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Guest Editorial

Developing the Professional

Gordon Riddle, PT, OCS, ATC, CSCS

To the newly graduated physical therapists and physical therapist assistants, I hope that many of you are settled into your desired area of practice and that your job is fulfilling. To the "seasoned" PT and PTA, I hope that you continue to be passionate about our profession and maintain an understanding of current literature and evidence-based practice. The formal education received at educational institutions provides the foundation for our professional career, and it is now time to build upon that foundation through continuing education.

When searching for employment, it is important to consider the potential for professional development in addition to considering annual salary, compensation package, vacation time, corporate structure, and retirement packages. Professional development is the process of lifelong learning and commitment to providing the best possible care to your patients. This can be as simple as attending local district, state, and national meetings, to networking with professionals in your area, region, country, or internationally. It is important when choosing a place of employment to consider the potential for mentoring, inquire of the facilities local and national networks, specialist certifications, and contributions to the profession. Not only can you be mentored by your employer and co-workers but also through a professional organization. The American Physical Therapy Association (APTA) offers many educational resources and access to information in order to stay current. Some of these include online journals, Hooked On Evidence, and Open Door Portal. In addition, discussion boards, blogs, and social media networks like Twitter, Facebook, LinkedIn, and YouTube offer unique learning and networking opportunities.

There are also many opportunities to be had from listening to other's experiences. The people you will listen to most throughout your career on a day to day basis are your patients. There is much to be learned from your patients, and they will help shape and develop your professional knowledge, skill, and decision making.

As you delve into the professional world, many of you will find yourselves mentoring others in a very short time. You may have these experiences with PT and PTA students, patients, and friends and family. The many facets of the physical therapy "world" will allow you to work with patients who are interested in learning more about our profession. This gives us as PTs and PTAs the ability to promote the profession. Several patients who I have treated over the years have often returned stating that their experience in physical therapy has prompted them to pursue a career in the profession. This is a very humbling experience, as you can impact someone's life in such a positive manner while they are dealing with their own personal ailments. This essentially gives you the opportunity to mentor them; they will always see you as a role model that has positively influenced their life and ultimately their decision in choosing or changing professions. As you develop professionally, it is important to remember that mentoring is a two-way street. There is much to be learned from those you mentor.

As a professional, you should strive to learn something everyday, have a positive influence on your patients and co-workers, and reflect on yourself often to determine your strengths and weaknesses. We must all realize that we are not perfect and that there is always more to learn.

As a new graduate and new professional, rather than viewing graduation as the completion of a portion of your career, it should be viewed as a milestone and a marker of the beginning of a new professional career.

I recall one of my professors and mentors, Steve Gough, telling me while I was in graduate school, "you have more time now than you will after you graduate and begin your career" and "it is easier to access information and stay current while in school." At the time, his wisdom was very difficult to understand because of the stress from our academic mentors. Now that I have practiced for several years, I have a deeper understanding of how true his observation and advice has become. After graduation, it becomes more difficult to access information, there is less time to review the literature, and there is often less opportunity to discuss patient cases and diagnoses.

To help avoid this information gap between education and clinical practice, I encourage all professionals and new graduates to become involved at the local, state, and national levels. Join your professional organizations as they advocate politically for us so that we can continue to provide quality care to our patients. Use resources such as the APTA's Learning Center and the Orthopaedic Section's Independent Study Courses to stay current. Also consider, contacting a professor or mentor to ask them a question regarding a specific patient that you are treating.

In PT school we are all introduced to psychological aspects of patient care, complex patients, cultural difference that influence treatment strategy, unique patient scenarios, and the role of politics in PT practice. It is only through experience that much of this becomes reality. It has been through my experience that I better understand how politics affects reimbursement and patient access and how the bureaucracy of the insurance industry dictates patient care. These issues are very frustrating and can be difficult to interpret. It is through mentorship and surrounding myself with people who have experience and a professional network that helped me to understand these matters.

I also encourage all of you who have read this to please provide this to your new graduates and co-workers who are not members of professional organizations to give them the opportunity to grow both professionally and personally.

The following are suggestions in choosing the right "fit" for your professional growth:

1. When interviewing for a job, consider the potential for professional development as part of your compensation package.
2. Become involved with your local, state, and national organizations.
3. Join the APTA and use the available resources.

4. Attend local, state, and national meetings.
5. Listen to your patients, as you can learn as much from them as they can from you.
6. Give back to the profession by volunteering and becoming a mentor for our future professionals.

The following are Professional Development Resources:

1. Perspectives Magazines.
2. APTA's social media networks such as Facebook, Twitter, LinkedIn, and YouTube.
3. APTA's blogs and discussion boards.
4. APTA's mentorship program.
5. APTA's Learning Center, Hooked On Evidence, Open Door, and professional journals.
6. Orthopedic Section's Independent Study Courses.
7. PT in Motion publication.

In summary, continuing education, mentoring, and lifelong learning are important aspects of professional development. We should always make every effort to learn and understand more. Practicing clinicians have something that new graduates do not, experience. In contrast often times new graduates have something practicing clinicians do not, access to the most current up-to-date physical therapy literature. This is why mentoring is so important, as it make us all better. Remember when you get up and go to work every day you are not only representing yourself and your employer, but you are representing the profession of Physical Therapy. This provides you with the unique opportunity to positively influence the public about our profession. Please remember that learning is a lifelong endeavor; thus we should always strive to become more educated to better ourselves and the profession.

Invited Commentary: Finding Common Ground

Beth Moody Jones, PT, DPT, OCS

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Knowledge of anatomy is one of the cornerstones of medicine and serves as a common frame of reference to make collaboration in research and clinical practice possible. Gross anatomy is one of the first classes a physical therapy student takes in his or her professional curriculum. For many of us, it can be one of the biggest challenges we face as we pursue our new profession given the volume, pace, and rigor of the course. Therapists must be able to identify structures, recognize their place within the body, and understand their function, particularly as it relates to movement. On an equally important level is knowledge and use of the "proper" nomenclature. For most of us, it is like learning a new language, as pronunciation, spelling, and proper use of many terms in anatomy were previously foreign. For example, the *funny bone* and the *shin* are no longer appropriate terminology for a licensed health professional. In order to effectively communicate with other medical professionals, we learn that we need to adopt the universal language of *medial epicondyle* and *tibia*. Language is, however, fluid and every year we hear of new words and phrases that have been formally welcomed into the English language, such as *ringtone, supersize,* and *drama queen*–all of which are located in the updated Merriam-Webster dictionary.[1] We also lose words that were once considered colloquial – like *sagittipotent* (definition: having great ability in archery) or *noscible* (definition: knowable; well-known).[2] The language of anatomy is no different as it is fluid and ever changing. Twelve years ago, the language of anatomy experienced major changes that many of us are not aware of.

The history of the anatomy language can be traced as far back as Hippocrates of Cos (*ca.* 460 BC – *ca.* 370 BC). Early anatomical terms came from Greek and Latin, the scientific languages of early anatomists. Beginning in the mid 1500s, when the first anatomy text was published in Switzerland by Andreas van Wesel,[3] thousands of new anatomical terms were added to our lexicon. Much of that new vocabulary continued to be based on Latin, in an effort to maintain commonality across cultures. That approach was both beneficial and detrimental at the same time. As cultural identities and national interests grew, communities began tailoring the Latin words to fit their native languages, resulting in a drift away from the common language of anatomy. As a result, in the early 20th century the International Federation of Associations of Anatomists (IFAA) created the International Anatomical Nomenclature Committee to establish a common Latin nomenclature that could be accepted internationally. This committee adopted 5 major revisions of *NominaAnatomica* from the 1950s to the 1980s. That nomenclature is what many of us learned as we studied anatomy. A sixth attempt to revise the *NominaAnatomica* in the 1980s was published without prior acceptance from the IFAA leading to an internal struggle between the committee and its chartered organization. In 1989 a new committee was formed by the IFAA called the Federative Committee on Anatomical Terminology (FCAT) whose purpose was to "ensure

(continued on page 146)

Table 1. Abridged List of Terms from TA Pertinent to the Physical Therapist

TA NEW TERMINOLOGY	PREVIOUS TERMINOLOGY
Lower Extremity	
Fibularis longus/brevis/tertius	Peroneus longus/brevis/tertius
Common/superficial/deep fibular nerve	Common/superficial/deep peroneal nerve
Tibial collateral ligament	Medial collateral ligament
Fibular collateral ligament	Lateral collateral ligament
Deep artery of the thigh	Profundafemoris artery
Patellar ligament	Patellar tendon
Ligament of head of femur	Ligamentumteres/capitus
Lateral cutaneous nerve of thigh	Lateral femoral cutaneous nerve
Tensor of the fascia lata	Tensor fasciae latae muscle
Medial ligament of ankle	Deltoid ligament
Upper Extremity	
Intertubercular sulcus	Bicipital groove
Superior transverse scapular ligament	Suprascapular ligament
Tuberosity of the ulna	Ulnar tuberosity
Greater/lesser tubercles	Greater/lesser tuberosities
Dorsal scapular nerve	Posterior scapular nerve
Extensor digitorum	Extensor digitorum communis muscle
Ulnar collateral ligament of wrist/elbow	Medial collateral ligament
Radial collateral ligament of wrist/elbow	Lateral collateral ligament
Cubital fossa	Antecubital fossa
Other	
Anterior/posterior	Ventral/dorsal
Spinal ganglion	Dorsal root ganglion
Cranial nerves –Roman numerals	Cranial nerves – Arabic numerals

Physical Therapy Management of a Patient with Cervicothoracic Dysfunction and Shoulder Impingement Syndrome: A Case Report

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ABSTRACT

Background and Purpose: Patients with upper quarter pain complaints can present with impairments at the cervical and thoracic spine. While upper extremity symptoms are often referred from the cervical spine, referral may result from thoracic spine dysfunction. **Case Description:** A 49-year-old woman with a 5-month history of neck and right shoulder pain was examined by a physical therapist. In addition to cervical and thoracic spine dysfunction, she had right upper extremity symptoms including diminished grip strength, which appeared to be consistent with T4 syndrome. **Outcomes:** She was seen for 5 visits and responded positively to soft tissue mobilization, nonthrust mobilization, thoracic spine thrust manipulation, exercise, and patient education. **Discussion:** Patients with neck pain, symptoms of T4 syndrome, and/or shoulder impingement syndrome can benefit from physical therapy intervention. Careful examination and evaluation are important for patients with upper quarter pain complaints.

Key Words: neck pain, thoracic spine, T4 syndrome

INTRODUCTION

Neck pain is a common health problem. Published reports estimate that 22% to 70% of the population will have neck pain some time in their lives.[1] Neck pain is common in all occupational categories and data show that up to 14% of workers have reported activity limitations as a result.[2] Though not as well-studied as neck pain, thoracic spine pain has been shown to occur across the lifespan of healthy individuals and is a common presentation in primary health care practice.[3] Prevalence of thoracic spine pain over a 3-month period was reported to range from 4.8% to 7.0%; while over a one-year period, the range was 3.5% to 34.8%.[3] Among only working adult cohorts, the one-year prevalence ranged from 3.0% to 55%, with most occupational groups having medians around 30%.[4]

Upper extremity symptoms may accompany problems in the cervical or thoracic region. Cervical radiculopathy, a condition defined as a disease of a cervical spinal nerve root, is most commonly caused by a cervical disc herniation, spondylitic spur, or osteophyte, and patients with cervical radiculopathy often report neck and/or arm pain.[5,6] However, arm pain may also be related to dysfunction of the upper thoracic spine. Some patients with upper thoracic spine pain who complained of upper extremity paresthesias, numbness, allodynia, and/or an increased perception of feeling hot or cold were found to have mobility restrictions of upper thoracic segments.[7-9] This constellation of symptoms is consistent with T4 syndrome, a condition described in previous reports.[7-10] Another source of upper extremity symptoms may be due to a specific joint pathology. Shoulder pain complaints are a common problem in the general population with a point prevalence reported to range from 7% to 26%,[11] with an incidence that peaks in ages 45 to 64 years.[12]

This case report describes the management of a patient with neck pain, upper thoracic pain, shoulder pain, and upper extremity symptoms who was referred by her rheumatologist. The case description will detail the patient's history, examination, initial clinical impression and intervention, further examination findings, prognosis, and outcome.

CASE DESCRIPTION

The 49-year-old female dental assistant was referred to physical therapy for examination and treatment of her neck and right shoulder pain. Her symptoms started 5 months prior, and gradually worsened over the past 8 weeks. Pain started on the left side of her neck and progressed to include her right shoulder, arm, and hand. Headaches started within the past week. She reported right shoulder pain described as an ache and sharp pain at her scapula and posterior elbow region. Numbness was reported at her thumb and index finger, and she noted increasing right hand weakness over the past 6 weeks. She also reported an intermittent "hot" sensation in her right arm although she could not relate it to a specific movement or position.

Neck symptoms were aggravated with left cervical rotation. Although she was right hand dominant, she avoided using her right upper extremity for all activities above shoulder height. She had difficulty opening jars, picking up heavy objects such as a gallon of milk, was unable to hold a pen securely, and could not write for long periods of time due to right hand fatigue. She described having moderate difficulty getting to sleep and a disrupted sleep pattern. While normal sleep duration was 6 to 7 hours per night, she was getting 4 hours of sleep per night and awakened 4 to 6 times due to pain. Her regular exercise routine consisted of walking on a treadmill 30 minutes, 6 days a week that she was able to continue at the time of examination.

