jobs in 3 similar industries. All industries involved constant manual material handling of product weighing up to 60 lbs. A post offer test battery was designed for each job based on a job site analysis that documented the strength and cardiovascular endurance demands. Dynamic lifting and isometric exertion tests were used to compare subject's strength with job match cut off scores that were based on the respective job essential functions. Because an individual can only work at a percentage of their maximum aerobic capacity for an extended period of time, a cardiovascular step test was used to assess the subject's aerobic capacity and scored against the National Institute of Occupational Safety and Health's (NIOSH) guidelines for the percent capacity at which an individual can work for extended periods of time.[15] Subjects were 468 new hire employees who completed the test battery and were monitored for musculoskeletal workers' compensation injuries and employment status. Time frames and subject demographics were not disclosed. Injury rates were determined by comparing injury incidence to the total number of hours worked by the respective group. Employment retention was determined by the number of subjects who were employed at 8 weeks post hire. A predictive validation study was conducted comparing the injury rate and employment retention of 377 subjects who passed the test battery versus 91 subjects who failed the test battery criteria.

New hires that passed the test battery had 47% less injuries than new hires who failed the test battery, significant at $\alpha < 0.001$. New hires that passed the test battery were 21% more likely to be employed at 8 weeks post hire than new hires who failed the test battery, significant at $\alpha < 0.05$.

In a separate study the authors examined the musculoskeletal injury rate for employees one year prior versus one year post implementation of the test battery for 175 other companies across the United States. In this study, applicants who did not pass the test battery were not hired. Injury reduction rates ranged from 37% to 54%.

The authors concluded that the test battery was effective in reducing the musculoskeletal injury rate across a wide range of industries and geographic locations and that the ergonomically based functional screen can be effective in identifying individuals who can safely perform physically demanding jobs.

Subject demographics were not disclosed; therefore, the applicability to a specific working population is speculative. The utilization of aerobic capacity as criteria to predict job performance is a unique approach compared to other published methodologies.

Nassau D. The effects of pre-work functional screening on lowering an employer's injury rate, medical costs, and lost days. *Spine*. 1999;24(3):269-274.

Nassau[16] conducted a 3-stage retrospective longitudinal study to evaluate the effectiveness of a pre-work functional screen on lowering workers' compensation costs and work related injuries. A pre-work functional screen was developed to test applicants for their ability to perform the physical essential functions of 16 jobs requiring heavy work demands as defined by the DOT at a regional hospital. Stages I and II were conducted from 1986 to 1992 and involve case management, patient education, and an early return to work program. Stage III involved the pre-work functional screen and was conducted from 1992 to 1996. Thirty of the 938 applicants did not pass the pre-work screen and were not hired. Injury rates and workers' compensation costs were compared between the screened employees and unscreened employees in other jobs.

In stage III, the injury rate per 100 employees was 0.58 for screened versus 0.97 for unscreened subjects; however, the reduction was not significant. There was a significant reduction, $P < 0.001$, in lost work days for screened (0.83) versus unscreened (3.83) subjects. Cost per musculoskeletal workers' compensation injury was significantly reduced for screened ($311) versus unscreened subjects ($1432). Nassau concluded that the pre-work functional screen was effective in lowering the severity of work related musculoskeletal injuries and workers' compensation costs.

Neither the subject demographics nor the pre-work screen test battery were disclosed which limits applicability and repro-

ducibility of the study. There is concern with the author comparing screened subjects in heavy jobs to unscreened subjects in less physically demanding jobs, as one would suspect lesser injury rates in the less physically demanding jobs. Perhaps comparing injury rates of subjects performing the same jobs prior to and after implementation of the pre-work screen would have been a better indicator of the screen's effect on injury rates.

DISCUSSION AND CLINICAL APPLICATION

Examination of the 5 articles provides good support for the effectiveness of pre-placement functional testing in reducing work related injuries and employment costs. Study designs reviewed were quasi-experimental and no randomized controlled trials were found. All studies reported a reduction in the incidence of work related musculoskeletal injuries but only Anderson et al[14] reported a significant reduction at 47%. All studies indicated that pre-placement functional testing is effective in reducing workers' compensation costs that far outweigh the expense of administering the tests. Littelton[8] reported a cost savings of $18 in expenses for every dollar spent on testing. Cost reductions were noted most often in the reduction of severity of injuries[8,16] which is directly related to reduction in medical expenses and lost work days.[10,16] Reductions in injury rates and costs were similar in study designs that compared screened to unscreened subjects in different time frames[8,12] and studies that compared subjects who passed or failed the screen in the same time frame.[10,14] A related case study reported by Scott[7] indicated a 25% reduction in the injury rate for screened subjects. Isokinetic pre-placement studies that tested subjects' strength matched to job requirements reported favorable reduction in injury incidence and workers' compensation costs as well.[5,6] Gassoway[12] and Anderson[14] reported an added benefit of improved employee retention which reduces recruiting, replacement, and training costs.

Various test methodologies were employed including dynamic and isometric lift tests, replication of essential job tasks such as patient transfers and aerobic testing. No one methodology appears superior to another; however, it is evident that specific test methods are most effective when they are matched to the essential job functions.[14,16] It appears that a pre-placement testing program is most effective for jobs with heavy physical demands or higher, and less effective for jobs with medium physical demands or lower as defined by the DOT.[8,10,16]

Based on the evidence outlined in this analysis, it would be appropriate to recommend an essential function based pre-placement testing program to employers as a strategy to lower injury rates and employment costs for employees performing heavy physical demands jobs. It would not be appropriate to recommend a functional pre-placement testing program for the purposes of predicting or preventing injury of specific job applicants. Further research on the effectiveness of pre-placement functional screens using a randomized controlled trial experimental design would add credibility to the body of evidence supporting the hiring strategy.

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PERFORMING ARTS

SPECIAL INTEREST GROUP

PASIG PRESIDENT'S MESSAGE

I want to take the opportunity to congratulate Amy Humphrey, DPT, OCS, MTC, Jeffrey Stenback, PT, OCS, and Jennifer Janowski, MPT, CSCS, on their recent exposure in the Advance for PT magazine article written by *Jonathan Bassett* entitled, "When the Show Must Go On." Please check out the following link. http://physical-therapy.advanceweb.com/Archives/Article-Archives/Must-Go-On-When-the-Show.aspx. The article showcases the work of performing arts physical therapists.

The PASIG is busy creating content for our resource page. It contains educational information related to dance, figure skating, gymnastics, musicians, and other performing artists. Please visit the Web site link for more information. http://www.orthopt.org/content/special_interest_groups/performing_arts/pasig_resources. If you would like to contribute content to this Web site, please contact me at joconnell@athletico.com.

Our very active research committee sends out a monthly e-blast to the membership about helpful topics in the treatment of performing artists. We are always looking for contributors to these blasts. If you are interested in contributing, please contact Annette Karim, PT, DPT, OCS, at akarim@evergreenpt.net.

We are excited about our upcoming elections for the position of Nominating Committee member and Vice President of the PASIG. The candidates are preparing for the late fall election. Please keep alert for election reminders and remember to cast your vote. We appreciate your commitment to the PASIG.

Also be sure to update your PASIG membership profile at our Web site: https://www.orthopt.org/surveys/membership_directory.php

Sincerely,
Julie O'Connell, PT, DPT, ATC
PASIG President

PASIG NEWS: PASIG STUDENT SCHOLARSHIP

Purpose: To recognize students for their contribution to performing arts medicine and to assist in defraying the cost of attending the Combined Sections Meeting (CSM).

Eligibility:

1. You must be a member of the Performing Arts Special Interest Group (PASIG).
2. You must be a student in an accredited physical therapy program when the research was conducted.
3. Your abstract for a poster or platform presentation abstract has been submitted and accepted to CSM.
4. You must attend CSM.
5. You must be listed as an author on the presentation.
6. You must participate in presenting the poster/platform.
7. Deadline for submission of your abstract for consideration for the PASIG scholarship is November 15 of the year preceding the CSM for which the scholarship is being offered.

Criteria for Selection:

1. The importance of the contribution of the abstract to the physical therapy management of performing arts physical therapy.
2. The clinical implications derived or suggested from the abstract.
3. The quality of the writing.
4. The clarity of the clinical information / data presented.