Her past medical history was significant for hypertension, Ménière disease, and a 20-year history of sarcoidosis. Past surgical history included hysterectomy (2008), cholecystectomy (2005), and surgical release for right carpal tunnel syndrome (2004). Previous symptoms from carpal tunnel syndrome were all in her right hand and were completely resolved after the surgical procedure. Regular medications she took were Benicar for hypertension, Topamax for neuropathic foot and ankle pain due to sarcoidosis, and a low dose estradiol patch for postmenopausal symptoms after hysterectomy. Prior to her physical therapy consult, she was prescribed a Prednisone dose pack for 7 days that resulted in temporary benefits in decreasing her pain. She reported currently taking 400 mg of ibuprofen at bedtime to help manage her neck and arm pain while sleeping.

To measure her pain and level of function, the patient completed several outcome measures. She was asked to rate her pain using the numeric pain rating scale (NPRS), an 11-point scale with 0 indicating "no pain" and 10 indicating "worst pain imaginable." Changes in pain intensity have been shown to be accurately measured using the NPRS.[13] She rated her worst pain over the past 48 hours at 10/10, and 7/10 at the time of exam. A global function rating of 70% was identified by the patient, with 0% representing "unable to perform any activity" and 100% representing "able to perform all activities without limitation." The global function rating scale is commonly used in the clinical setting to measure a patient's self-reported function. While it has not been validated specifically in patients with neck pain, it has shown a strong correlation with well-established outcome measures for the shoulder.[14]

Her disability related to her current condition was assessed with the Neck Disability Index (NDI). The NDI contains 10 items, 7 related to activities of daily living, two related to pain, and one related to concentration.[15] Each item is scored from 0 to 5 and the total score is expressed as a percentage. Higher scores correspond to greater disability, and in patients with neck pain, the NDI has been shown to be reliable and valid.[15] Her score at her initial visit was 28% indicating a mild level of disability.

Measures of pain, disability, function, and number of sleep disturbances are summarized in Table 1.

Table 1. Measurement Results for the Patient's Pain, Global Function, Disability, and Sleep Disturbance

Test or Measure	1st visit	3rd visit	5th visit
Numeric Pain Rating Scale* (worst pain over past 48 hours)	10/10	2/10	0/10
Global Rating of Function (%)	70	90	90
Neck Disability Index (%)**	28	8	4
Number of sleep disturbances per night	4-6	2	1

***Minimal Clinically Important Difference (MCID) = 1.3[25]**
****MCID = 19%[25]**

Table 2. Measurements of the Patient's Cervical Range of Motion

	1st visit		3rd visit		5th visit	
Cervical range of motion	**Degrees of motion**	**Presence of pain (yes/no); location of pain**	**Degrees of motion**	**Presence of pain (yes/no); location of pain**	**Degrees of motion**	**Presence of pain (yes/no); location of pain**
Flexion	40	Yes; central cervicothoracic spine	45	No	45	No
Extension	35	Yes; central cervicothoracic spine	50	No	50	No
Right rotation	50	Yes; right cervical	60	No	60	No
Left rotation	45	Yes; left cervical	60	No	60	No

PHYSICAL EXAM

Gait assessment showed minimal trunk rotation and no right arm swing: she maintained her right glenohumeral joint in adduction and internal rotation, the elbow extended, and palmar surface of the hand contacting her right anterolateral thigh. Static posture assessment was performed in standing with reference to normal posture as described by Kendall and McCreary.[16] She demonstrated a forward position of the right glenohumeral joint relative to the frontal plane. The right scapula was abducted with a mild anterior tilt. Her cervical spine was in normal midline position relative to the frontal and sagittal planes, and her shoulder girdles were visually level from an anterior view.

Motions of the cervical spine and associated symptom responses were measured and results are summarized in Table 2. An inclinometer was used to measure cervical flexion and extension, while cervical rotation was measured with a standard goniometer. The details of these measurement procedures have been described elsewhere,[1] and have acceptable reliability.[17] Strength was assessed using standard manual muscle tests as described by Kendall and McCreary.[16] Grip strength was measured using a Jamar Hand Dynamometer (Patterson Medical Holdings, Inc, Bolingbrook, IL), in which the average value of 3 maximum attempts was recorded. The results are summarized in Table 3. Sensation testing was intact to light touch in dermatomes C5 through T1. With sharp-dull discrimination, she reported an increase of a "hot" sensation in her right upper arm with stimuli applied to right C6 and C7 dermatomes while a normal response was reported elsewhere. The "hot" sensation did not resolve and continued throughout the remainder of the examination. Deep tendon reflexes were normal for the biceps (C5), brachioradialis (C6), and triceps (C7). Range of motion of the thoracic spine and glenohumeral joints were not measured at the initial visit.

Provocation tests of the test item cluster for cervical radiculopathy were performed, as described by Wainner et al,[18] to screen for presence of cervical radiculopathy. A negative response was reported with Spurling A test. The neck distraction test was also negative. An Upper Limb Tension Test A was attempted on the right upper extremity; however, the patient was guarded and apprehensive and reported a painful response in her shoulder girdle immediately with glenohumeral abduction to 45°.

Palpation assessment revealed tenderness to the following muscles of the right upper quarter: upper trapezius, levator scapula, infraspinatus, teres minor, and thoracic paraspinals in the T1 through T6 region. Suboccipital musculature was nontender to palpation. Passive intervertebral mobility tests showed decreased left lateral glide at C4 through C6, pain and hypomobility T1 through T6, particularly at T4, with posterior-anterior pressures. Using palpation and visual assessment, the therapist also believed T4 spinous process was right of midline. Mobility assessment of the cervical and thoracic spine in patients with mechanical neck pain has poor to fair reliability,[17] while poor reliability has been demonstrated with identification of segmental dysfunction in the thoracic spine.[19]

INITIAL CLINICAL IMPRESSION

Evaluation of all examination findings resulted in a clinical impression of 3 problems: (1) neck pain with hypomobility at lower cervical segments, (2) upper thoracic spine dysfunction, and (3) right upper quarter protective muscle guarding associated with adverse neural tension, disuse, and weakness. Considering results from the provocation tests,[18] the therapist ruled out cervical radiculopathy. The therapist felt that the patient's neck pain best fit the "mobility" classification as proposed by Childs et al.[20] With the key thoracic segment identified as T4, her complaint of headache, pain in the upper thoracic spine region, right upper extremity paresthesias, allodynia, and weakness were similar to descriptions of T4 syndrome.[7,8,10]

The patient's medical history of sarcoidosis did not appear to be contributing to her current problem as her neck pain was mechanically related to movement and could be elicited by examiner provocation tests. She also did not demonstrate any key signs and symptoms associated with any serious pathological neck condition.[20] At this time, she appeared to be an excellent candidate for physical therapy intervention, specifically for manual therapy, a home exercise program, and patient education.

INITIAL PHYSICAL THERAPY INTERVENTION

Since she had significant muscle tenderness and guarding, the goal was to encourage relaxation with use of gentle manual therapy techniques. The physical therapy interventions have been summarized in Table 4. In addition to soft tissue and nonthrust mobilizations performed to the cervical spine, a thoracic spine thrust manipulation was performed to improve mobility and right rotation at T4. The patient was positioned prone and T4 spinous process was identified. Standing at the head of the table and using pisiform contacts, the therapist placed her right hand on the patient's right T5 transverse process and left hand on the left T4 transverse process (Figure 1). A high velocity, low amplitude thrust attempting right rotation of the T4 segment was performed as the patient exhaled. The patient reported an immediate decrease in right arm symptoms, and resolution of the "hot" sensation in her upper arm. Grade II posterior to anterior mobilizations were performed on T2 through T6, which concluded the manual therapy intervention.

She was instructed in an exercise program (see Table 4) intended to diminish protective muscle guarding and encourage normal motion of her right upper quarter. The exercises were to be performed without any increase in shoulder or arm pain. She was also instructed in a cervical rotation active range of motion exercise and this exercise is described elsewhere.[21]

The plan for follow-up was guided by discussion with the patient. She expressed a strong interest in attending physical therapy once a week, due to work responsibilities and the therapist's schedule. She desired to focus on a home exercise program under the therapist's guidance. The initial plan resulted in a mutual agreement to weekly visits over a 4- to 6-week period.

FOLLOW-UP AND CLINICAL IMPRESSION

One week later, she stated she no longer experienced numbness, tingling, or "hot" sensations in her right arm, and improved strength in her right hand. She was able to rotate her neck while driving, reported less neck pain, and experienced no headaches since her initial visit. Primary concerns were pain in her right upper thoracic spine exacerbated with walking on her treadmill, continued difficulty sleeping, and pain in her right shoulder area.

Examination of her cervical spine showed improved cervical range of motion in all directions with neck pain reported at end ranges of left rotation and extension. Upper thoracic spine posture appeared to have a decreased kyphosis relative to normal. Thoracic range of motion, visually assessed in sitting, showed limited flexion and left rotation, both accompanied by pain at end ranges of motion. Manual segmental mobility assessment in prone revealed hypomobility T2 through T6 with posterior-anterior pressures. Manual therapy interventions were performed to her cervical and thoracic spine, and are summarized in Table 4.

Table 3. Measurement of the Patient's Strength

Strength (5/5 = Normal)	1st visit		3rd visit		5th visit	
	Right	Left	Right	Left	Right	Left
Deltoid (C5)	5/5	5/5	NA	NA	5/5	5/5
Biceps brachii & Extensor carpi radialis longus and brevis (C6)	4/5	5/5	NA	NA	5/5	5/5
Triceps brachii & Flexor carpi radialis (C7)	4/5	5/5	NA	NA	5/5	5/5
Grip – Dynamometer (C8-T1)	22 Kg	32 Kg	32 Kg	32 Kg	32 Kg	32 Kg

NA = not assessed

Table 4. Summary of Physical Therapy Interventions

Interventions	1st visit	2nd visit	3rd visit	4th visit	5th visit
Manual therapy	Soft tissue mobilization to: • Cervical spine • Upper thoracic spine Manual cervical traction Grade II left lateral glide mobilization to C4-C6 Thrust manipulation – extension and right rotation T4 Grade II posterior-anterior mobilizations T2-T6	Same as 1st visit, plus: • Seated thoracic spine thrust manipulation • Supine upper thoracic spine thrust manipulation	Seated thoracic spine thrust manipulation Thrust manipulation – extension and right rotation T4 Grade II posterior-anterior mobilizations T2-T6	Soft tissue mobilization to: • Cervical spine • Stretch levator scapulae • Upper thoracic spine Manual cervical traction Grade II left lateral glide mobilization to C4-C6	None
Exercise	Supine shoulder active assisted flexion, 2 sets, 5 reps, 2x/day Standing wall walks – right shoulder flexion with scapular stabilization, 1 set, 5 reps, 3x/day Cervical rotation active range of motion, 1 set, 5 reps, 3x/day	Same as 1st visit, plus: • Pendulum exercise, right shoulder, 2-3 min, 5x/day • Icepack application, right shoulder, 15 min, 1-2x/day	Same as 2nd visit	Same as 3rd visit, plus: • Bilateral Shoulder external rotation with green resistance band, 1 set, 10 reps, once/day • Wall pushups plus, 1 set, 10 reps, once/day • Right levator scapula stretch, 3 reps, 10 sec, 3x/day	• Pendulum exercise, 2-3 min, 3x/day • Bilateral Shoulder external rotation with green resistance band, 2 sets, 10 reps, once/day • Wall pushups plus, 2 sets, 10 reps, once/day • Right levator scapula stretch, 3 reps, 10 sec, 3x/day
Patient Education	Posture – retraction of right shoulder girdle Increase use of right UE with walking and in painfree motions Move neck in painfree motion	Same as 1st visit, plus: • Sleep postures, using pillow for right UE support in scapular plane	Same as 2nd visit, plus: • Instruct patient in vacuuming technique to ↓ strain on right shoulder; ↑ use of LEs and stabilize scapula.	Same as 3rd visit	Review: • Posture • Sleep postures

Since neither cervical nor thoracic spine range of motion provoked her right shoulder pain complaints, an exam was performed to her right shoulder. Active ranges of motion of both shoulders were equal; however, all right shoulder motions were accompanied by pain. Isometric resisted tests to shoulder flexion, abduction, external rotation (infraspinatus test), and internal rotation were all strong and painful. Provocation tests of Hawkins-Kennedy impingement sign and empty can sign (pain and weakness) were positive, while external rotation lag sign and drop arm sign were negative. Palpation of all rotator cuff tendons produced significant tenderness.[22]

Given the positive provocation results for both Hawkins-Kennedy impingement sign and infraspinatus test, the therapist determined that the best working diagnosis for

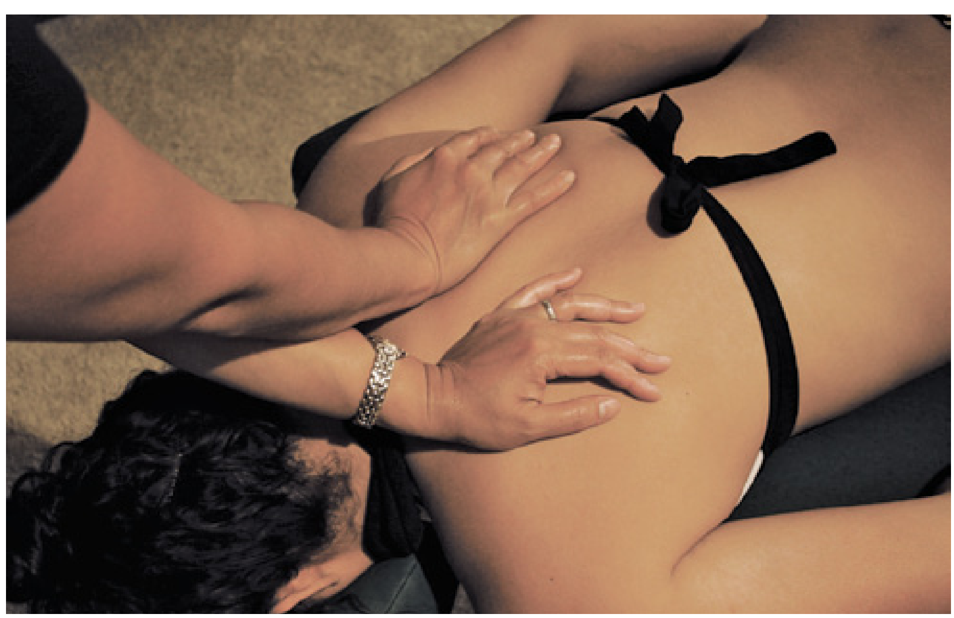

Figure 1. Thoracic spine thrust manipulation to improve mobility and right rotation at T4.

Table 5. Clinical Tests, Probabilities, and Likelihood Ratios for the Diagnostic Classification of Shoulder Impingement Syndrome

Diagnostic Classification	Clinical Tests	Number of positive tests = Probability of diagnosis, Likelihood Ratio (LR)
Shoulder impingement syndrome	Hawkins-Kennedy impingement sign	All three tests positive = 0.95, LR 10.56
	Painful arc sign	Two of three tests positive = 0.90, LR 5.03
	Infraspinatus test	One of three tests positive = 0.63, LR 0.90
		None of three tests positive = 0.24, LR 0.17

Data summarized from Park et al[23]

her shoulder pain complaints was shoulder impingement syndrome. In a study by Park et al,[23] if two of the 3 tests were positive, the probability of shoulder impingement syndrome was 90%, with a likelihood ratio of 5.03 (Table 5). The patient was instructed in a home exercise program of pendulum exercise, cryotherapy for pain management, and modification of her sleeping posture (Table 4).

INTERVENTION AND OUTCOME

Over the next 3 visits, manual therapy was provided in order to resolve specific joint dysfunctions based on accessory motion testing of the cervical and thoracic spine or soft tissue tightness (Table 4). Her exercise program was progressed with the focus on improving pain-free shoulder function. While she reported that pendulum exercises continued to help diminish her shoulder pain, strengthening exercises were not tolerated as well. After a trial of several strengthening exercises for the shoulder and scapulothoracic region, only shoulder external rotation with elastic band resistance and wall pushups plus (wall pushups with scapular protraction upon elbow extension) could be performed without an increase in shoulder pain.

Over time, the patient showed gains in her cervical range of motion and strength (see Tables 2 and 3). She reported no perception of strength loss in her right hand despite the expectation that the dominant right hand should be 10% stronger, based on evidence by Crosby et al.[24] She also reported a steady decline in pain levels, disability, and the number of sleep disturbances (see Table 1). Her pain rating on the NPRS decreased from a high of 10/10 to 0/10, and her NDI decreased from 28% to 4%. According to Cleland et al,[25] a 1.3 point change in the NPRS was found to be the minimal clinically important difference (MCID) in patients with mechanical neck pain, while the MCID for the NDI was a change of 19%.

The patient was pleased with her overall improvement and desired discharge after 5 weeks of physical therapy. Two weeks after discharge, the therapist called the patient as a follow-up. She reported no episodes of neck or upper thoracic pain, and only occasional episodes of right shoulder discomfort that she was managing independently with her exercise program.

DISCUSSION

Patients who present with impairments in the upper quarter require careful examination and evaluation in order to determine the best physical therapy diagnosis and intervention. While neck pain and thoracic spine pain are conditions that frequently originate from those anatomical areas, upper extremity pain complaints may be related to a specific joint pathology, or to problems in the cervical or thoracic spine. In this patient case, her specific glenohumeral joint pain was believed to be due to subacromial impingement syndrome, and her right upper extremity paresthesias, allodynia, and weakness appear to have been related to her upper thoracic spine dysfunction.

Unlike the relationship between cervical spine dysfunction and arm pain,[6,18] little evidence exists supporting the relationship between thoracic spine dysfunction and upper extremity symptoms. Her clinical presentation and response to treatment was similar to T4 syndrome, described in previous reports.[7,8,10] The syndrome has been characterized by a constellation of symptoms such as upper extremity paresthesias, glove-like numbness of the hand and forearm, grip weakness, nondermatomal aches or pains, hand feels hot or cold, and a dull generalized headache.[7,8,10] Due to the proximity of the ganglia of the thoracic sympathetic trunk, peripheral symptoms are believed to result from abnormal mechanical stress resulting from thoracic spine dysfunction.[9,10] Examination findings may show no upper extremity neurologic loss, symptoms unchanged with spinal motion, and pain and/or hypomobility in the upper thoracic spine, frequently at T3 or T4.[7,10] Successful interventions that have been reported include intramuscular injection of bupivacaine at the 4th thoracic paraspinal level,[8] thoracic spine thrust manipulation,[7] nonthrust mobilization to the thoracic spine,[8] and flexibility and strength exercises to address upper thoracic spine impairments.[7] The patient described in this case report had immediate resolution of her right upper extremity symptoms, including her perception of a "hot" sensation after a thrust manipulation to T4 at her initial visit.

Although her primary complaint of neck pain may have been influenced by thoracic spine impairments, it is difficult to attribute cause and effect between thoracic spine thrust manipulation and her diminished complaints of neck pain, since manual therapy interventions were also performed to her cervical spine. Nonthrust vertebral mobilizations to the cervical spine have been shown to benefit patients with neck pain.[26] For this patient, her neck pain improved after manual therapy to both the cervical and thoracic spines, in addition to exercise and patient education.

Lastly, shoulder impingement is a common condition seen by physical therapists,[27] however, her shoulder pathology was not detected until her neck and arm pain diminished. On the patient's second visit, the therapist was able to diagnose the shoulder pathology and devise an exercise program consisting of low-level stretching and strengthening exercises, and instructions on improving her shoulder girdle posture. The patient's gradual improvement was consistent with reports that have shown that exercise and changing posture can result in decreased shoulder pain and improved function in patients with shoulder impingement syndrome.[28,29]

CONCLUSION

This case report describes the successful physical therapy management of a patient with cervicothoracic pain, upper extremity symptoms, and shoulder impingement. While it is common to have upper extremity symptoms referred from cervical dysfunction, this patient may have had referred symptoms from upper thoracic spine dysfunction. Physical therapy interventions such as soft tissue mobilization, nonthrust mobilization to cervical and thoracic spines, thoracic spine thrust manipulation, exercise, and patient education were used. The patient was adherent to her home program and had a positive outcome.

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Effectiveness of Neuromuscular Conditioning to Prevent Anterior Cruciate Ligament Injuries in Female Athletes: A Critical Synthesis of Literature

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ABSTRACT

Background and Purpose: Anterior cruciate ligament (ACL) injuries are common among female athletes. The purpose of this literature review was to assess the effectiveness of neuromuscular conditioning to modify biomechanical risk factors for ACL injury. **Method:** A structured literature search was conducted to identify primary research articles. Articles were graded according to their strength of evidence and a qualitative literature review was completed. **Results:** Seven primary research studies were available for analysis that documented the effects of neuromuscular conditioning (range of evidence grades: 1B-3B). Lower limb kinematics, lower limb kinetics, and incidence of tears were the primary outcomes measures. **Discussion:** The effectiveness of neuromuscular training to modify the theoretical and actual risks for ACL injury is promising but not yet adequately confirmed in the literature. **Clinical Relevance:** Preliminary evidence indicates the effectiveness of neuromuscular training to reduce ACL injury risk, although mechanisms and optimal dosage of exercise remain unclear.

Key Words: anterior cruciate ligament, female, injury, risk factors, biomechanical, neuromuscular training, exercise

BACKGROUND

The anterior cruciate ligament (ACL) is an important stabilizer of the knee and is placed at risk for injury during numerous sports-related activities. Anterior cruciate ligament injuries are more common among female athletes.[1,2] In fact, female athletes are 4 to 6 times more likely to sustain a knee injury compared to male athletes.[1,2] Furthermore, the knee is the most commonly injured joint in the lower extremity, with the ACL being the most affected.[3] Anterior cruciate ligament injuries may require surgery, extensive rehabilitation, and lead to an increased risk of degenerative arthritis.[4] Researchers have identified specific kinetic and kinematic risk factors among female athletes that increase their risk of injury. Studies have been focused on the use of neuromuscular conditioning to modify such biomechanical risks. These neuromuscular conditioning programs involve stretching, strengthening, plyometric, and functional agility exercises that may improve landing techniques, strengthen muscles, and increase overall stability.[4,5]

Multiple intrinsic and extrinsic risk factors differentiate female athletes from the male athletic population, and place them at a higher risk of sustaining an ACL injury. An increased risk of injury has been attributed to anatomical, hormonal, environmental, and biomechanical risk factors.[5] Researchers have identified anatomical differences among females, such as greater pelvic size, smaller ACL size, and larger Q angle, all of which may contribute to an increased risk of injury.[5] In addition, hormonal changes occurring monthly, such as increases in estrogen and relaxin, lead to a decrease in collagen synthesis and contribute to lower tensile properties.[5] Although there are numerous factors that contribute to injury, some biomechanical risk factors may be efficiently addressed, and therefore must become the focus of injury prevention. By understanding that biomechanical risks have the potential to be modified, focus can be placed on the clinical application of neuromuscular conditioning programs to improve certain biomechanical elements.

Biomechanical risks may be attributed to both the kinetics and kinematics of the lower extremity. Numerous biomechanical factors exist among female athletes, such as greater knee extension and valgus during landing, greater hip and knee internal rotation during single-legged landings, and greater quadriceps dependence.[6] Researchers suggest that kinematics within the coronal and sagittal planes may contribute to ACL injury, in particular, decreased knee flexion angles upon foot strike in the sagittal plane and increased knee valgus angles in the coronal plane both play a role in increasing the risk for injury.[7] Furthermore, Imwalle et al[8] found that motions and torques in the coronal plane play a significant role, and suggested that the focus of training must be placed upon controlling motions within this plane. However, it is important to recognize that injury is often due to several motions in multiple planes. Therefore proper training in both the coronal and sagittal planes are necessary to decrease the risk of injury.[8] In addition kinetic risk factors contribute to an increased risk of ACL injury. Researchers suggest that a decrease in knee flexion in conjunction with large quadriceps contraction leads to anterior tibial shear forces that may contribute to ACL ruptures.[9] By understanding the biomechanical elements, the effectiveness of neuromuscular conditioning on the modification of these controllable risk factors may be investigated.

The importance of implementing neuromuscular training programs to modify kinetic and kinematic risks recently has become an intense focus of research.[4,5] Although the interest in ACL injury prevention has expanded in recent years, studies with higher levels of evidence remain minimal. Current evidence shows that neuromuscular training programs can alter biomechanical risk factors, indirectly decrease the potential for injury, and ultimately improve athletic performance.[9] However, researchers have yet to focus on specific neuromuscular training programs and the direct effects they have on ACL injury prevention. Thus, the purpose of this literature review is to assess the biomechanical risk factors associated with ACL injury among female athletes and compare the current literature on the effectiveness of neuromuscular conditioning in the modification of such risks.

METHODS

A literature search for neuromuscular conditioning and the prevention of ACL injuries among female athletes was conducted using the following key words: *anterior cruciate ligament, ACL, athlete, biomechanical risk factors, females, injury, kinematics, kinetics, neuromuscular conditioning, neuromuscular training, prevention,* and *risk factors*. The search was conducted in the following databases: Academic Search Complete, CINAHL, Cochrane Library, PubMed, SCOPUS, and SPORTDiscus. Only primary research studies that were published in peer-reviewed journals, written in the English language, and studied female athletes were included in this review (Table 1).

Sackett's levels of evidence were determined for each research study in order to establish their methodological quality (Table 2).[10] Using a number and letter scale from 1A being the strongest and most reliable, to 5 being the least reliable, each study was rated on this scale.[10] One study was rated at level 1B,[4] one study at level 2B,[5] and 5 studies at level 3B.[6,7,11,12,13] Subsequently, each study was assessed critically with focus placed upon key interventions, patient populations, outcomes measures, and significant results (Table 3).

Table 1. Description of Searches for Studies Conducted on Neuromuscular Conditioning for Anterior Cruciate Ligament Injury Prevention in Female Athletes

Name of Article	Academic Search Complete	CINAHL	Cochrane Library	PubMed	SCOPUS	SPORT Discus
Date of Search	December 5, 2010	December 4, 2010	December 5, 2010	December 3, 2010	December 2, 2010	December 5, 2010
Total no. articles found	28	21	24	18	51	29
No. articles appropriate for review	4	4	4	2	5	2
Chappell and Limpisvasti[7]	X	X			X	
Gilchrist et al[4]	X	X	X	X		
Mandelbaum et al[5]	X	X			X	
Lim et al[6]			X			
Myer et al[11]			X		X	
Myer et al[12]			X		X	X
Zebis et al[13]	X	X		X	X	X

Table 2. Operational Definitions for Levels of Evidence[10]

Level of Evidence	Description
1A	Systematic review of randomized controlled trials (RCT)
1B	RCTs with narrow confidence intervals
1C	All or none case series
2A	Systematic review cohort studies
2B	Cohort study/low quality RCT
2C	Outcomes research
3A	Systematic review of case controlled studies
3B	Case-controlled study
4	Case series, poor cohort case controlled
5	Expert opinion

RESULTS

A total of 7 studies were found on neuromuscular conditioning and ACL injury prevention among female athletes. Although particular publication years were not specified in the search parameters, the studies reviewed were published between 2005 and 2009. Of these, one was a randomized control trial,[4] one was a cohort study,[5] and 5 were controlled laboratory studies.[6,7,11,12,13]

Neuromuscular Conditioning and Modification of Coronal and Sagittal Plane Kinematics

Four studies examined the effects of neuromuscular conditioning on the modification of coronal and sagittal plane kinematics, with the emphasis placed on the reduction of ACL injuries through the modification of biomechanical risk factors.