Award Committee: The committee consists of:

1. The PASIG Student Scholarship Committee Chairperson.
2. The PASIG Research Committee Chairperson.
3. The PASIG Education Committee Chairperson.

Notification of the Award:

The recipient of the award will be notified in December (of the year preceding the CSM for which the scholarship is being offered) by the PASIG Scholarship Chairperson.

CASE STUDY: Rehabilitation of an Orofacial Overuse Syndrome in a Brass Instrumentalist

Jeffrey Stenback, PT, OCS

While wind instrumentalists are not as frequently injured as a string or keyboard player, they can still experience an injury. When the younger (and often less experienced) musician lapses into an overuse injury, we can often look to the calendar and coordinate the timing of their injury with preparation for a competition, recital, audition, or jury. The likelihood of that overuse injury is potentially increased if other risk factors, such as stress, are present.[1] Additional risk factors might be rapid, repetitive or loud passages, difficult fingering, a perfectionist personality, playing multiple instruments, a new or advanced repertoire, or a change in pedagogy. Whatever the musician's diagnosis, a graded intervention that helps the musician understand proper pacing of their practice habits is critical to managing this patient subtype. In addition to the necessary flexibility, strengthening and endurance training for postural stability, education of the musician patient is within our venue as physical therapists. Better preparation regarding inherent risks is a necessary goal. This case study was chosen to illustrate a few of these issues.

The treatment of the performing artist begins with the initial evaluation. A 24-year-old male trumpet player was sent to my orthopaedic physical therapy practice on referral from a local maxillofacial surgeon with whom I regularly work. The diagnosis was right temporomandibular (TMJ) arthralgia with no prior history and negative testing for internal derangement. The patient was a music major in a 4-year university program and a senior in the midst of preparing for his juries. Juries are a required practical exam whereby an individual demonstrates

their skill level after culmination of 4 years of academic and performance studies. It is a requirement in order to graduate. The student spends a good portion of their last year preparing for this final program and then presents to a group of professors who determine whether or not the student has demonstrated enough advanced skills and knowledge of his instrument to merit the granting of his music degree. Long hours of practice and a great deal of stress are part of this process.

Case in Point

This young man's initial complaints were of facial soreness [right greater than left; numeric pain rating scale (NPRS) level of 6/10] approximately 5 minutes into playing his instrument. His symptoms worsened as he continued playing to the point that he was no longer able to practice without facial pain. His symptoms were noted with chewing firmer foods, but not to the extent noted when playing the trumpet. He began to experience a loss of muscular control in the facial muscles and some minor facial swelling, right greater than left. This loss of muscular control in the facial muscles of a musician necessarily involves their "embouchure," defined by Merriam-Webster as: "the purposeful arrangement of the facial muscles and the shaping of the lips to the mouthpiece on woodwind or brass instruments in order to produce sound." An embouchure collapse is the loss of this muscular control and is combined with strength deficits in the orofacial muscles. This collapse is often due to too much playing or excessive pressure on the mouthpiece.[1] He also complained of frontal and retro-orbital headaches, and more recently, some difficulty swallowing. He was very concerned about having to stop practicing and fearful of returning to play.

Upon further questioning, the patient related that he was definitely under a great deal of stress as he prepared for his juries. He admitted that he was a "clencher" and stated that he was averaging only about 4 to 5 hours of sleep at night. He had gotten to the point where he was unable to play his instrument without pain and had decided to stop playing entirely to see if his symptoms would resolve. A critical component of the patient history is inquiring about practice habits. In this case, his practice habits were enlightening as to the cause of his problems. Typically, he would practice about two hours per day on his primary instrument (trumpet) and reported practicing with a band that played locally for another 2 to 3 hours per week. As part of his schooling and for theory classes/composition purposes, he also played the piano. However, as he returned from a school break about half way through the school year, he had dramatically increased his practice time to approximately 9 hours per day in an attempt to prepare for his senior juries.

The young man's mother (a physical therapy assistant herself) had accompanied him to his evaluation. She voiced concern about how her son's symptoms had escalated and had insisted that he take a leave from school, come home, and be evaluated by professionals with whom she was familiar. She stated that since her son had returned home, he was somewhat withdrawn, had very low energy and was sleeping a great deal, sometimes 11 to 12 hours per day.

The Initial Evaluation

The young man's posture demonstrated a moderate forward head posture with rounded shoulders, slightly protracted scapulae, and an increased kyphosis (Figure 1). He demonstrated a 1 mm right mandibular resting deviation and had minimal swelling over the right TMJ. His jaw opening demonstrated a slight right deviation, although his opening excursion was within functional limits at approximately 40 mm (Figure 2). Lateral excursion was 5 mm to the left and 3 mm to the right. Normal excursion is considered 10 mm to each side. Protrusion was past neutral, but with a slight right deviation as well. All motions were with complaints of discomfort in the right greater than left facial muscles.

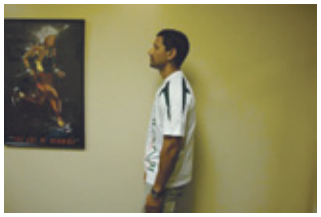


Figure 1. Posture at initial visit.

Figure 2. Mandibular opening, but with right deviation.

Cervical movements were limited bilaterally and all motions were with discomfort reported at end range (forward bending ~ 75%, backwards bending and bilateral rotation ~ 50%). For manual muscle testing he demonstrated a 4- out of 5 in the lateral mandibular movers and protrusors through his available range. His cervical extensors and lateral cervical flexors were also 4- out of 5 through their available range, but also included the bilateral rotator cuff and mid-scapular musculature with the same muscle grade. Full range of motion was noted in the upper extremities. Palpation revealed multiple active trigger points in the right greater than left temporalis muscles, medial greater than lateral pterygoids, masseters, and hyoid groups (all muscles responsible for clenching and lateral mandibular movement). He also had notable shortening of his cervical extensors and anterior chest/shoulder musculature. Trigger points continued into his right greater than left suboccipital muscles, longus colli (often involved with complaints of difficulty swallowing), sternocleidomastoid, middle scalenes, upper trapezius, midscapular, and pectoral muscles.

End feels were capsular in the temporomandibular joints with pain on right mandibular long axis distraction; cervical end feels were also capsular with right cervical discomfort in the mid-cervical spine (grade 2/3 with passive intervertebral motion (PIVM) testing in sidebending). Assessment of respiration, demonstrated shallow upper chest breathing, with slightly less excursion in the left lateral chest wall.

The problem list for this patient was as follows:

1. Loss of neuromuscular control in the orofacial musculature for his activities of daily living (ie, playing the trumpet).
2. Poor posture with altered TMJ/cervical spine/upper quarter function.
3. Inefficient respiratory pattern with decreased chest expansion left greater than right.
4. Not currently playing the trumpet. When possible after an injury, it is best to avoid complete cessation of playing an instrument as it helps the musician maintain their "chops." In this case, the patient had already ceased playing and it was felt that getting further along

in treatment prior to restarting play was advisable.

5. Fear of returning to the instrument; possible depression.

At this point it is important to point out that while this young man's primary complaint was of loss of his embouchure, we have also identified problems relating to his symptoms that are outside of his initial diagnosis of TMJ arthralgia. The minor swelling noted in his right TMJ is probably secondary to inflammation in the area and this accounts for pain noted during right long axis distraction of his mandible. He demonstrated poor, though not atypical posture with altered biomechanics throughout the orofacial region, cervical spine, and bilateral upper quarters. We can theorize a possible progression of symptoms that is helpful in understanding how the patient arrived at this point: As he increased his practice hours, he experienced more pain while playing and progressively lost control of his orofacial musculature (his embouchure). His postural support deteriorated further. This progressive loss of muscular control fostered increased anxiety, which may have added to his pain complaints and tension within the involved muscles. It was not known whether or not his recent swallowing difficulties were solely due to his overuse syndrome. We agreed that we would try to address this area within his treatment and seek further professional intervention if his symptoms of difficulty swallowing did not respond. His current upper chest respiratory pattern was probably more recent, as it is difficult to play a wind or brass instrument without diaphragmatic breathing. Using upper chest and accessory muscles is inefficient and only adds more strain to the overtaxed postural muscles. Ongoing attempts to play probably aggravated existing trigger points, further deteriorating his muscular control and posture. Finally, he also demonstrated possible signs of depression. This is perhaps not a surprise when one considers what the patient could stand to lose if he was unable to return to playing his instrument. The lack of energy, excessive sleep, and fear of returning to his instrument are all indications of concern. A referral to a psychologist was considered.