In a randomized controlled trial, Chappell and Limpisvasti,[7] compared the kinetics and kinematics of 33 NCAA Division I female collegiate athletes before and after undergoing a neuromuscular training program.[7] The athletes underwent a 10 to 15 minute program that incorporated core strengthening, dynamic stability, jump training, and plyometric exercises 6 days a week for 6 weeks.[7] Following intervention, results showed a significant increase in knee flexion angles upon foot strike (p = .003) and maximum knee flexion angles during stance phase (p = .006). In addition, there was a decrease in maximum dynamic knee valgus (p = .04).[7] The work conducted by Chappell and Limpisvasti[7] recognized the importance of neuromuscular training in the modification of risk factors and supported the position that neuromuscular training aids in the prevention of ACL injuries among female athletes.

In a subsequent study by Lim et al,[6] the focus of the intervention was placed on proper biomechanics and the modification

Table 3. Description and Outcomes of Studies Evaluating Neuromuscular Conditioning for Anterior Cruciate Ligament Injury Prevention in Female Athletes

Study	Type of Study	Sackett Level of Evidenc[12]	Frequency, Duration, Conditions	Patient Population
Chappell & Limpisvasti[7]	Controlled Laboratory Study	3B	6 times/wk for 6 wks, 10 exercises performed in 10-15 min, prevention program included core strengthening, dynamic joint stability and balance training, jump training, and plyometrics	30 female NCAA Division I athletes: 12 basketball athletes, 18 soccer athletes, with no history of knee injuries. Mean age 19 ± 1.2 yrs Mean height 174 ± 8.5 cm, Mean wt 69.8 ± 10.9 kg
Gilchrist et al[4]	Randomized control trial	1B	3 times/wk for 12 wks PEP* Program, included stretching, strengthening, plyometrics, agilities, and avoidance of high-risk positions	61 NCAA Division I women's soccer teams: 26 intervention teams (583 athletes), 35 control teams (852 athletes)
Lim et al[6]	Controlled Laboratory Study	3B	20 min during regular team basketball practice for 8 wks, 6 part SIPTP†	22 high school female basketball players, 2 teams: 11 intervention athletes, 11 control athletes, with no history of lower extremity injuries, Mean height 171.3 ± 6.9 cm, Mean body mass 63.9 ± 5.3 kg, Mean age 17.1 ± 1.1 yrs
Mandelbaum et al[5]	Cohort Study	2B	20 min PEP program during team practice for 1 yr, included stretching, strengthening, plyometric, and agility exercises. Resources included an instructional warm-up videotape and literature packet	Year 1- 52 intervention teams (1041 athletes), 95 control teams (1905 athletes). Year 2- 45 intervention teams (844 athletes), 112 control teams (1913 athletes). Ages 14-18. All female soccer teams in the Coast Soccer League of Southern California
Myer et al[11]	Controlled Laboratory Study	3B	3 times/wk for 7 wks of a neuromuscular training program	29 high school female soccer and basketball athletes: 18 intervention athletes, 11 control athletes, n intervention group: mean height and body mass 165.5 ± 6.5 cm 64.6 ± 10.4 kg In control group- mean ht and body mass168.9 ± 9.1 cm and 64.0 ± 7.9 kg
Myer et al[12]	Controlled Laboratory Study	3B	90 min plyometric or dynamic stabilization program for 18 sessions in 7 wks	18 high school volleyball female athletes, 8 subjects in plyometric group, 10 subjects in balance group Mean age for both groups 15.90 ± .8 yrs In plyometric group: initial height 169.5 ± 6.1 cm, and body mass 61.4 ± 7.3 kg In balance group: initial height 168.0 ± 7.3 cm, body mass 66.4 ±11.8 kg
Zebis et al[13]	Controlled Laboratory Study	3B	6 months of regular training as control group. Followed by 20 min, 2 times/wk for 18 wks of a neuromuscular training program with 6 levels, each level performed 2x/wk for 3 wks before progressing to the next level	20 female athletes: 12 elite soccer players, 8 elite handball players, 2 teams Age 26 ± 3 yr, Height 174 ± 6 cm, Wt 70 ± 9 kg

*** Prevent injury and Enhance Performance (PEP) Program[4] consists of warm-up, stretching, strengthening, plyometrics, and sport specific agility exercises.**
† Sports injury prevention training program (SIPTP)[6] is composed of 6 parts (warm-up, stretching, strengthening, plyometrics, agility and alternative exercise–warm down).

Important Outcome Measures	Important Results
3-dimensional motion analysis, force plate data, vertical jump and hop tests, 1 drop jump, 1 vertical stop jump	Neuromuscular training program modified movement patterns by increasing knee flexion during stance phase of drop jump but not stop jump, and decreasing dynamic knee valgus moment during stance phase of stop jump but not drop jump.
Weekly participation and injury reports, observational and written surveys	PEP Program was effective at preventing ACL injuries. Results showed a 70% decrease in non-contact ACL injuries in intervention groups. The overall ACL injury rate among intervention athletes was 1.7 times less than control athletes.
Rebound-jump task using motion analysis measurements, video graphic and analog data, EMG data	Neuromuscular training may alter kinematic risks associated with ACL injuries. Results showed an increase in strength and flexibility. Greater knee flexion angles and maximum knee abduction torques were observed in the experimental group.
Weekly injury report form, knee injury questionnaire, confirmation of a non-contact ACL tear included a history, physical, MRI or arthroscopic procedure	Significant results showed that the use of a neuromuscular training program may have a direct benefit in reducing ACL injuries. Results from year 1 indicated an 88% overall reduction of ACL injury per athlete. Results following year 2 showed a 74% reduction in ACL injuries in the intervention group.
Drop vertical jump using 3-dimensional motion analysis testing, video cameras, and force platforms	Following neuromuscular training, significant reductions observed among "high-risk" females regarding risk factors to ACL injury. High risk athletes attained a 13% decrease in peak knee abduction torques, while no significant effects shown among low risk femaleathletes.Results also showed knee abduction moments among high risk athletes had not reduced to the same level as low risk athletes.
3-dimensional lower limb joint kinematics testing with force platforms to evaluate drop vertical jump and single legged medial drop landing tasks	Significant reductions in knee valgus moments in both the plyometric and balance training groups. Both protocols decreased hip adduction angles during medial drop landing. Plyometric training significantly increased knee flexion upon initial contact during drop vertical jump. Both plyometric and balance training showed similar effects on the kinematics within the coronal plane. However, only plyometric training produced positive effects in the sagittal plane.
EMG analysis during side cutting maneuver with force plates, goniometric measurements	Significant increase in activity of the semitendinosus muscle following neuromuscular training. Program altered the neuromuscular activation patterns of the medial hamstring during side cutting without altering the activity patterns of the quadriceps, thereby decreasing anterior tibial shearing associated with ACL injury.

of coronal and sagittal plane motions. The study examined the effectiveness of a neuromuscular training program on increasing the flexibility and strength of female athletes in order to improve biomechanical properties related to ACL injury.[6] Subjects included 22 high school female athletes in either a control or intervention group.[6] During the 8-week training period, the intervention group underwent a 6-part prevention program that involved warm-up, stretching, strengthening, plyometrics, and agility.[6] Results were obtained through the use of pre- and posttraining motion analysis measurements. The experimental group showed an increase in strength (p = .004 to .04) and an increase in flexibility (p = .022).[6] The female athletes also exhibited greater knee flexion angles (p = .023) and maximum knee abduction torques (p = .043),[6] whereas, the control group showed no statistical differences between pre- and posttraining for any of the parameters tested (p = .084 to .873).[6] The necessity of incorporating a neuromuscular training program was confirmed through the modification of biomechanical risk factors. However, a limitation included the assumption of a cause-effect relationship.[6] Researchers did not study the direct effects of the specific neuromuscular conditioning program on the reduction of ACL injury. Instead, the focus of the study, much like many other studies, was to assess the effects of a training program on biomechanical risk factors. Consequently, the study involves a relatively low level of evidence and therefore the information provided may not be considered highly reliable or generalizable.

In a controlled laboratory study, Myer et al[12] found that female athletes displayed an increase in knee valgus in the coronal plane and a decrease in knee flexion in the sagittal plane when compared to male athletes during landing and pivoting maneuvers. The authors examined how improving lower extremity kinematics would contribute to decreased sagittal plane motion and increased coronal plane motion, and ultimately reduce the risk of injury.[12] The researchers compared the effects of plyometric jumping and dynamic stabilization during landing, and assessed the contributions to coronal and sagittal plane motions linked to an increased risk of ACL injury.[12] Eighteen high school female athletes participated in the study, with half of the subjects undergoing a 90-minute plyometric training program for 12 to 18 sessions, and the other half undergoing a dynamic stabilization program.[12] Data was collected using 3-dimensional lower limb joint kinematics testing.[12] The results showed that both the plyometric and balance training protocols decreased hip adduction angles.[12] These results confirmed that neuromuscular training improved coronal plane kinematics and indirectly reduced the risk of ACL injury. In addition, the results showed that athletes in the plyometric training group increased knee flexion upon initial contact ($p = .047$) while there was no effect on athletes in the balance training group.[12] Although plyometric and balance training showed similar effects on the kinematics within the coronal plane, only plyometric training produced positive effects in the sagittal plane.[12] These results indicate that certain neuromuscular training techniques may not be as effective at modifying biomechanical risk factors as was previously believed.

Myer et al[11] focused on the identification of female athletes at high risk of sustaining an injury primarily due to knee abduction moments > 25.5 Nm, and assessed whether a neuromuscular training program could effectively minimize those risks. Knee kinematics were measured using the drop vertical jump (DVJ) test.[11] The controlled laboratory study concluded that 16 female athletes were at high risk (knee abduction moment > 25.5 Nm) and 13 were at low risk (knee abduction moment < 25.5 Nm).[11] Athletes in the intervention group participated in a neuromuscular training program 3 days a week for 7 weeks. Results indicated that the prevention program did modify biomechanical risks factors associated with coronal plane kinematics, but did not show the high percentage of modifications that was expected.[11] Data showed that high risk athletes attained a 13% decrease in their peak knee abduction torques, with no significant effects shown among low risk female athletes.[11] Researchers also found that knee abduction moments among high risk athletes were not reduced to the same level as the low risk athletes.[11] Although Myer and his colleagues recognized a decrease in biomechanical risk factors, they were not able to show that training effectively reduced knee abduction to a low risk level. In addition, neuromuscular training did not show significant changes, leading to uncertainty when implementing prevention programs for all female athletes.

Given that the 4 studies on the effects of neuromuscular training and the modification of coronal and sagittal plane kinematics were rated with lower levels of evidence, conclusions have to be made with caution. Three of the studies[6,7,12] supported the use of neuromuscular training to alter kinematics within the sagittal and coronal plane, while one study[11] disputed the magnitude of the effects on the modification of risk factors and the ultimate prevention of ACL injury. Additionally, by specifically assessing plyometric and balance training, one study[12] showed that not all types of neuromuscular training were equally effective at altering both coronal and sagittal kinematics. Although it appears that neuromuscular training is effective at reducing the risk of ACL injury among female athletes, further research is required to determine specific types of training for these athletes.

Neuromuscular Conditioning and Kinetic Modifications

In a controlled laboratory study, Zebis et al[13] assessed the effects of neuromuscular training on kinetic modifications. The importance of neural activation patterns between the hamstring and quadriceps muscles was addressed. Twenty female athletes underwent neuromuscular training following 6 months of regular training as the control group.[13] All athletes participated in a 20-minute training program 2 times a week for 18 weeks.[13] The program consisted of 6 levels, each of which were performed 2 times a week for 3 weeks before moving on to the next level.[13] The exercises focused on improving neuromuscular control during standing, running, jumping, cutting, and landing tasks.[13] Researchers found that activity in the semitendinosus muscle was significantly increased following neuromuscular training ($p < .01$) and that activity onset of the semitendinosus increased before foot strike ($p < .05$) compared to activity prior to training.[13] In addition, the training altered the neuromuscular activation patterns of the medial hamstring during side cutting without altering the activity patterns of the quadriceps.[13] The significance of hamstring to quadriceps synergy highlighted the potential for injury when hamstring activation ineffectively counteracted eccentric quadriceps forces. To further confirm the positive effects of training on the reduction of ACL injury, the researchers noted that no ACL injuries occurred among the subjects during the neuromuscular training season in comparison to two ACL injuries during the 6-month control season.[13] When compared to no training; it is evident that prevention programs can modify kinetic risk factors. However, it must be noted that the poor synchronization of data between kinetic and kinematic factors within the studies limits the validity of the findings. The researchers focused on kinetic factors with regards to the sagittal plane and not the coronal plane, while kinematic data was addressed with regards to the coronal plane. Without combined analysis of the kinetic and kinematic findings in both planes, it is difficult to draw conclusions on the effectiveness of training.

Given this study on the modification of kinetic factors, limited conclusions may be formulated regarding the importance of conditioning. Due to the relatively low level of evidence, more studies are required to independently verify the effectiveness of neuromuscular conditioning on the modification of kinetic factors in all planes.

Clinical Effects of Neuromuscular Training Programs

In two studies, researchers examined the overall effects of neuromuscular training programs on the incidence of ACL injuries among female athletes. The training programs involved a combination of stretching, strengthening, plyometric, and agility exercises.