The working diagnoses with this patient were:

1. Right greater than left TMJ arthralgia. This diagnosis infers a more gradual onset of symptoms as opposed to a traumatic event, with altered TMJ mechanics.
2. Embouchure overuse syndrome. This term is applicable due to the rapid increase in playing time and the resultant loss of control in the orofacial musculature.
3. Postural dysfunction.

Treatment

There were several areas to address in this patient, beginning with respiration and teaching the patient to use diaphragmatic breathing. A progression from supine and sidelying postures to sitting and standing with increasingly challenging tasks (in terms of both body posturing and duration of exercise) was helpful. He performed lateral chest expansion exercises in sidelying and in sitting/standing to incorporate trunk rotation (Figures 3 and 4).

Measurements of progress included an ability to demonstrate proper breathing patterns in various postures and voicing/phonation for progressively longer periods. During this time the patient was also referred back to a former local mentor and brass teacher who started him on basic trumpet warm-up practice drills for very short (5-10 minute) periods and progressed him from elementary to more skilled musical material. He was initially limited to practicing his instrument with familiar pieces and for only 10 minute intervals as long as they were pain-free. Examples of embouchure exercises will be discussed later.

Figure 3. Sidelying stretch for left lateral chest expansion coordinated with breathing.

Figure 4. Sidelying stretch for left lateral chest expansion with trunk and cervical rotation coordinated with breathing.

Musculoskeletal issues in this patient involved both local and more global groups. Basic rest position of the tongue and cervical neutral positioning, along with neutral trunk/pelvic neutral positioning were addressed. He was taught a supine sleep position with multiple pillows (Figure 5) and proper sitting posture for use with all static ADL.

Figure 5. Supine position for sleep. Includes ramped pillows under head and shoulders, a pillow under head and shoulders, a pillow under either forearm and pillows (or their equivalent) under knees.

He already had a nightguard splint that he was encouraged to begin using again to help manage his clenching behavior. Manual techniques were employed to address flexibility needs throughout both extraoral and intraoral regions of his orofacial muscles. He was given a home exercise program for the mandible, cervical spine, and upper quarters for reinforcement. This program was progressed during his treatment and he was responsible for continuing independently after treatment was completed. Measurement of progress constituted his ability to demonstrate improved postural awareness with an increase in pain-free range of motion and successful demonstration of his home exercises. Interventions included neuromuscular exercises to teach basic rotation versus translation exercises for the TMJ, isometric exercises for the mandible, orofacial strengthening to address his deviations, along with clearing of the cervical spine and strengthening of the cervical spine and upper quarters. Measurement of neuromuscular progress included improvement in manual muscle testing, functional outcome improvements, and an increase in orofacial muscular control. Trigger points were addressed in all areas at each session, beginning with the cervical spine and upper trapezius and progressively including the pectoral/anterior shoulder, thoracic and orofacial muscles. Measurement of progress with trigger points included an ongoing assessment of active trigger points with a decrease in their excitability. A psychological referral was made near the end of the second week of treatment and the patient was followed through most of his physical therapy treatment. Both the

Figure 6. Proprioceptive cueing with resistance to left side of mandible. Used to help correct right deviation on opening.

Figure 7. Isometric resistance exercise around head to facilitate cervical stabilizers.

patient and his mother agreed that in order to move forward, a psychological assessment and treatment plan was a necessary component of his treatment to help him address his fears and rebuild his confidence. His mentor addressed basic embouchure skills specific to his instrument and helped with his return-to-play progression.

This young man's prognosis was good as long as he was compliant, completed the prescribed therapy, and was able to pace his return to the trumpet. Making sure all variables were considered were critical to the success of this case (ie, respiratory pattern, musculoskeletal and neuromuscular issues, active trigger points, altered ADL/posture, return to play considerations, and psychological components). The initially identified loss of embouchure had to be expanded to address dysfunction in several regions. His treatment therefore required an approach that addressed each of these areas.

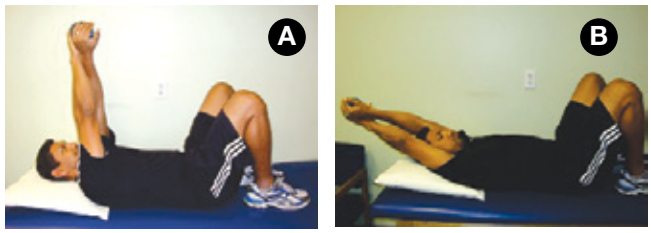
Exercise for stabilization and function

As noted already, the patient was started on diaphragmatic breathing exercises, lateral chest expansion exercises (as noted in Figures 3 and 4), cervical/pelvic neutral and rotation versus translation exercises for the mandible. Proprioceptive exercises for the jaw and cervical spine were included early on with light isometrics (Figures 6 and 7).

Basic postural strengthening and stability needed to include not just his orofacial region, but also his cervical spine and upper quarters. These issues were challenged with progressively weighted balls or cables or resistance bands in various positions and progressed through increasingly more demanding posturing for increased durations (Figures 8A, B, 9, 10).

Demonstration of an awareness of stability with increased muscular control in the cervical spine and upper quarter and lumbopelvic region was required before progressing either his resistance or physical challenge (ie, maintenance of cervical, jaw and pelvic positions during performance of exercises). Focused diaphragmatic breathing or active phonation was included with all activity (ie, counting out loud, controlled forceful blowing out during movement). As he reintroduced his instrument into his exercise routine, a degree of fine motor control in the upper quarters was incorporated in various upper quarter ranges, both in and out of postures that mimicked his trumpet playing position (Figures 11A, B).

Initially, the patient was seen 3 times per week and progressively weaned from care over two months for a total of 20 visits. He gradually noted increased muscular control throughout the cervical spine, upper quarters, and orofacial region with



Figures 8A. Starting position for overhead clasp exercise with a weighted ball. Focus on scapular control throughout range of motion, cervical and mandibular neutral posturing without clenching. All exercises were coordinated with breathing. B. End position for overhead clasp exercise with a weighted ball. Exercises were progressed through various postures, durations and resistance.

Figure 9. Diagonal weighted lift on gymnastic ball for upper quarter stability, cervical/trunk rotation and balance.

Figure 10. Side planks with rotation and resistance band for more advanced stability with rotation.

decreased pain complaints and greater ease of movement. His sleep returned to normal (approximately 7-8 hours a night) and he exhibited less clenching behavior.

Embouchure Skills

When dealing with wind and brass instrumentalists, a basic awareness of embouchure skills is helpful. Each person's embouchure is individualized, but still demonstrates a pattern as well. A correct embouchure as described by Farkas is as follows: (1) not puckered, (2) not smiling, (3) should not be "bunched up," (4) should have a flat chin, (5) jaw should be thrust forward slightly, (6) lips should be even, (7) teeth should provide support for the pressure placed on the lips.[2] An incorrect embouchure allows air to escape from the sides of the mouth, incorporates a "smiling" embouchure or demonstrates some kind of muscular collapse. The "smiling" embouchure is inefficient and considered incorrect by most teachers. How the embouchure position sounds is also important. A correct embouchure sounds like a mosquito (called "buzzing"), while an incorrect embouchure is uncontrolled with a loss of breath control.[3-6] (Note: these references are hyperlinks to YouTube videos and a good starting point for understanding embouchures)

"Slurring" and "bending" are two exercises that are useful in building a musician's "chops." They are performed with subtle changes in the embouchure and require muscular control to perform correctly. Slurring is a lip exercise where the musician is required to "slur" one note to another in a smooth or "legato" fashion, either up or down in a continuous unbroken sound. This exercise helps to develop flexibility and endurance of the embouchure muscles. Bending is a lip exercise where the musi-

Figure 11A. Fine motor exercise for fingers/hand combined with proximal stabilization using resistance web for progressively longer durations. B. Fine motor exercise for fingers/hand combined with proximal stabilization using resistance web in playing posture for progressively longer durations.

cian "bends" the note by 1/2 to 1/4 inch pitch in a continuous sound which helps to develop strength.