In a randomized control trial by Gilchrist et al,[4] a neuromuscular training program was developed to reduce the risk of noncontact ACL injuries among female athletes. The study included 1435 female collegiate soccer athletes on NCAA Division I teams.[4] There were 35 control teams and 26 intervention teams that underwent a 12-week training program involving stretching, strengthening, plyometric, and agility exercises.[4] The findings showed a 70% decrease in noncontact ACL injuries in the intervention group compared to the control group.[4] In addition, the intervention group suffered no ACL injuries in the second half of the season while the control group encountered ACL injuries (0.000 injuries in intervention group vs. 0.249 injuries in control group; $p = .025$).[4] This study confirmed the positive impact neuromuscular training programs may have on the prevention of ACL injuries among female athletes. Limitations of the trial included lack of specificity in exercises performed by the control group and the inability to supervise all intervention groups to ensure adherence to the program.

In a subsequent study, Mandelbaum et

al[5] examined the effects of prevention programs over a two-year period. The purpose of the nonrandomized cohort study was to determine whether a neuromuscular and proprioceptive training program decreased the incidence of ACL injuries among female soccer players. The study was conducted over a 2-year period with different intervention and control groups each year.[5] During year one, 1041 high school female soccer athletes were enrolled in the prevention program, and 1905 female athletes were in the control group.[5] During year two, 844 high school female athletes were enrolled in the prevention program, and 1913 female athletes were in the control group.[5] The intervention group underwent a 20-minute neuromuscular training program during every team practice for one year.[5] The program consisted of stretching, strengthening, plyometric, and agility exercises while the control group continued a regular warm-up program.[5] In year one, the trial indicated an 88% overall reduction of ACL injury per athlete compared to the control group.[5] In year two, the results showed a 74% reduction in ACL injuries in the intervention group compared to the control group.[5] Mandelbaum et al concluded that neuromuscular conditioning programs were effective at reducing the risk of ACL injury and, in addition, had positive effects when used over an extended period of time. It must be noted that this study was limited by lack of randomization.

These studies suggest neuromuscular conditioning can reduce the incidence of ACL tears in female athletes. Because relatively strong levels of evidence characterized both studies, more confident conclusions may be made regarding the efficacy of neuromuscular training on the reduction of ACL injury.

DISCUSSION

The 7 studies presented in this paper investigated the importance of neuromuscular conditioning in the modification of kinetic and kinematic risks. Although research on the subject is still developing, the results from these studies show some promising outcomes for neuromuscular training and the modification of biomechanical risk factors associated with ACL injury.

Four studies[6,7,11,12] assessed the effects of neuromuscular conditioning on the modification of kinematic risk factors. The evidence indicated the importance of neuromuscular training on risk modification within the coronal and sagittal planes. Three of the studies supported the positive effects of neuromuscular training,[6,7,12] while one study[11] disputed the significance of the effects. Additionally, one study[12] found that not all types of neuromuscular training are equally effective at altering coronal and sagittal kinematics. Although the overall data supported the use of neuromuscular conditioning on the modification of kinematic risks, further research is required to determine valuable types of training exercises and their level of effectiveness.

One study[13] assessed the effects of neuromuscular training on kinetic factors linked with an increased risk of ACL injury. Evidence strongly supported the use of neuromuscular conditioning and found that after training, there was an increase in hamstring activity as well as modification in the neuromuscular activation pattern. Because this study focused on the sagittal plane only, further research is required to confidently affirm the effectiveness of neuromuscular conditioning on the modification of kinetic factors in all planes.

Two studies[4,5] with higher levels of evidence examined the effects of neuromuscular training programs on the reduction of ACL injuries among female athletes. These studies validated the importance of neuromuscular training in the reduction of ACL injuries. While both studies confirmed the effectiveness of training programs, one study[5] found additional positive effects of training over an extended period of time.

CONCLUSION

The purpose of this literature review was to assess the biomechanical risk factors associated with ACL injury and evaluate current literature on the effectiveness of neuromuscular conditioning in the modification of such risks. Research analysis on kinetic and kinematic factors provided evidence in support of neuromuscular conditioning and the modification of risk factors. Overall, it may be concluded that neuromuscular conditioning modifies biomechanical risk factors and indirectly reduces the risk for ACL injury among female athletes. Although focus has been placed on the use of neuromuscular conditioning to modify risks, little research is available on the direct effects of specific neuromuscular training programs. As research on the subject continues to evolve, emphasis must be placed on the assessment of specific neuromuscular training programs and ACL injury prevention. Furthermore, current research provides information regarding the use of neuromuscular conditioning for female athletes at risk of sustaining an injury. However, studies with stronger levels of evidence must be conducted to further determine the effects of neuromuscular conditioning on the modification of risk factors and the reduction of ACL injury among female athletes.

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INVITED COMMENTARY: FINDING COMMON GROUND

(continued from page 132)

democratic input on terminology" with international acceptance.[4] This committee consisted of 20 members from 16 countries. The committee worked for 10 years to build consensus of terminology that would clarify anatomical terms and allow for better communication between speakers of many languages. In 1998 the committee published *TerminologiaAnatomica*[5] (TA), creating a lexicon that transformed the original Latin into terms based on English– the new language of science. There were also fundamental changes to some of the basic Latin terms that had been used for years. Most significantly, they changed much of the language many of us struggled to learn and have come to know so well.

TerminologiaAnatomica was published internationally but received only limited exposure among medical practitioners. While text books quickly adopted the new terminology, educators have been inconsistent in applying the new standards in instruction. Some anatomy curricula have adopted only subsets of the terms[3,6] and thus regional differences have cropped up within North America. Journals were slow to adopt the terminology, most likely due to lack of knowledge of the change. Eventually journals supported the changes through editorials[7] and adopted the changes through their editorial processes. Implementing these changes has been a slow and confusing process for many. This is certainly true for the clinical instructor or clinician who has graduated and has been practicing for over 10 years. These experienced and knowledgeable clinicians work with current students and recently graduated/licensed Physical Therapists who have learned new terminology such as the *fibularis brevis* as opposed to the *peroneus brevis*.

It has been 12 years (1999) since the last updated publication on anatomy terminology and there is still a lack of adoption of the new terms. The authors of one study in 2008[3] stated that they "highly recommend" following the last revision of the TA in any educational, scientific, translating, editing, revising and publishing activities." As an anatomy instructor (within a physical therapy program at a major medical center) who has embraced the international committee's recommendations, I add my enthusiastic support for fully adopting the new TA. To achieve success, we must increase awareness of the new standards through media beyond just the anatomical literature. Table 1 briefly lists some of the changes that directly relate to physical therapy. Adopting the changes in this table is a small but important first step toward broader change that will improve communication between all medical professionals, both in the research and clinic settings.

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Multimodal Treatment Including Thoracic Manipulation for the Management of Chronic Neck Pain and Headaches: A Case Report

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ABSTRACT

Study Design: Case Report. **Background:** This case report outlines the efficacy of multimodal treatment including thoracic manipulation on a patient with chronic neck pain and headaches. **Case Description:** The patient was a 31-year-old woman with chronic neck pain and secondary complaints that included daily headaches, limited cervical mobility, and symptoms in the hand including pain, swelling, paresthesias, and weakness. The interventions used were thoracic and cervicothoracic manipulation, exercise, and electrical stimulation. **Outcomes:** Pretreatment scores were 38% on the Neck Disability Index (NDI), 3/10 on the Patient Specific Functional Scale (PSFS) for turning her head while driving, and 8/10 on the Numeric Pain Scale (NPS). Posttreatment scores following 5 treatments were 6% on the NDI, 10/10 on the PSFS, and 0-1/10 on the NPS. Global Rating of change was +7. **Discussion:** Thoracic manipulation techniques have been demonstrated to be effective in patients with acute neck pain, but treatment effectiveness for patients with chronic neck pain is sparse.

Key Words: manual therapy, thoracic spine, cervical spine, headaches

BACKGROUND

Neck pain is a common musculoskeletal complaint with an annual incidence in adults of 14.6%.[1] After experiencing an episode of neck pain, 22% of the population will have at least one recurrent episode.[1] Many interventions are used by physical therapists in the treatment of mechanical neck pain including thrust manipulation. In patients with acute neck pain, immediate analgesic effects have been demonstrated following thoracic manipulation.[2] From a biomechanical perspective, manipulation of spinal segments that are hypomobile may improve mobility, thereby decreasing abnormal forces on the spine.[3,4] Other effects of manipulation include altered mechanoreceptor discharge and changes in sensory processing.[5]

Research studies have demonstrated positive effects of manipulation directed toward the thoracic spine in patients with acute neck pain.[2,6-10] A systematic review and meta-analysis found sufficient evidence to support thoracic spine manipulation for the management of acute mechanical neck pain and decreased mobility.[10] Significantly greater reductions in pain and disability have been demonstrated with thrust manipulation in comparison to nonthrust mobilization.[6] Two studies compared the effectiveness of an electro/thermal therapy program with and without thoracic spine thrust manipulation.[8,9] In both studies, the manipulation group demonstrated greater improvement in all outcome measures with statistically significant improvements in pain, cervical range of motion (ROM), and disability. In a study comparing an exercise program with and without thoracic manipulation, the manipulation group experienced significantly lower pain scores at one week and significantly lower disability scores at one week, 4 weeks, and 6 months.[7]

While research describes the effects of thoracic manipulation on subjects with acute neck pain, there is little physical therapy research on subjects with chronic neck pain. The average duration of neck symptoms in several studies was 18 days,[8] 19 days,[9] 55 days,[6] 64 days,[7] and 13 weeks.[2] Chronic neck pain lasting more than 6 months is a significant problem; 37% who experience an episode of neck pain will go on to have chronic symptoms[1] and nearly one-third of these subjects will report continued health care utilization for their symptoms at a 5-year follow-up.[11] Due to the prevalence and costs associated with treatment of chronic neck pain, establishing a management strategy to address this issue is important for physical therapists. The purpose of this case study is to describe the effects of multimodal therapy including thoracic manipulation on a patient with chronic mechanical neck pain.

CASE DESCRIPTION

Patient History

The subject in this case report was a 31-year-old woman referred for outpatient physical therapy with a primary complaint of neck pain and a medical diagnosis of mild degenerative joint disease in the cervical spine with reversal of normal cervical lordosis. The findings on the radiograph report were narrowing at the C3 and C5 interspace, slight hypertrophic change at C5, and reversal of the cervical lordosis. The patient's self-reported medical history was unremarkable with the exception of the patient having been previously diagnosed with depression. She reported no significant history of injury or trauma to her head, neck, or upper extremities. She denied a personal or family history of cancer or rheumatoid arthritis, and denied a personal history of osteoporosis or osteopenia. Her current medications included Calcium Carbonate, fish oil, Levoxyl, Sertraline (prescribed as an anti-depressive agent), daily multivitamin, Ibuprofen, and Tylenol extra strength. The patient worked as a medical resident in anesthesiology. Her work duties included prolonged standing or prolonged sitting and typing.

The patient sought medical care due to ongoing neck pain and headaches. She stated her first symptom was neck pain that started insidiously more than 6 months prior to starting physical therapy. She rated her initial symptoms as 8/10 on the 11 point Numeric Pain Scale (NPS), with a rating of zero indicating absence of pain and a rating of 10 indicating pain that would necessitate a trip to the emergency room. She attempted to manage her symptoms for one week using Ibuprofen and Tylenol without success. The patient then sought medical attention and was prescribed a muscle relaxant (Flexeril, 2mg), which was taken 3 times per day for one week and initially reduced her symptoms to a manageable level.

For 6 months following the onset of symptoms, the patient experienced daily headaches that often lasted over one hour. When she experienced headaches she had sensitivity to light, loud noises, and strong smells. She rated the headaches as 7-8/10 on the NPS. Her neck pain and stiffness were worse in the morning and worse on the left side. Other symptoms were intermittent and included bilateral hand pain, paresthesias in 4 fingers, hand swelling, and grip weakness. At the time of her therapy appointment, she was managing these symptoms with 200 mg of Ibuprofen up to 4 times daily and 500 mg of Tylenol extra strength up to two times daily.

Examination

Prior to the physical therapy evaluation, the Neck Disability Index (NDI) and Patient Specific Functional Scale (PSFS) were administered. The NDI is a patient-completed questionnaire designed to quantify disability associated with neck pain and reportedly has a high degree of reliability, internal consistency, sensitivity to severity, and sensitivity to change.[12] The patient scored a 38% on the NDI indicating moderate disability. When asked about difficulty with daily activities, the patient identified difficulty with turning her head while driving and rated this activity as 3/10 on the PSFS. On this scale, a score of zero indicates being unable to do the activity and a score of 10 indicates the ability to do the activity with ease. In patients with neck pain or dysfunction, the PSFS has excellent reliability, validity, and sensitivity to change.[13,14] The patient stated her goals were decreased neck pain, decreased intensity and frequency of headaches, and increased neck mobility.

This patient was chosen for this case report due to her chronic neck pain and unusual presentation of symptoms. The symptoms into her hands did not follow a specific dermatome or peripheral nerve distribution, and she was unsure if they were affected by changes in posture. She reported difficulty performing daily activities due to pain and impaired neck mobility. Based on her history, a thorough examination was indicated to determine if she was appropriate for physical therapy intervention.

Table 1. Physician and Certified Nurse Practitioner Examination

Allergies	No known medication allergies.
General	Moves stiffly. No cervical or supraclavicular adenopathy.
Vitals	Weight 70.5kg Blood Pressure 102/68 mmHg right arm
Neck	Neck is supple, range of motion limited in all directions due to pain.
Reflexes	Intact reflexes in upper extremities.
Skin	Pale, warm, dry.
Heart	Regular rate and rhythm, S1 and S2.
Lungs	Clear throughout to auscultation.
Spine	Mild tenderness to lower cervical vertebrae, tenderness in paraspinals between scapulae, tenderness in bilateral trapezius muscles.
Joints	Full range of motion in shoulders, elbows, wrists, hands, and fingers. Equal and symmetrical grip strength.
Extremities	Intact and symmetrical sensation in upper extremities, normal and symmetrical strength in upper extremities.
Impression	Mechanical neck pain.