In producing higher and lower tones, the embouchure changes slightly. Higher tones require greater muscular control than lower tones. Often, these skills can be practiced with only the mouthpiece before attaching the rest of the instrument. Scales are typically familiar to most musicians and are usually a good starting point as they return to their instrument or as they begin their warm-up. The embouchure should be maintained throughout the entire scale and scales should be begun in the more comfortable mid-range, rather than at a very high or low pitch.

DISCUSSION

This case study discusses a musician with an embouchure problem. But we would have failed in his treatment had we only treated this orofacial region. An approach that addressed his inefficient respiration, cervical and upper quarter involvement, and a psychological component helped round out his program. Our primary goals were accomplished through progressive specific physical demands, specific trigger point management, and controlled biomechanics that were applicable to his activities of daily living. Ultimately, this patient learned to avoid posturing that was detrimental to his art form, decreased his clenching behavior, and focused on a return to more basic playing technique. Once he was able to re-establish a solid foundation, he was able to start progressing to more advanced skills with his instrument. As his function improved, his level of anxiety about playing his instrument decreased and his confidence appeared to grow. He gradually noted increased muscular control throughout the cervical spine, upper quarters, and orofacial region with decreased pain complaints and greater ease of movement. His mentor guided him through embouchure skills and a graded repertoire as he continued his physical therapy treatment. At one month follow-up he had returned to school and was managing his remaining symptoms independently. He was successfully able to complete preparations for his senior juries.

This case study illustrates several risk factors that are unique to musicians and demonstrates how a graded return to activity and playing can lead to a successful outcome.

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FOOT & ANKLE

SPECIAL INTEREST GROUP

President's Corner

As the fall season approaches and your thoughts turn to the holidays, please take a few minutes to invest in your education and profession! Make plans now to attend the Combined Section's Meeting (CSM) in San Diego and/or the Orthopaedic Section's first annual meeting in Orlando. Research regarding orthopaedic foot and ankle concepts is flourishing! At both of these meetings, new research and cutting-edge rehabilitation strategies will be presented for your benefit. Even more exciting is that our Orthopaedic Section membership is leading the way! Check out the updates below and see how our profession drives the many discussions about rehabilitation! Then, contact us to play a role in furthering knowledge in physical therapy practice of the foot and ankle! You are part of our total intelligence…you have ideas no one else has considered…make your voice heard!

FASIG's Sneak Peek into CSM

Our Research Chair, Todd Davenport, has put together an outstanding program for CSM San Diego. It seems that many physical therapists at CSM enjoy talking about running, so Todd has invited Irene Davis, Bryan Heiderscheidt, and Nicole Haas to present the following program:

Thursday, January 24, 2013:

"Staying on the Right Track: Current Concepts in the Care and Prevention of Running Injuries of the Foot and Ankle."

A panel discussion will be a large part of this presentation, so bring your questions!

In addition to the program above, the FASIG will be sponsoring the following program:
Tuesday, January 22, 2013

"When Should Manual Therapy and Foot Orthoses be added to the Physical Therapy Plan of Care?"

Part 1: 8:00 AM – 10:00 AM

Part 2: 11:00 AM – 12:00 PM

The FASIG Membership meeting will follow in the same room: 12:00 PM – 1:00 PM

Curriculum Task Force

Chris Neville leads our very exciting project intended to help entry-level PT programs design and implement foot and ankle material into their orthopaedic curriculum. This huge project makes the FASIG an integral part of the process by which Physical Therapy education programs can stay current with research and clinical care techniques.

Clinical Pearl

The Peroneal Muscles: Reconciling Manual Muscle Testing (open kinetic chain) vs. Functional Strength Testing (closed kinetic chain)

While discussing the art of manual muscle testing with a recent student, our staff was quick to remind him of the importance of joint and muscle positioning during testing. Initially, the student tested the lateral compartment of the leg by asking the patient for resisted eversion, with the patient seated and the foot held at neutral. We then showed him Lucille Daniels' muscle testing manual (*Muscle Testing: Techniques of Manual Examination*, Saunders, ©1956) which demonstrated that testing of the peroneals should come "from plantarflexion." Hence, the student was reminded to carefully muscle test the peroneals by asking for eversion from a position of plantarflexion.

Daniels did not elaborate nor differentiate the two peroneal (now called fibularis) muscles, but we wanted the student to better understand how fibularis longus and brevis function. In an effort to demonstrate the function of both, particularly in a functional or closed kinetic chain fashion, we arranged for a simple heel-raise test.

A patient was asked to perform a simple single-leg, heel-raise motion, starting from a hanging position off a step (Figure 1). We asked for complete plantarflexion, urging the patient to rise as high as possible on to the metatarsal heads. We observed the very important rear-foot inversion, as represented by the line bisecting the calcaneus (Figure 2). Yet, the position of the metatarsals suggests weightbearing has moved laterally on the plantar surface, largely on the fourth and fifth metatarsal heads. It is only when the patient is reminded to place most of his weight onto the first and second metatarsal heads that the bisecting line, extending from the calcaneus through the central gastrocnemius, becomes much less (Figure 3). The calcaneus remains inverted, but now the peroneus brevis has everted the forefoot and the fibularis longus has plantarflexed the first ray. The result

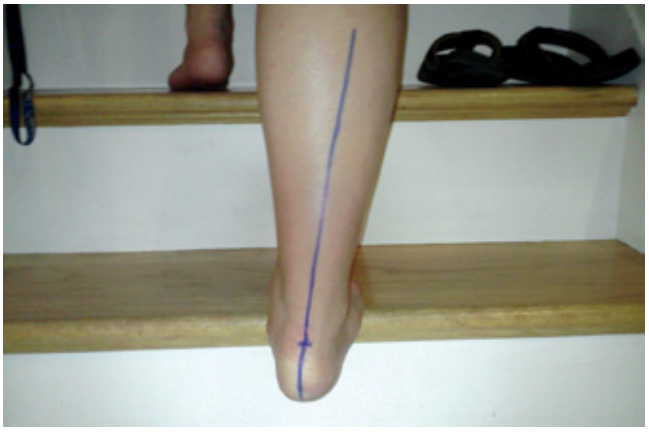

Figure 1

Figure 2

Figure 3

is medial translation of plantar pressure.

We urge our students to ask for a heel-raise test to assess plantarflexion strength. However, those patients with strong fibularis muscles will tend to stay more medial on the plantar aspect of their foot as they rise into a plantarflexed position. Similarly, we ask for functional strengthening to mimic this test, for push-off during gait requires the foot be locked at the rearfoot and the medial longitudinal arch be maintained. This phenomenon, the synergistic action of the plantarflexors and everters, can become dyskinetic with conditions that are compensated by lateral plantar weightbearing (hallux valgus, hallux rigidus, sesamoiditis, etc).

Submitted by Clarke Brown, President FASIG

The **President's Corner** and **Clinical Pearl** are regular segments of the FASIG's OPTP contribution. Please send us your clinical pearls or interesting foot and ankle case studies!

IMAGING

SPECIAL INTEREST GROUP

IMAGING EDUCATION IN PHYSICAL THERAPY PROGRAMS

As this issue lands in your mailbox we plan to have sent a survey to physical therapy education programs seeking information on imaging education. If you receive this survey, please take a couple of minutes to complete it. The information gathered will help to shape guidance on imaging content in physical therapy education.

Here's an update on some of the activities we have been working on:

- Developing an online membership directory for the Imaging Special Interest Group (ISIG). Hopefully to be up by the time you read this. Please log on to the Orthopaedic Section Web site at http://www.orthopt.org/ to preview and update the directory.
- The ISIG would like to promote standardized imaging terminology. This has been identified as a need across health care. If you have resources/references that we could disseminate, please send them to dr.white@miltonortho.com.
- Work is underway in establishing a Research Committee. We hope to have the committee formed in time for the next issue of this newsletter.
- Work is well under way in developing curriculum guidance for imaging in PT education. Dr. Bill Boissonnault is heading up this project.

DO YOU HAVE INTERESTING IMAGING INFORMATION TO SHARE?

Please consider contributing to the newsletter. Items of interest with a focus on imaging in PT practice, education, and research are welcome. Send your ideas to dr.white@miltonortho.com.

WE ARE GROWING! JOIN US!

The NEW Orthopaedic Section ISIG is growing! We are excited that so many individuals have joined our new SIG in such a short period of time. You can join the ISIG by sending an E-mail to Tara Fredrickson at tfred@orthopt.org.

Imaging Special Interest Group Officers

President
Douglas M. White, DPT, OCS
(follow at: @Douglas_M_White)

Vice President
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PAIN MANAGEMENT

SPECIAL INTEREST GROUP

President's Message

The one thing that is constant is change. The way we look at our persistent pain patients has evolved from only the bio medical model to the bio psychosocial model, which has given us a new dimension on successful treatment. One of my students, last year, found that with many of our patients who initially scored high on the FABQ improved in function but continued to score high on the FABQ at discharge. Since we cannot change a person's beliefs in a short period of time, perhaps understanding what their beliefs are and treating accordingly is enough for successful treatment. This idea was recently reinforced by the Sindhu et al[1] study.

Thank you Nate for sharing your case report with us in this issue of OP.

I hope you have a happy, safe, and pain free fall.

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Management of a Client with Chronic, Unexplained Musculoskeletal Pain Using the Biopsychosocial Model

Nate Sorum, PT, DPT
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BACKGROUND AND PURPOSE

Chronic pain is very common, affecting 100 million adults in the United States.[1] The primary mechanisms of pain change drastically from the acute to the chronic stage. The biomedical and the biopsychosocial model are two well-known models for the assessment and treatment of musculoskeletal pain. The goal of the clinician in the biomedical model is to identify the physiological defect causing the pain and then treat the defect thereby eliminating pain. In the biopsychosocial model, the clinician evaluates and treats pain as an interaction of biological, psychological, and sociocultural factors.[2] The biomedical model is generally sufficient for acute conditions, but often ineffective for chronic pain conditions.[2] If the biopsychosocial model is not used to treat chronic pain, key mechanisms of the client's pain may not be addressed, making resolution of pain difficult if not impossible.[2]

Acute pain is primarily caused by nociception from body tissues associated with clear injury or pathology. The goal of treatment in this stage is to decrease nociceptive output to the central nervous system. Based on characteristics of the pathology, involved body tissues, age, co-morbidities and other factors, an expected healing time frame can be estimated after which pain should not exist due to nociception from the original injury.

Chronic pain can be described as pain that persists past normal tissue healing time, occurs in the absence of tissue damage, and/or results in disability out of proportion with physical findings.[2] Central nervous system sensitization plays a dominant role in chronic pain. As pain persists, the magnitude of nociceptive input increases along with an elevated response to nociception in the central nervous system. Pain may be entirely out of proportion with actual threat to body tissues. Nociception may be produced in the tissues due to leading to pain output from the brain. However, even non-noxious stimuli to intact albeit weak, deconditioned tissues may be sufficient to produce nociception leading to pain. Pain may also be experienced independent of nociception, through other types of input to the central nervous system.[3] For more information on the other types of input read *Explain Pain*.[3]

Psychosocial factors highly modulate the experience of acute and chronic pain through supraspinal mechanisms.[2,4,5] Factors such as pain catastrophizing, fear-avoidance, poor self-efficacy, and psychological distress are highly correlated with individuals suffering from chronic pain.[5] These factors may be further intensified by the client's inaccurate, deep-seated belief that painful tissues are still damaged and/or at risk. Psychosocial factors are known to significantly influence patient outcomes; therefore, they should be viewed as modifiable treatment objectives and not merely as barriers.[6] Treatment approaches should differ substantially when treating acute versus chronic pain.[2,5]

There were two treatment goals in this case study. The first goal was to decrease fear of pain by educating the client that her chronic pain was due to an extremely complex, protective brain and not damaged body tissues. This was accomplished through one-on-one pain neuroscience education, recommended reading materials, and reinforcing these principles throughout the plan of care.The second goal was to gradually expose her to activities previously avoided due to pain. The purpose of this case study is to demonstrate one successful way of using a simple, evidence-based approach for treatment of a client with chronic pain.

CASE DESCRIPTION

History

A 40-year-old, single female was referred to physical therapy from a podiatrist for ultrasound and iontophoresis for left foot pain. The injury to the dorsum of the left foot occurred from kicking a car door shut approximately 6 months ago. At the time of the initial injury, the client went to urgent care due to severe pain and swelling in her left foot. Radiographs were unremarkable. Urgent care personnel educated her to protect, ice, and elevate her foot and take ibuprofen.

In the six months preceding the initial physical therapy evaluation, the client went to an internist because of continued

Table 1. Home Exercise Prescription

	Session 1	2	3	4	5	6	7	8
Weight Shifts in Standing	1 min, 1x/hr	1 min, 1x/hr	1 min, 1x/hr	dc				
SL Balance (performed on right and left)	2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day	3 x 30 sec, 2x/day
Graded Walking Program			1 min/2 hours, +30 sec every 2 days					
Body Weight Squats			3 x 1 min, 1x/day	3 x 1 min, 1x/day	3 x 1 min, 1x/day	3 x 1 min, 1x/day	3 x 1 min, 1x/day	3 x 1 min, 1x/day
SL Heel Raises (performed on right and left)			1 x failure, 1x/day	3 x failure, 1x/day	3 x failure, 1x/day	3 x failure, 1x/day	3 x failure, 1x/day	3 x failure, 1x/day

SL=single leg, dc=discontinued

pain and swelling. Radiographs were unremarkable. She was then referred to a podiatrist and a MRI was taken. The client reported that minor tendon damage was found on the MRI, but the podiatrist was not able to explain why her pain continued to be so severe.

She reported that her sedentary office job was highly stressful and she suffered from insomnia. The client was moderately obese. She reported that she was exercising regularly prior to her foot injury and that she had lost fifty pounds. After the injury, she had gained all the weight back due to her inability to exercise. This further increased her distress.

The client received some relief with acupuncture, but only for two days before pain returned to previous levels. She was only able to wear one pair of open-topped flats that prevent pressure to the top of the foot. Her foot pain was so intense a week prior to the physical therapy initial evaluation that she cried for two hours. Prior to that painful episode, she had not participated in any more activity than normal. She stopped taking prescribed narcotics because she did not like the way they made her feel. She also discontinued taking over-the-counter medications because they did not reduce her symptoms. She complained of limitation with all weight-bearing activities due to pain. Walking and stairs were highly aggravating.

Pain assessment was measured using a verbal 0-10 scale where 0 represents no pain and 10 represents the worst pain imaginable. Current and lowest pain was 2/10, in non-weight bearing. Worst pain was 10/10 with prolonged standing, walking, or stairs. Patient goals were to walk one to two hours daily, workout, and ascend and descend stairs with no pain or difficulty.

The client ambulated with antalgic gait with excessive right lateral shift, shorter stance time on left during walking over level surface and stairs. There was moderate edema throughout dorsum of left foot. Skin temperature and pallor appeared normal. Palpation revealed allodynia to light manual tapping near metatarsal-phalangeal joints 2-4. Hyperalgesia was evident with deep pressure throughout the dorsal and plantar surfaces of the left foot.

Ankle active and passive range of motion was within functional limits with minimal discrepancies comparing right and left. Gross strength measurements were 4/5 throughout left knee and ankle and 5/5 on the right. Minimal hypomobility was found with accessory movements of left foot and ankle joints that were similar to asymptomatic right foot. All joint accessory movements were painful on left foot and ankle, but did not reproduce worst pain.

Clinical Impression

Allodynia, secondary hyperalgesia, pain lasting 6 months, no evidence of tissue damage, maladaptive psychosocial factors, and pain and disability out of proportion with tissue injury were characteristic of a chronic pain syndrome. Minor strength and range of motion limitations were not viewed as a primary cause of pain. Therefore, a treatment plan consisting of pain neuroscience education, graded exposure, walking program, and basic lower extremity strengthening exercises was used.

Intervention

Approximately 25 minutes of one-on-one pain neurophysiology education on each of the first two sessions.The initial examination was one hour, with seven 30-45 minute follow-up sessions. In the remaining sessions, pain neurophysiology education was given and reviewed during manual therapy or therapeutic exercise interventions. Key topics addressed through education were that pain is an output of the brain, hurt does not equal harm, the complex multi-factorial nature of pain perception, peripheral and central sensitization, pain is the brain's tool to protect the body from real or perceived tissue damage, and the role of psychosocial factors such as hypervigilance, coping-skills, fear-avoidance, self-efficacy, and pain behaviors.[3] The books, *Explaining Pain* and *Dissolving Pain*, were recommended to the client. The client purchased and read *Dissolving Pain*.