Table 2. Measurements of Cervical Active Range of Motion

Motion	Initial Evaluation (Day 1)	Day 14	Day 28
Right Sidebending	30º	50º	50º
Left Sidebending	40º	45º	45º
Right Rotation	30º	65º	75º
Left Rotation	30º	65º	70º

Prior to the physical therapy examination, the consulting physician and a certified nurse practitioner performed comprehensive physical examinations to rule out medical red flags (Table 1). The patient was diagnosed with mechanical neck pain, and was referred to physical therapy for evaluation and treatment. Based on the primary complaint of neck pain with headaches, and considering symptoms into both hands, the patient's primary dysfunction was hypothesized to be in the cervical or upper thoracic spine.

Upon visual observation, the patient had relatively reduced cervical and thoracic curves. A ROM screening of the spine and upper extremities was performed. Goniometer and inclinometer measurements were taken following standard procedures.[15] Lumbar spine ROM was within normal limits, and upper extremity active range of motion (AROM) performed in standing was normal and symmetrical.[15] While seated, the patient performed AROM of the cervical spine, which was limited in extension, sidebending in both directions, and rotation in both directions. No cervical AROM movements were pain relieving, and the patient reported increased pain at end range in all directions with exception to extension. Range of motion measurements are shown in Table 2.

To assess strength and rule out neurologic dysfunction, the examiner performed manual muscle testing of myotomes C2-T1, sensory testing (light touch sensation) of dermatomes C3-T2, and examined deep tendon reflexes.[16,17] No strength or sensory deficits were noted. Deep tendon reflexes for C6, C7, and C8 were normal and symmetrical. Palpation was performed to identify areas of soft tissue dysfunction. Increased tone was noted bilaterally on the cervical and upper thoracic paraspinals, upper trapezius, scalenes, and levator scapulae. The Spurling test and the Distraction test were performed to aid in ruling out nerve impingement or entrapment in the cervical spine, and both tests were negative. The Spurling test has a sensitivity of 77%;[17]

Figure 1. Hand placement position during performance of the thoracic opening manipulation.

Figure 2. Position prior to thoracic opening manipulation.

therefore, a negative test is helpful in ruling out radicular or neurologic pathology. The Sharp-Purser test (specificity 96%, sensitivity 69%),[17] Vertebro-Basilar Artery test, Alar ligament test, and Transverse ligament tests were performed[18] as a cervical spine screen to determine if contraindications to physical therapy treatment were present and all were negative.

Joint play was assessed starting with the patient in the prone position with her arms resting at her sides. The therapist applied posteroanterior central vertebral pressure[17] from C7-T8. Pain and tenderness were reported by the patient from T2-T5 and joint hypomobility was noted by the therapist at T4 and T5. With the patient in the seated position, the therapist then palpated the transverse processes of the thoracic spine from T1-T8. The patient performed flexion and extension during palpation at each level, and hypomobility was noted again at the T4 and T5. Motion testing was then performed at each level of the thoracic spine in both a flexion and extension bias. The therapist stood at the patient's side, using the thumb of one hand to palpate each spinous process with the other arm reaching in front of the patient to her opposite shoulder. The therapist's shoulder was used to shift the patient's weight onto her opposite buttock, sidebending the patient towards the examiner. While performing this movement, sidebending in this same direction was localized at each spinous process by using the thumb to individually stress each vertebral segment. Hypomobility and tenderness were found during right sidebending at T4 while in a trunk flexed (biased) position. While manual palpation techniques may have limited reliability in patients with neck pain,[19] they contributed meaningful information regarding joint play and motion during the examination of this patient.

Based on the patient's posture, decreased ROM in the cervical spine, location of myofascial pain, and location of muscle guarding, the dysfunction was localized to the lower cervical and upper thoracic spine. The negative Spurling test, negative distraction test, and nondermatomal pattern of paresthesias aided in ruling out cervical radiculopathy as a primary cause. Normal sensory tests, myotome tests, and deep tendon reflex tests provided further evidence of a non-neurologic cause. Joint hypomobility and moderate tenderness localized to the thoracic spine at segments T4 and T5 indicated dysfunction at these segments as a possible primary cause. Myofascial tenderness to palpation in the cervical and thoracic paraspinal musculature was likely a secondary finding.

The patient's primary impairments included mechanical neck pain, impaired posture, myofascial pain, headaches, and upper extremity paresthesias resulting in a decreased ability to fulfill her work role and perform activities related to turning her head and neck. Appropriate physical therapy practice patterns from the *Guide to Physical Therapist Practice* included impaired posture (4B), impaired muscle performance (4C), impaired joint mobility, motor function, muscle performance, and ROM associated with connective tissue dysfunction (4D).[20]

In addition to the NDI, PSFS, and NPS, the 15-point Global Rating of Change (GROC), the patient's subjective report of headache frequency and intensity, and cervical ROM measurements were used to measure patient progress. This patient was a good candidate to receive thoracic manipulation, as she had neck pain and limited spinal mobility. In addition to the randomized controlled trials previously described, a Cochrane Review for treatment of mechanical neck disorders found that manipulation in combination with exercise was effective for alleviating persistent neck pain and improving function.[21] Based on previous studies of patients with acute neck pain,[2,6-10] this patient may benefit from physical therapy treatment by decreased pain ratings and improved disability scores.

Intervention

Prior to each treatment, the therapist assessed segmental mobility of the thoracic spine. Prone posteroanterior central vertebral pressure was applied on the spinous processes, and segmental motion testing was performed as previously described in the examination section. During treatments one and two, joint hypomobility and discomfort were found at T4. During treatment 3, joint hypomobility was found at T5. In all 3 cases, the joint was limited in flexion, and a thoracic opening manipulation was performed.

To perform the thoracic opening manipulation (Figures 1 and 2), the patient was placed in supine and instructed to cross her arms in front of her chest, grasping her opposite shoulder with each hand. The therapist was positioned on the right side of the patient and rolled the patient's upper body to her right to allow access to the spine. The thenar eminence of the therapist's right hand was placed on the patient's left transverse processes, with the level of the second digit one level below the targeted vertebrae. The hand position used for this manipulation was open palm, fingers flexed, and thumb in extension. The patient was rolled back into the supine position on top of the therapist's hand. The therapist used the left hand and chest to introduce a flexion and slight side-bending bias in the direction of limitation through the patient's forearms. The patient was instructed to take a deep breath in and then exhale. The therapist exerted a progressive, posteriorly directed force through the patient's forearms during exhalation. Once available joint play was taken up, a high velocity, low amplitude thrust was administered through the patient's crossed arms in an anterior to posterior direction.

During treatment sessions 4 and 5, normal mobility was noted at T4 and T5 during both prone posteroanterior central vertebral pressure and motion testing. Joint hypomobility and tenderness were found at T1-T2, and palpation revealed continued muscle guarding in the lower cervical paraspinal muscles. The patient responded well to previous joint manipulations, and remained in favor of repeating this intervention. To apply specific intervention to T1, T2, and the lower cervical spine, a cervicothoracic junction manipulation was administered.

To perform the cervicothoracic junction manipulation (Figure 3), the patient was seated on the plinth with the therapist standing behind her. The therapist reached under the patient's arms and grasped her wrists with palms facing down. The patient was instructed to interlace her fingers and place them behind her neck. A rolled towel was placed between the therapist's chest and the patient's thoracic spine, with the top of the towel level with the T3 vertebral segment. The therapist used his chest to administer a posterior to anterior force into the patient's cervical and thoracic spine through the rolled towel. Once joint play was taken up, the manipulation was performed by applying pressure through the rolled towel in an anterior direction and applying a posterior and superior distraction force directed through the patient's arms.

Table 3. Daily Home Exercise Program

Exercise	Following treatment 1	Following treatments 2 and 3	Following treatments 4 and 5
Sidelying shoulder circles	10 repetitions	10 repetitions	10 repetitions
Quadruped thoracic mobility	10 repetitions	10 repetitions	10 repetitions
Cervical stabilization		10 repetitions, 5 second hold head supported	10 repetitions, 5 second hold with head lift
Mobilization with movement, cervical rotation			3 repetitions at each cervical level

Several other interventions were administered during the duration of physical therapy care. These included high volt electrical stimulation in conjunction with thermotherapy, mobilization with movement to the cervical spine, and a home exercise program. The electrical stimulation and thermotherapy modalities were applied to the upper back and neck for 30 minutes prior to each treatment to decrease pain and muscle tension. Electrical stimulation was delivered through two channels with one electrode from each channel placed on each side of the spine on the cervical paraspinals, and a second electrode placed on the upper trapezius muscle midway between the spine and the acromion process. Electrical stimulation was administered with negative polarity at 90 pulses per second and continuous rate. Sustained natural apophyseal glides, a mobilization with movement technique, was performed during the fourth and fifth treatment sessions to increase cervical rotation.[22]

Figure 3. Cervicothoracic junction manipulation.

The patient was instructed in a home exercise program starting after the first treatment session. To ensure the patient was performing the exercises correctly, they were reviewed both verbally and via patient demonstration at each appointment. A shoulder circle exercise was performed in sidelying to increase mobility in the thoracic spine and cervical spine, decrease anterior chest tightness, and activate scapular stabilizers. A quadruped thoracic mobility exercise into flexion and extension was used to increase mobility in the thoracic spine and strengthen the scapular protractors. A cervical stabilization exercise performed in supine was chosen to target the deep cervical flexors, which can be inhibited by pain and prolonged poor posture. The final home exercise was sustained natural apophyseal glides to increase cervical rotation. This was performed with a hand towel as described by Mulligan.[22] The progression of home exercises is detailed in Table 3.

OUTCOMES

Following thoracic manipulation at the initial physical therapy visit, the patient demonstrated immediate improvement. Her pain level of 8/10 on the NPS decreased to 4/10, and she reported less difficulty with neck rotation. The day after this treatment the patient's neck pain remained decreased, and for the first day in more than 6 months she did not report a headache.

On day 3, the second treatment session, the patient demonstrated continued improvement. Her pain level started at 5/10

Table 4. Outcome Measures

Outcome Measure	Initial Evaluation (Day 1)	Day 14	Day 28
Neck Disability Index	38%	18%	6%
Patient Specific Functional Scale (turning head while driving)	3/10	8/10	10/10
Global Rating of Change	N/A	+7 (a very great deal better)	+7 (a very great deal better)
Numeric Pain Scale	7-8/10	1-4/10	0-1/10

and dropped to 1/10 following manipulation and her home exercise program. Following this treatment session, the patient went on vacation. She reported decreased neck pain and elimination of headaches from day 3 to day 11. During her vacation, she traveled approximately 3,400 total miles by car, and only after day 11 did she experience exacerbation of symptoms.

On day 14, the third treatment session, the patient initially rated her pain as 4/10. Following thoracic manipulation and exercise, her pain level again dropped to 1/10. Active range of motion measurements were taken following treatment (see Table 2), and the NDI, PSFS, and GROC were administered (Table 4). Following 3 physical therapy treatments, the patient demonstrated improvement in pain level, headache frequency and intensity, cervical ROM, and ability to turn her head and neck during activities including driving and working. Specifically, she reported on the NDI that headaches started as severe and frequent and improved to moderate and infrequent. On the GROC, she indicated that she felt a great deal better (+7).

On day 16, treatment number 4, the patient reported neck pain and a headache that she rated as 7-8/10. She attributed her symptoms to working a full day shift and then working a full night shift with less than 3 hours of sleep. Following intervention, her pain level decreased to 5/10, and she stated she felt somewhat better. On the fifth and final treatment session (day 21), the patient reported being headache-free for the previous 5 days but continued to have mild neck pain which she rated as 3/10. Following intervention, her neck pain had decreased to 0-1/10.

After 5 physical therapy treatments, the patient demonstrated improvement in pain levels, headache frequency and intensity, ROM, and functional improvement. The patient stated she no longer had pain, paresthesias, weakness, or swelling in either hand. On the NDI, the patient reported being able to take care of herself normally without having increased pain, as well as having no difficulty with sleeping. She stated she had no headache at all, which improved from severe, daily headaches initially and moderate, infrequent headaches on day 14. The patient no longer had neck pain when turning her head while driving. This corresponded to her scoring a 10/10 on the PSFS indicating no difficulty. Lastly, she scored a +7 on the GROC, indicating she was a very great deal better. The patient was discharged with all physical therapy goals met.

DISCUSSION

There is evidence that thoracic manipulation is an effective intervention for patients with acute mechanical neck pain, although only one study included a follow-up longer than 4 weeks.[2,6-9,21] The effectiveness of thoracic manipulation performed by a physical therapist in the treatment of patients with a primary complaint of chronic neck pain has not yet been demonstrated.[21] This case report, however, describes how spinal manipulation was applied to the thoracic spine and cervicothoracic junction to treat a 31-year-old female with chronic neck pain lasting longer than 6 months and secondary complaints of daily headaches, hand pain, weakness, swelling, and paresthesias. The patient in this case report experienced clinically significant improvement in all outcome measures including a 32% decrease on the NDI, a 7-point increase on the PSFS, a score of +7 on the GROC, and a 7-point decrease on the NPS. In patients with neck pain, a change of 3.5-9.5 points (7-19%) on the NDI indicates a clinically significant change,[23-25] and a 1.18 point difference on the PSFS indicates a clinically important difference. On the GROC, scores of +6 and +7 have been reported as large changes in patient status.[26] Furthermore, in patients with chronic pain, a change of two points on the 11-point NPS indicates a clinically significant difference.[27]

The manipulations described in this case report were specifically targeted to T4, T5, and C7-T1 segments, which were hypomobile during examination. Some of the improvements demonstrated in this case report are likely explained by the concept of regional interdependence,[28] that impairments in a remote anatomical region may contribute to, or be associated with the patient's primary complaint. A two-year prospective study found decreased C7-T1 and T3-T4 mobility a significant predictor of headaches, and decreased C7-T1 and T1-T2 mobility a significant predictor of subjective weakness in the hands.[29] For the patient described in this case report, decreased thoracic spine and cervicothoracic junction mobility may have contributed to symptoms in other anatomical regions including headaches and upper extremity pain, paresthesias, and subjective hand weakness. This provides a possible explanation of why she experienced relief from these symptoms following manipulation targeted at the thoracic spine and cervicothoracic junction.

It is likely thoracic manipulation had a significant effect on the patient's recovery; however, a cause-and-effect relationship cannot be determined. It is possible that other factors including healing time, medication, and cointerventions may have lead to symptom improvement. The patient experienced daily symptoms for over 6 months, and demonstrated a dramatic decrease in symptoms following manipulation during the first physical therapy treatment, so it is unlikely that time alone could be responsible for her improvement. Although medications may have been helpful, the patient had been unsuccessful at managing her symptoms with medications prior to starting physical therapy treatment. In addition, she stated that she attributed her improvement to manipulation and participation in her home exercise program. With regards to examination, previous research has demonstrated substandard levels of reliability when manual palpation techniques are used on patients with neck pain.[19]

This case report demonstrates that a multimodal treatment including thoracic manipulation provided relief to a patient with chronic neck pain and headaches. To provide evidence-based care for patients with chronic neck pain, randomized controlled trials should be performed on the use of thoracic manipulation in this population, and should include a long-term follow-up evaluation. Because many thoracic manipulation techniques are used in physical therapy practice, research focused on identifying the most efficacious manipulation technique would be beneficial.

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Isolated Exercises versus Standard Treatment for the Shoulder in an Industrial Setting

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ABSTRACT

Background and Purpose: Cumulative trauma disorders are common in industrial workers, leading to morbidity and disability. This study compared the effectiveness of home exercise programs with standard medical treatment, for individuals with shoulder injuries, in an industrial setting. **Methods:** A convenience sample of 9 industrial employees, were randomly placed into either a control group (n = 5) consisting of standard medical care or an exercise group (n = 4) consisting of a home exercise program. Participants were evaluated 3 times during a 6-month period using a disability index survey and measurements of shoulder range of motion and strength. **Findings:** Three significant findings were found between the groups (two strength measurements and one measure of disablement), with improvement noted in the exercise group. Trends were also observed in greater improvement in the exercise group in strength and disability index scores. **Clinical Relevance:** This study provides limited support for the use of home exercise programs as a secondary intervention in an industrial setting.

Key Words: musculoskeletal disorders, secondary intervention, worker training, isolated exercise, shoulder

INTRODUCTION

Cumulative trauma disorders (CTDs) are very common in industrial workers. These injuries can occur for a number of reasons including vibration; forceful/repetitive activity; and awkward, prolonged, or static positions of the worker.[1-3] Cumulative trauma disorders can be classified as chronic musculoskeletal injuries that may progress without intervention. Presently, these injuries are one of the leading causes for morbidity and disability in industrial countries. The disability resulting from these injuries, in particular, can be economically detrimental for both the employee and the employer. Cumulative trauma disorders can significantly affect employers by loss of productivity, loss of revenue, increased administrative expenses, and increased overhead due to ever rising medical costs.[1] Cumulative trauma disorders accounted for over one-third of all workers compensation claims, and work related injuries costs the United States over $54 billion annually.[4]

The most common regions of the body affected by CTDs are the spine and shoulder, with the shoulder selected as the focus of this study.[1,5] The most common interventions used to address these injuries in the industrial environment are to either discontinue or modify the motion/job in question, or to address the musculoskeletal deficits that may be predisposing workers to these chronic injuries.[1,3,5] Only a minimal amount of research has been done to document the effects of preventative care on CTDs. The majority of published research studies focused on the care of individuals after a major injury occurred and ways to return the worker to his or her preinjury status.

A number of research studies confirmed that those who work in the industrial sector are at higher risk for CTDs.[4,6,7] These studies alluded to the idea that industrial workers are in greater need of preventative exercise programs than the general population. The literature suggested a multidimensional approach to prevention, with activities that incorporated strength training, flexibility training, and changes to the workplace environment.[4,6,7]

The purpose of this study was to identify if a correlation existed between the implementation of a preventative exercise program and a reduction in disparities of shoulder strength, shoulder range of motion (ROM), and upper extremity function in the shoulders of industrial workers with a shoulder complaint. Specifically, this study compared the effectiveness of a home exercise program with a standard medical treatment for individuals with shoulder complaints, in an industrial setting.

METHODS

Participants

Approval for this study was obtained from Oakland University's Human Subjects Review Board (IRB). The study used a quasi-experimental design. The participants were selected as a sample of convenience from employees working at a plant in Detroit, Michigan, where diesel engines were manufactured. In this industrial setting, employees work on assembly lines in jobs that often require the employees to engage in repetitive overhead movements, use vibrating tools/machinery for prolonged periods of time, and lift heavy engine components. The facility had an on-site physical therapy program at the time of the study, and at any point in time approximately 70% of the employees seeking rehabilitation had suffered a shoulder injury. The inclusion criteria for the study were individuals: (1) employed at the industrial plant where the study took place, (2) between the ages of 18-65, and (3) had a shoulder complaint related to the work environment. The exclusion criteria included: (1) current rotator cuff tears or superior labrum anterior posterior (SLAP) lesions, (2) a recent shoulder surgery, (3) an injury that would require a future surgery (full rotator cuff tear, etc.), (4) participants who were currently in physical therapy or other treatment for the shoulder, and (5) other co-morbidities that impact shoulder function such as cervical dysfunction.

Procedures

At the initial evaluation, all participants meeting the inclusion and exclusion criteria were given a verbal description of the study and invited to participate. Those participants who signed the informed consent were given a prescription for physical therapy from the on-site physician, and then began the evaluation procedure that was the same for all participants. First, each participant drew a slip of paper from a container. One slip was labeled 'exercise group,' the other slip labeled 'control group.' (By signing the informed consent, participants knew they would be given exercises for their shoulder either at the beginning or end of 6 months of data collection.) After random assignment into a group, the participant was asked to complete a Disability Index survey. The on-site physical therapist then measured ROM and conducted manual muscle tests (MMT) for each participant (initial evaluation). As part of the evaluation process, the physical therapist also asked questions and observed the participant for any of the exclusion criteria not identified during the initial interview. Participants were reevaluated at 3- and 6-month intervals using the disability index and shoulder ROM and MMT measures described previously. To prevent bias, the physical therapist did not keep any of the data collection sheets at the facility and did not have access to any data until completion of the study. Therefore, each time the participant was measured for active range of motion (AROM) and MMT, the previous recorded data was not known. However, during data collection, the physical therapist was often asked how to progress exercises by exercise group participants, so blinding to group assignment was not possible.

Table 1. Mann-Whitney *U*-Test Results for Shoulder Girdle Strength

	Painful Shoulder Sig. (2-tailed)	Uninvolved Shoulder Sig. (2-tailed)
Flexion	**0.046***	0.508
Abduction	0.102	0.278
Rhomboid	0.439	0.317
Serratus	1.000	1.000
Latissimus	0.765	0.356
Middle Trapezius	**0.040***	0.304
Horizontal Abduction	0.108	0.874
Extension	0.767	0.278

***Significant at the .05 level**

Outcome Measures

The Disability Index used in this study was a modification of the Disablement in the Physically Active (DPA) Scale.[8-10] The DPA contains 4 components: impairments, functional limitations, disability, and quality of life.[9] Impairments were categorized as pain, decreased motion, decreased muscle function, and instability. Functional limitations were identified by problems with skill performance, maintenance of positions, fitness, and changing directions. Disability consisted of problems with participation in daily activities. Finally, quality of life addressed uncertainty and fear, stress and pressure, mood and frustration, overall energy, and altered relationships.[9] The original DPA was tested psychometrically and found to be a reliable, valid, and responsive instrument.[10] Our index contained the same 16 questions as the original DPA with minor word changes in 4 questions. Three questions added "in my shoulder" to the original question, and the remaining question replaced the words "physical activity" with "at my job." In addition, the examples listed below each question were changed, if needed, to be specific for the shoulder (Appendix 1). Each question was rated on a 5-point scale where one equaled "no problem" and 5 equaled "the problem(s) severely affect(s) me." Since our disability index did not contain the exact wording as the original DPA, psychometric test results could not be assumed. Therefore, we conducted a pilot study to determine the reliability of our Disability Index. Fifteen participants randomly volunteered from a variety of jobs in the plant, and were asked to complete the survey two times over a 3-day period. The participants in the pilot study (n = 15) were not the same employees who later participated in the actual study (n = 9). However, the pilot study participants were included only if they had a shoulder complaint within the last year. The interclass correlation coefficient (3,1) for all questions ranged from 0.86 to 1.0.

Manual muscle testing and goniometric measurements have been shown to be valid and reliable.[11-13] The goniometric measurements collected in this study were shoulder: flexion, abduction, internal rotation, external rotation, and extension. These measurements were taken in the standard testing positions as described by Norkin and Levangie.[14] Muscle testing was performed in the standard testing position (sitting or prone), using a 5-point scale, as described in Daniels and Worthingham's Muscle Testing.[15] The muscle groups tested were the shoulder flexors, extensors, abductors, horizontal abductors, and internal/external rotators. Individual muscles tested were the rhomboids, serratus anterior, middle trapezius, and lower trapezius.

Interventions

Throughout the duration of the study, both the "exercise" (n = 4) and "control" (n = 5) groups received standard treatment from the nursing staff that consisted of heat and/or ice and anti-inflammatory medications, when needed. The nursing staff members did not participate in the study in any other fashion except to provide anti-inflammatory medications or ice/heat as requested by participants. None of the study's participants received in house physical therapy during the study. The only physical therapy intervention provided was to the exercise group. This group of participants was given a home exercise program designed specifically to address deficits (strength or AROM) identified during the initial examination. Exercises were selected from a software program developed by Visual Health Information System (Tacoma, WA). All exercises were completed using Thera-Band elastic resistance or isotonic hand weights. All participants in the exercise group were given pictorial handouts of each exercise, in addition to a verbal description and physical demonstration of each exercise. These participants were then asked to demonstrate the exercise, and instruction continued until the participant could demonstrate the exercise correctly. The instruction in home exercises was only given at the time of the initial evaluation. Exercise participants were instructed how to progress exercises by starting with 3 sets of 8, progressing to 3 sets of 15, and then increasing weight and or Thera-Band resistance and returning to 3 sets of 8. (Exercise group participants could see the in-house physical therapist at any time for new Thera-band.) New exercises were not added to the home exercise program. The participants simply increased the number of sets or Thera-band resistance to the exercises given at the initial evaluation. The control group went through the initial evaluation and was then informed to continue standard nursing care (as described above) until the next recheck in 3 months. No physical therapy interventions were provided to participants in this group. Throughout the duration of the study, the onsite physical therapist was available to answer questions from participants in either group. In addition, monthly calls were made by student physical therapists to field questions from all participants and to check if the exercise group participants were still completing their home exercise program. (Although the student physical therapists did not participate in any of the evaluations, the students were given a copy of the home exercise program for each participant in the exercise group to assist with answering questions from members of this group.)

Statistical Analysis

Due to the small sample size (n = *9*) and the data not meeting the assumptions of normality, nonparametric analyses were used on all outcome measures in the study. To see if either group had changes in shoulder AROM, shoulder strength, or disability index scores over time (across the three data collections sessions), a Friedman two-way analysis of variance of ranks (ANOVA) was used. To determine if either group exhibited a within group change across the data collection period, specifically comparing the initial evaluation to the 3 month re-evaluation, the 3 month and 6 month re-evaluations, and the initial evaluation and 6 month re-evaluation, Wilcoxon signed-rank tests were conducted. Finally, Mann-Whitney *U*-Tests were used to analyze between group differences in the changes in the two groups' means over the 3 data collection periods (initial to 3 months, 3 to 6 months, and initial to 6 months) as outlined previously. Like the previous statistical analyses, Mann-Whitney *U*-tests were conducted for all 3 outcome measures (AROM, strength, and disability index scores). Manual muscle strength data was inputted into the analytical software using an 8-point scale, which ranged from 4 to 11, where 4 = MMT grade 3-, 5 = MMT grade 3, 6 = MMT grade 3+, 7 = MMT grade 4-, etc. SPSS 17.0 (Chicago, IL) was used for statistical analysis and significance was set at .05.

RESULTS

Participants

Eleven participants volunteered for the study. Two participants did not finish the study, one for a health issue not related to the shoulder, and one due to a lay-off. Therefore, all results were tabulated using data from 9 male participants, with an age range from 35-58 years old. All participants were given a diagnosis of "shoulder strain" by the in-house physician, since the exclusion criteria specifically excluded injuries that would require surgeries or other treatment interventions (cortisone shots, physical therapy, etc.) during the course of the study. Due to policies within the facility, additional demographic data were not collected. The exercise and control groups did not differ significantly in their shoulder AROM or disability index scores at the beginning of the study. Strength measures also did not differ with the exception of shoulder flexion. The control group was significantly stronger in this measure (p = .012) at the beginning of the study, despite random assignment of participants to groups.