On the sixth visit, the client was administered the Neurophysiology of Pain Test. A formal score was not recorded. The client was educated on incorrect answers and correct answers were reinforced using drawings and metaphors.

Table 1 outlines the client's prescribed home exercise program. Selection of type and dosage of therapeutic exercises during therapy and home exercise program were primarily aimed at graded exposure to pain provoking stimuli with less emphasis on strength training. The client tolerated manual therapy interventions, but reported that it was very unpleasant. Therefore, manual therapy interventions were discontinued due to minimal evidence of clinically significant effects.

A graded walking exercise program was initiated on the third visit. The therapist and the client discussed an acceptable dosage

Table 2. Outcome Measures

	Session 1	Session 8
PCOQ	See text	NT
Verbal Pain Scale		
1. Worst	10/10	0/10
2. Current	2/10	0/10
3. Best	2/10	0/10
CCHQ	31/50	45/50*
PSFS		
1. Walking 1-2 hours	2/10	10/10
2. Exercising 30 minutes	0/10	10/10
3. Ascend/descend 2 flights of stairs	3/10	10/10

PCOQ=Patient-Centered Outcomes Questionnaire, NT=not tested at discharge, CCHQ=Care Connections Health Questionnaire, PSFS=Patient-Specific Functional Scale

*Client reported that left foot was at full function and that remaining limitation was due to bilateral shin pain with moderate or high-intensity walking that she had for more than 20 years

and rate of increase of the walking program. The client could walk for one minute with minimal aggravation of left foot pain. The client was to walk for one minute every waking two hours of the day. Thirty seconds was added to the time walked every two days. When the time reached 5 minutes, the frequency was decreased to 3 times per day. When the time reached 15 minutes, the frequency was decreased to 2 times per day. The outlined walking program was followed during the first several visits, after which the client increased walking duration as tolerated because she did not have increased pain.

OUTCOMES

The Patient-Centered Outcomes Questionnaire (PCOQ) was administered at the first visit to evaluate levels of pain, fatigue, emotional distress, and interference with daily activities where 0 is none and 100 is worst imaginable. The client reported a usual pain level of 20, fatigue level of 40, emotional distress level of 50, and interference with daily activities of 50. This outcome measure was not re-tested at discharge.

The Care Connections Health Questionnaire (CCHQ) was used to assess lower extremity level of function. At initial evaluation, the client scored 31/50 where 0 is unable and 50 is full function. At discharge, the client scored a 45/50; however, her functional limitation was due to bilateral anterior shin pain with moderate to high intensity physical activity that she had for greater than 20 years and not from left foot pain.

The Patient-Specific Functional Scale (PSFS) was used to rate high-importance activities on a 0-10 scale where 0 is unable to perform activity and 10 is able to perform activity at the same level as before the injury or problem. Three activities were rated. Walking one to two hours was rated at 2/10 at initial evaluation, and 10/10 at eighth visit. Exercising 30 minutes was rated at 0/10 at initial evaluation, and 10/10 at eighth visit. Stairs (2 flights up or down) was rated at 3/10 at initial evaluation, and 10/10 at eighth visit.

A verbal pain scale was used where 0 is no pain and 10 is worst pain imaginable. At initial evaluation, current and best pain was 2/10 and worst pain was 10/10. At discharge, current, best, and worst pain was 0/10. Formal pain levels were not taken at follow-up visits other than discharge due to a purposeful focus on function rather than pain. However, the client reported consistent improvement of symptoms throughout the plan of care. Table 2 outlines outcome data collected.

DISCUSSION

The client in this case saw multiple health care professions who were not able to find the pain generator using the biomedical model. The client demonstrated maladaptive pain perceptions and behaviors that were not addressed prior to physical therapy. These perceptions and behaviors may have even been negatively influenced by interaction with other health care professionals the client came in contact with. The author believes that the use of the biopsychosocial model for evaluation of the acute injury may have prevented the transition to chronic pain. Based on the clinical findings from the initial physical therapy examination and the client's response to the treatment, central nervous system mechanisms played a primary role in the amplification and maintenance of the client's painful state and that no distinct peripheral physiological dysfunction was present.

This case highlights the efficacy of the biopsychosocial model that led the author to use pain neurophysiology education and graded exposure. Utilization of specific therapeutic exercise interventions was secondary to decreasing fear and promoting overall activity. It also suggests the inadequacy of the biomedical model for treating acute pain in some clients with maladaptive psychosocial factors.

Pain neurophysiology education was effective in reducing the client's fear of pain that promoted the client's compliance with the prescribed home exercise program. A graded walking program, basic balance exercises, and simple strengthening exercises were selected primarily to promote the client confronting previously feared activities.

The client was never formally diagnosed with complex regional pain syndrome (CRPS). In retrospect, the client did meet the International Association for the Study of Pain (IASP) diagnostic criteria for type I CRPS. It is unknown whether other evidence-based treatment approaches would have been more efficient; however, the treatment approach used in this case study had a positive patient outcome.

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ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

Letter from the President

At the time of submission of this newsletter, the IAVRPT International Symposium has yet to occur. I am not able to attend but I do know that some of our members will be attending (and others presenting). We'll be sure to get an update from those members as soon as we can.

On another international front, the IAPTAT, the international group petitioning for recognition as a WCPT subgroup has started an international electronic mail listserve. To enroll in this listserve, you must be a physical therapist or physiotherapist and interested in or practicing in animal rehabilitation/physical therapy. Please contact me if you're interested in joining in the 'conversation.'

We're actively updating the ARSIG Website to include a member profile page and more timely legislative information. Stay tuned for updates and check us out at www.orthopt.org!

Amie Lamoreaux Hesbach, MSPT, CCRP, CCRT

Exciting News to Share!

We have been approved for a preconference continuing education course at next year's CSM! It is entitled "Manual Therapy for Mechanical Dysfunctions of the Canine Lumber Spine: Human and Canine Comparisons." This preconference course will be sponsored by the Orthopaedic Section, APTA, at the Combined Sections Meeting (CSM) in San Diego, California. The course will be on Monday, January 21, 2013. The presenters will be Cindy McGregor and Laurie Edge-Hughes.

Application of the Neuroplasticity Theory through the use of the Feldenkrais Method with a Canine with Traumatic Spinal Cord Injury: A Case Study

Tammy Culpepper Wolfe, DPT, PT, CCRP, GCFP
The K9 Body Shop, PC, Arvada, CO

BACKGROUND AND PURPOSE

The Neuroplasticity Theory has gained widespread attention in the past several years in the medical and physical therapy professions. It states that, instead of being static, the central nervous system (CNS) can adapt its organization, structure, and function in response to changing internal and external stimulus.[1] There is current research and study focused on understanding neuroplasticity and how to take advantage of that plasticity. Although the theory is well documented, there is little documentation in the literature applying the theory to current treatment practices.[2] One of the least documented treatment methods is the Feldenkrais Method. Although the Feldenkrais Method has become a familiar term with clinicians in the physical therapy profession, there has been little clinical research to explain how it is performed and applied in patient care. While physical therapy on canines is based upon clinical evidence, only recently has there been research to test and describe the methodology of canine treatment regimen, practice, or efficacy.

The CNS has the capacity to adapt and alter its structure and function in response to a variety of internal and external pressures. This neural plasticity is the mechanism by which the CNS encodes experiences and learns new behaviors. It is also the mechanism by which the damaged CNS relearns lost behavior in response to rehabilitation.[3] Neuroplasticity includes the capacity of neurons throughout the CNS to change their structure and function in support of normal development and learning, as well as in response to injury or disease. Cortical maps can show reorganization in expanded synaptic connections among neurons and corresponding changes in function among those neurons. These maps were conventionally thought of as constant once an individual matured, but it is now understood that parts of them can change, expand, or shrink considerably.[4] Extended, skilled use of a body part causes its representation in the motor and somatosensory cortex to expand into surrounding areas. These changes occur relatively quickly (within hours), so it is thought that the changes probably depend on previously inactive, preexisting connections.[4] In cases of injury, immobilization, or amputation, surrounding areas of the cerebral cortex take over the region of the affected part.[4] After spinal cord injury, plastic changes occur at all levels of the CNS, including the cortex, other areas of the brain, and the spinal cord. These changes occur both rostral and caudal to the lesion.

It is thought that both spontaneous plasticity and activity-dependent plasticity can occur.[5] Spontaneous plasticity is thought to contribute to neurological return, but it may also have maladaptive effects, such as elevated muscle tone and pain. Activity-dependent plasticity occurs in response to afferent (sensory) input, causing adaptive neuronal changes. The mechanisms of activity-dependent plasticity appear to involve functional and structural changes at all levels of the CNS.[8] On the behavioral level, there is recovery of sensory, motor, and autonomic function. At the spinal cord level, there may be normalization of reflexes and strengthening of motor-evoked potentials. Neuroanatomically, axonal and dendritic sprouting and even neurogenesis have been observed. In addition, on the cellular level, synaptic strengthening and up-regulation of neurotransmitters takes place.[6] It is activity-dependent plasticity that physical therapy intervention focuses on, and interventions are chosen that will develop the CNS in ways that will normalize function.

Although the Feldenkrais Method was being practiced before the Neuroplasticity Theory was developed, there has been little scientific explanation for how use of the method might achieve the excellent results that were being reported. The Feldenkrais Method was developed by Moshe Feldenkrais during the 1940s through the early 1980s. He was accomplished in Jujitsu and Judo and earned his degree in mechanical and electrical engineering and a Doctorate of Science in Engineering. After reinjuring

an old soccer injury and deciding against knee surgery, he began developing what later became the Feldenkrais Method.[7] Since he chose to teach his method to the general public, the method developed in holistic, alternative medicine circles and has only recently been acknowledged as a legitimate form of treatment in main stream physical therapy. Due to the paths of the method development, there has been very little research published on the topic. What has been completed has primarily been focused on the Awareness Through Movement (ATM) aspect of the method. Intervention in this case study was based on the concepts of the other aspect of the method, functional integration (FI).

In ATM, the students (the term used by Moshe Feldenkrais, instead of "patients") are verbally instructed to move in a series of very specific ways, one movement building upon the previous sequence of movements; FI is an intensive, individual-specific manual technique. In FI, the teacher (practitioner) uses various manual techniques to promote changes in the CNS by communicating to the student how they habitually move, and then offers different movement options for better efficiency, coordination, and fluidity. In the process, the CNS develops new functional motor patterns and new patterns of movement emerge. At times, those new patterns emerge immediately and permanently, and at other times, the patterns and changes may occur over several days after a lesson. The slower changes is seen several times over weeks or months, new movement patterns may emerge at any time during that period of lessons as one lesson builds upon another.

The changes that take place can be explained by the Neuroplasticity Theory, given the assumption that the activity-dependent plasticity occurs during the FI lesson. Activity-dependent plasticity depends upon sensory input from an external stimulus. During an FI lesson, the practitioner gives various types of manual sensory input to the student to allow them to explore and learn new possibilities of functional movement, using their bodies in ways that are unfamiliar or have been forgotten because of injury or illness. The manual techniques facilitate learning of new connections throughout the body and result in movement patterns that are more efficient, comfortable, and functional.

Although an FI lesson uses some manual skills already mastered by a physical therapist, the intention of the practitioner is more instructive than corrective in nature. Through kinetic rapport, the student learns how to reorganize his body posturing and movements, including his limitations, in new and more effective ways. The areas in which he operates effectively and comfortably then begin to expand into other functions not previously achievable.[8] According to the Neuroplasticity Theory, this unusual, purposeful and functional sensory input causes the CNS to form new connections at every level.

As an example of how standard PT techniques can be used in a Feldenkrais Method is described here. A joint may be mobilized during an FI lesson, but it will not be mobilized as an isolated action. It will always be mobilized as part of a functional movement, in relationship to the rest of the body's whole movement pattern, and in relationship to the changes taking place in the whole body at the time. For example, thoracic vertebra T8 may be mobilized as part of a dynamic "reaching across midline" movement, instead of statically without the student's input. Information is given in various situations and settings for the purpose of allowing neuroplasticity to take place in a broader spectrum instead of only in specific circumstances.[1]

This case study was chosen to demonstrate the Neuroplasticity Theory because FI was done in various positions and ways to assist the patient in re-learning a variety of functional patterns in several body positions.

CASE DESCRIPTION

The patient was a two-year-old, active, female Shiba Inu, without prior health conditions. The 26-pound dog was in a car during an automobile accident and was thrown head-first into the windshield upon impact. After receiving medical care in an emergency veterinary hospital, she arrived for physical therapy 10 days following the accident.

The patient was being carried by her owner upon arrival. When she was placed on the rug, she had difficulty maintaining a lying position while watching the others in the room without losing her balance.

Examination

The patient was bright, alert, and responsive (BAR), and her pulse and heart rate were normal and regular. She was non-ambulatory or grade 1 on the neurologic gait scale (Table 1).[9] She required two people to transfer from sternal to standing and to maintain a standing position. She was able to transfer and maintain sitting with assistance of one person using both hands to assist and stabilize her in that position. She was able to independently transfer from right lateral recumbency to sternal, but she required a one-person assist to transfer from left lateral recumbency to sternal. Her posture in standing was Schiff-Sherrington positioning bilaterally with upper motor neuron signs and extensor tone in forelimbs (FLs) and lower motor neuron signs and flexor tone in the hind limbs (HLs).[10] Cervical right rotation was 50% of normal. All other passive range of motion was normal, as defined by Jaegger et al.[11] Muscle spasms were palpable in the epaxial muscles bilaterally from the cervical through the lumbar spine and in the bilateral external obliques. Proprioception reflexes were assessed in standing position and were delayed in the left FL and left HL and absent in the right

Table 1. Neurologic Gait Scale

5	Normal strength and coordination
4	Can stand to support; minimal paraparesis and ataxia
3	Can stand to support but frequently stumbles and falls; mild paraparesis and ataxia
2	Unable to stand to support; when assisted, moves limbs readily but stumbles and falls frequently; moderate paraparesis and ataxia
1	Unable to stand to support; slight movement when supported by the tail; severe paraparesis
0	Absence of purposeful movement; paraplegia

Table 2. Canine Functional Scale

1. Able to position self to urinate?	1	2	3	4	5
2. Able to position self to defecate?	1	2	3	4	5
3. Able to transfer from lying to sitting and vice versa?	1	2	3	4	5
4. Able to transfer from sitting to standing and vice versa?	1	2	3	4	5
5. Able to transfer from lying to standing and vice versa?	1	2	3	4	5
6. Able to roll over?	1	2	3	4	5
7. Able to scratch behind its ears?	1	2	3	4	5
8. Able to ascend stairs?	1	2	3	4	5
9. Able to descend stairs?	1	2	3	4	5
10. Able to walk up an incline/hill?	1	2	3	4	5
11. Able to get in and out of your car?	1	2	3	4	5
12. Able to get on/off a couch or bed?	1	2	3	4	5
13. Able to run?	1	2	3	4	5
14. Able to jump?	1	2	3	4	5

FL and right HL. Patellar reflexes were 3+ bilaterally. Flexor withdrawal reflexes were intact bilaterally and extensor patterning was present only on the right HL. Both tests were done in lateral recumbency. There was no pain response on examination. Deep pain sensation when tested with hemostats was intact in all 4 extremities. She was able to initiate voluntary movement in all 4 extremities.

Her owner's goals were to maximize his dog's functional independence and to reach the highest quality of life possible. He stressed his desire for her to walk independently and hoped for normal bowel and bladder control, which she did not have at the time. She was scored as a 14/56 on the Canine Functional Scale (Table 2).[12] Her prognosis for reaching the goals was good, based on the fact that her deep pain sensation was intact and that she had voluntary muscle contraction in all extremities.[13]

A diagnosis of tetraparesis with possible cervical disc herniation was made, based upon examination findings. The dog clearly needed to form new neurologic connections and re-learn basic functional movements, coordination, and balance to be able to function normally again. Therefore, she was an excellent candidate to receive FI as the primary form of treatment. The plan of care was to see the patient on a weekly basis for FI and implementation of a progressive home care program. Treatments would be spread further apart, based upon the patient's progress and the client's economic constraints. Underwater treadmill exercise for strengthening and balance training[14] was to be added when the patient was able to ambulate in water with assistance of one person. Short-term goals were: (1) independent transfers from lying and sitting to standing; (2) maintain sitting position without assistance on carpeted surface; and (3) maintain standing without assistance on carpeted surface. Long-term goals were: (1) independent gait on all surfaces for 20 minutes; (2) independence going up and down stairs of all surfaces; and (3) independence in urination and defecation positioning (Table 3).

INTERVENTION

Because of the nature of FI, it would be impractical and nearly impossible to document exactly what was done in a 20 to 30 minute FI lesson. Although each Feldenkrais Practitioner is trained in a 4-year program and spends 800 to 1000 hours in class, each practitioner has an individualized approach to his or her performance of a lesson. However, any practitioner who was provided with specific functional movements to facilitate, would structure the lesson in a similar manner. Table 4 illustrates the intervention in its logical order.

The patient was seen for a total of 8 visits over a period of 11 weeks. Because of the client's economic situation, the patient received FI as part of the treatment for only the first 4 visits (Table 4). All home care exercises were to be done twice daily. Repetitions were determined by the dog's continued willingness to perform the exercise. The owner was given written instructions and pictures to assist him in performing the home care program. The exercises given are well known in the canine physical therapy profession. Rationale for home exercise progression was based on the dog's ability to master the previous exercises. The rationale for FI focus was based upon the functional activity and movement patterns that the dog needed to re-learn in order to return to normal activity. The sequence was based upon simple to more complex activities and movements and also based upon the movements that the dog was able and willing to learn in any given lesson.

OUTCOMES

Animal physical therapy is a relatively new specialty field with little standardization of any outcome forms, measurements, or tests. There are 4 gait or lameness scales the author is familiar with, two pain scales, several functional scales, and two body

Table 3. Patient Goal Accomplishment

Short Term Goals	Visit # Goal Met
1. (I) transfers from lying to standing	2
2. (I) transfers from sitting to standing	2
3. Maintain sitting position (I) on carpeted surface	1
4. Maintain standing (I) on carpeted surface	2
Long Term Goals	
1. (I) gait on all surfaces for 20 min.	5
2. (I) going up and down stairs of all surfaces	5
3. (I) in urination and defecation positioning	4

Abbreviation: I, independent

Table 4. Interventions

Visit	Focus of FI Lesson	Positions of FI	Immediate Change After FI	Home Care Program/ Other Treatment Given	Progress Noted at Next Visit
1	Shifting weight through the trunk and into each extremity in order to weight bear in standing.	Lateral recumbency, sternal lying, standing	Maintains standing with one hand assistance for 10 seconds on smooth carpet. Maintains sitting without assistance 30 sec.	Massage to epaxials & obliques 15 min; standing and sitting with as little support as possible, extremities placed correctly by owner; oscillations through hind paws (stifle held in extension) into pelvis in sternal lying; rhythmic stabilization to shoulders, hips and trunk in lying; PROM to HLs 20 reps bid.	(I) transfers to sitting and standing from all lying positions, but falls as soon as she stands. Sits (I) and able to move head and shift weight as she watches other clients and patients (8 days later).
2	Weight shifting through extremities from the core in various functional patterns, including gait.	Sternal lying, sitting, standing	Comes to standing and maintains stance without assist. Takes 4 steps before falling.	Rhythmic stabilization in sitting; slow ambulation on nonabrasive surfaces with harness support; skin care for knuckling paws.	(I) sit to standing and walking 20 ft (I) on carpet; turns head and shifts wt (I); gait grade 3 (7 days later).
3	Core to limb differentiation strategies for play and functional activities.	Sternal lying, standing	Able to keep balance on carpet with 1 extremity lifted. Takes moderate challenge in standing.	Challenges in standing with single leg lifted; rhythmic stabilization in standing on multiple surfaces.	Gait grade 4; functional assessment 37/56;(I) up stairs with moderate assist down; trots (I); bowel/ bladder control (28 days later).
4	Core integration with extremity movement.	Sternal lying, sitting, standing	None	Ladder step overs; weave poles; 1 leg balance on air mattress; UT 1.0 mph x 5 min, .75 mph x 3 min with one hand and life vest assist for balance, 10" water level.	(I) down stairs (7 days),
5	None	N/A	None	Obstacle course, figure 8s, circles cw and ccw; UT 10" water level, 1.0 mph x 10 min with leash to vest, single hand assistance 50% of the time.	None observed. Owner reported increased endurance and dog running after squirrels in park (7 days).
6	None	N/A	None	2 leg balance on air mattress with challenges; UT 10" water level, 1.0 mph x 11 min with leash to vest, single hand assist less than 25% of time.	None observed. Owner reported increased endurance and dog running after squirrels in park (7 days).
7	None	N/A	None	Gym ball exercises with patient standing and sitting on ball for balance and coordination; UT 10" water level, 1.0 mph x 12 min with assist as in visit #6.	Gait grade 4 all surfaces. Video taken of walking gait in clinic on slick surfaces. Functional assessment 50/56 (7 days).
8	None	N/A	None	UT 10" water level, 1.0 mph x 12 min with previous single hand leash assist 25% of the time, without life vest.	Economic discharge.

Abbreviations: FI, functional integration; PROM, passive range of motion; HL, hind limbs; I, independent; UT, underwater treadmill

composition scales--none of which have any studies of reliability or validity. However, with the given lameness grading and functional assessment scales used in the case study, progress toward the client's goals can be identified. Both scales are easy to use and have objective guidelines in which to assess the patient's status. Improved functional activities were documented, both immediately after FI and between visits to physical therapy. The lameness grade improved from zero to 4 out of 5 possible stages. The assessment score improved from 14 to 50 out of 56 possible points. Despite the lack of evidence of reliability or validity in these measures, there were observable improvements in the functional status of the patient as a result of physical therapy intervention.

DISCUSSION

The purpose of this case was to apply the Neuroplasticity Theory by use of FI as a mode of rehabilitation of a canine with a traumatic spinal cord injury. While it is impossible to know what changes took place structurally and chemically in the CNS of this dog during the 11 weeks of physical therapy intervention, it is possible to observe the outcomes of this intervention. At the time of evaluation, the patient exhibited signs of significant CNS disruption and injury, resulting in Schiff-Sherrington posturing and severely limited functional mobility. Following the FI sessions, there were immediate changes in functional patterns of movement, such as the ability to maintain sitting and standing balance and the ability to take independent steps. Drawing on the assumptions of the Neuroplasticity Theory, one conclusion may be that activity-dependent neuroplasticity took place in the CNS during the FI lessons. Research has shown a high correlation between early functional training with appropriate sensory input and improved walking function;[15] however, it is impossible to isolate the contribution of the FI versus the balance and strengthening exercises.

This study is one of many studies needed in the areas of neuroplasticity and rehabilitation. One of the questions that the study leaves unanswered is if FI is as effective in changing the CNS and improving functional movement patterns as other currently used physical therapy techniques and modalities. As in many canine neurological injuries, it remains unknown as to how much of the dog's recovery might have been due to spontaneous plasticity. Since the original spinal cord injury was not quantified by advanced diagnostics, the structural recovery taking place in the CNS was impossible to assess.

To assist in assessing the actual change taking place during the treatment process, standardization of reliable and valid measurement tools represents another aspect of this case study that requires further research. This case study demonstrates the need for more research and creative thinking concerning how physical therapists can develop more effective treatment techniques while using our ever-growing understanding of neuroplasticity of the CNS after injury and throughout the rehabilitation process.

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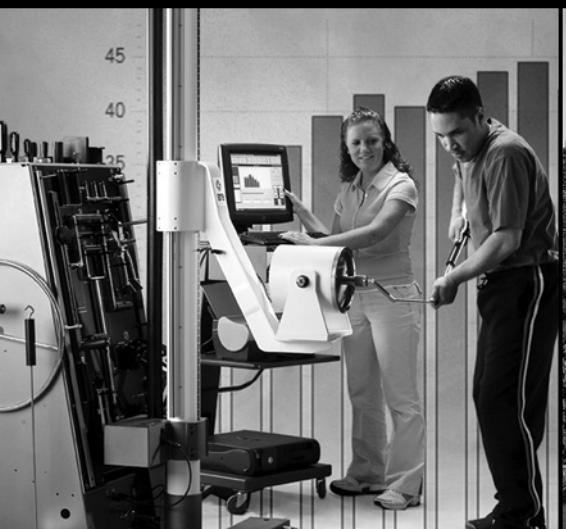

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