Differences in group means for shoulder AROM, shoulder muscle strength, and disability index scores across the 6 months duration of the study, were not significant for either the exercise or control group, using Friedman ANOVA. These findings were validated by Wilcoxon signed-rank tests that also found no significant changes in either the exercise or control groups across specific time intervals during the data collection period (initial to 3 months, 3 to 6 months, and initial to 6 months).

Differences in strength were compared between the two groups, between the 3 data collection periods. For the uninvolved shoulder, no significant differences were found. For the involved shoulder, significant differences were identified between the initial evaluation and the 6 month re-evaluation in shoulder flexion (p = .046) and mid-trapezius (p = .040) strength (Table 1). The exercise group increased in shoulder flexion from 8.83 (MMT 4+) to 9.50 (MMT 5-), and in mid-trapezius strength from 7.00 (MMT 4-) to 9.50 (MMT 5-). The control group had no change in shoulder flexion remaining at an 11.00 (MMT 5) throughout the study, and had a mild increase in mid-trapezius strength from 7.80 (MMT 4) to 9.25 (MMT 4+). While a statistically significant difference was identified between the groups in flexion and mid-trapezius strength, within group changes were not statistically significant. However a trend of improved strength was observed in the exercise group, where 7 of the 10 MMT measurements improved, compared to only 4 out of 10 MMT measurements in the control group (Figures 1 and 2).

Changes in the means of the disability index scores were compared between the two groups, between the data sessions as described previously. One significant difference was found between initial evaluation and 6-month re-evaluation (p = .044). The specific question asked "Do I have difficulty with changing directions in activity?" The exercise group's scores improved from 4.0 (moderately affects) to 2.75 (slightly

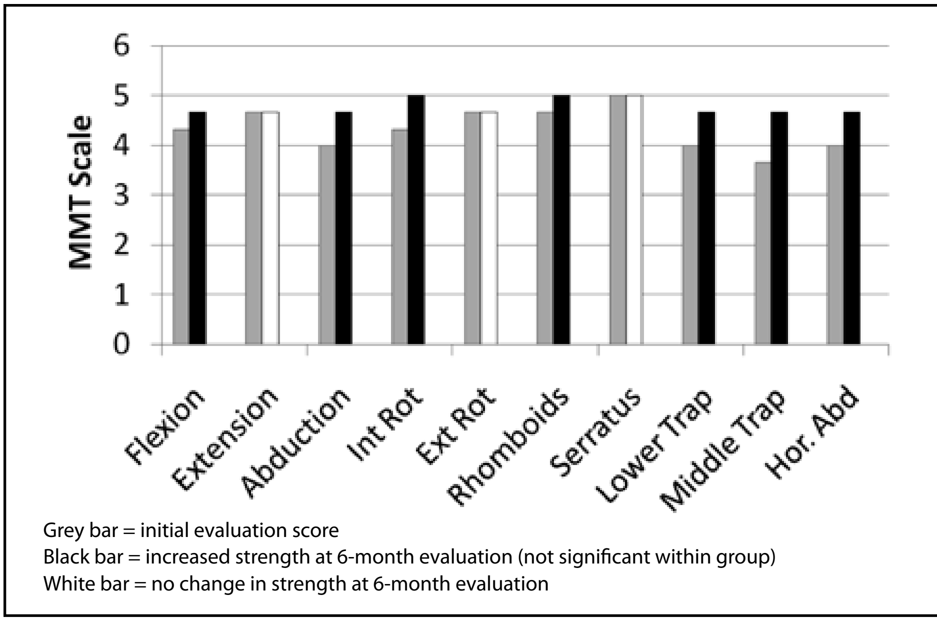


Figure 1. Mean strength scores of the exercise group's involved shoulder (initial evaluation to 6 months).

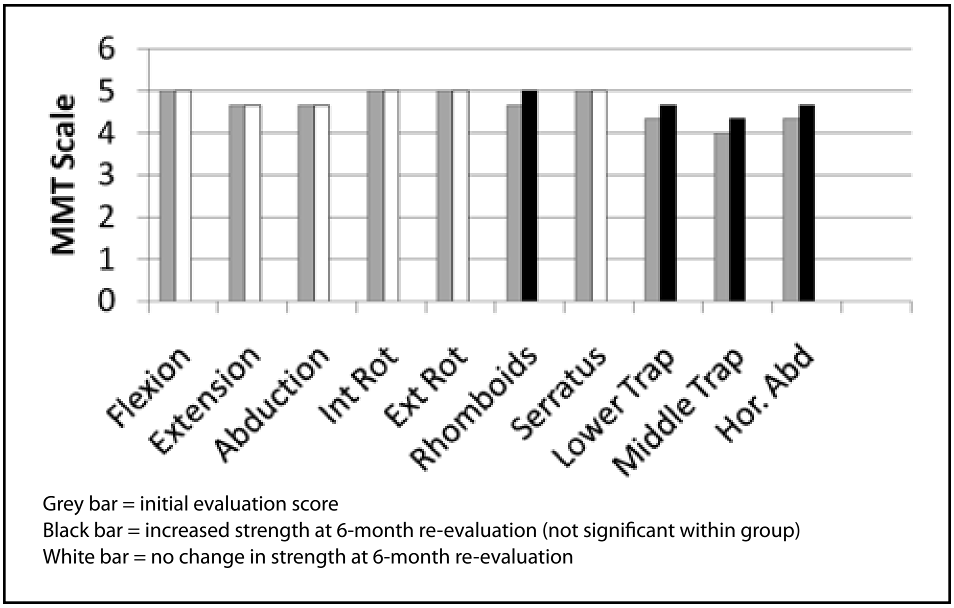


Figure 2. Mean strength scores of the control group's involved shoulder (initial evaluation to 6 months).

affects). The control group's scores remained at 2.25 (does not affect) at both the initial and 6-month evaluations. Again, while between groups differences were statistically significant for one question, within group differences were not significantly for either group across time. However, a trend was once again observed in that the exercise group reported improvement (declining scores) in all but two questions (Figure 3). The control group, on the other hand, reported no change in 5 questions and a decline (increased scores) on 3 questions (Figure 4).

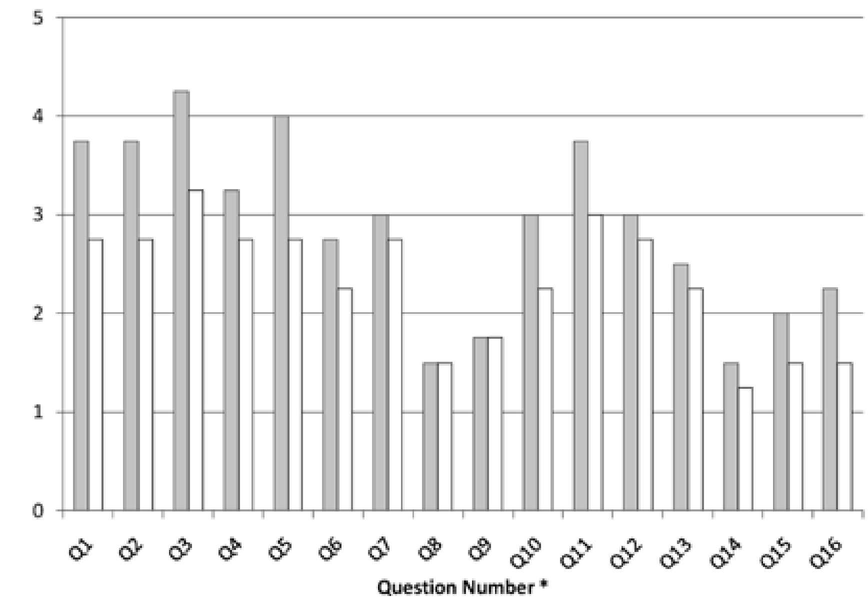
Finally, changes in the means for shoulder AROM were compared between the two groups, between the 3 data sessions, and were not found to be statistically different. In addition, although participants were given exercises logs to track compliance with the home exercise program, only one participant completed the exercise log. His compliance level was approximately 82.1%.

DISCUSSION

Three types of interventions were identified by Boocock et al[6] to help workers stay healthy within industrial environments–primary, secondary, and tertiary. Primary interventions occur before an "at risk" population acquires any signs or symptoms of concern. Secondary interventions are executed after the occurrence of a condition or concern. Tertiary interventions are provided to individuals with chronically disabling conditions. The home exercise programs used in this study were provided as a secondary intervention. Although the authors would have preferred a primary intervention program, difficulties within the industrial environment can pose challenges for implementing such programs. Many companies are resistant to devote time or resources to activities that have few published studies, or research where the findings were not significant. Research in primary prevention in particular, may have difficulty achieving statistical significance since it is difficult to determine which workers will definitely develop a condition or concern. One study by Faucett,[4] for example, found a significant increase in symptoms in a control group, a mild decrease in symptoms in an education group, and no change in symptoms in a group receiving muscle relaxation techniques. However, the authors were unable to find a statistical difference in injury rate among the 3 groups, an area that is of particular concern to employers.

More research has focused on secondary interventions such as mechanical changes or modifications to the work place,[6] or musculoskeletal modifications for the worker that may help prevent future injury.[4,7,16] Our study focused on musculoskeletal modification through the use of exercises to correct strength and AROM deficits in participants with a shoulder complaint. While there were no changes in AROM for the exercise group, this group did not have AROM deficits at the start of the study that warranted application of therapeutic exercise to correct the deficit. Therefore, specific AROM exercises were not prescribed. However, the exercise group did have strength deficits identified at the beginning of the study, and consequently were given home exercises directed specifically at weak muscles. Twenty percent of the strength measurements were significantly different between initial evaluation and 6 month re-evaluation when comparing the exercise and control group's means. These results are similar to a study by Oldervoll et al[16] that compared aerobic exercise, a strengthening and fitness program, and a control group for changes in low back pain and functioning in female hospital workers. Oldervoll et al[16] reported improvement in aerobic capacity in participants in an aerobic exercise program, but no change in aerobic fitness in the control group or the group participating in a strengthening and fitness program. These results validate that specific improvements may be related to specific exercise interventions, or specificity of training. Our study found specificity of training. Since the exercise group was not given AROM exercises, AROM did not improve. On the other hand, all exercise group participants were given strengthening exercises and improvements were observed in strength in this group.

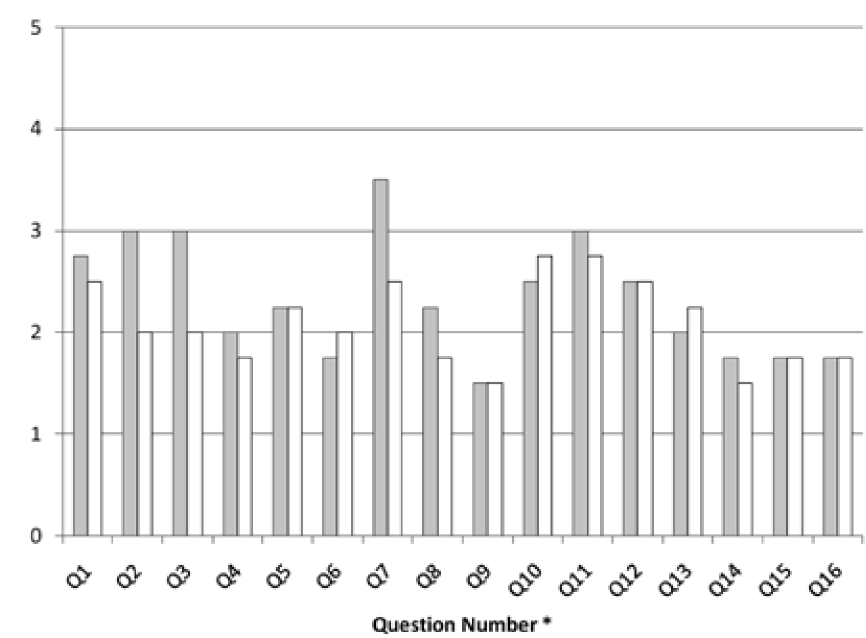
Regardless of the exercise intervention (aerobic exercises or a strengthening and fitness program), Oldervoll et al[16] reported significant reduction in low back pain in the treatment groups compared to the control group. While our study included pain as an outcome measure, the disability index survey we used also included a variety of characteristics of disablement including impairments, functional limitations, disability, and quality of life, as mentioned previously. While pain did not significantly differ between the groups or within the groups across time, trends were observed for a greater reduction in disablement in the exercise group compared to the control group. Scores on our disability index improved in all but two categories (12.5%) for the treatment (exercise) group, while the control group experienced either a worsening of scores (18.8%) or scores that remained the same (31.2%) (Figures 3 and 4). The categories that did not change for the exercise participants were functional limitations: (1) job duties involving reaching, carrying, and lifting; and (2) job duties involving coordination, agility, precision, and balance. For the control group the categories that remained the same were categories addressing functional



*Refer to Appendix 1 for specific questions.

Y Axis:
1 = no problems
2 = does not affect
3 = slightly affects
4 = moderately affects
5 = severely affects

Figure 3. Mean disability index scores of exercise group (initial evaluation to 6 months).



*Refer to Appendix 1 for specific questions.

Y Axis:
1 = no problems
2 = does not affect
3 = slightly affects
4 = moderately affects
5 = severely affects

Figure 4. Mean disability index scores of control group (initial evaluation to 6 months).

limitations and quality of life: (1) changing directions; (2) job duties that require coordination, agility, precision, and balance; (3) overall fitness; (4) decreased overall energy; and (5) changes in mood and/or increased frustration. However, the control group also had a decline in several categories that addressed disability and quality of life to include (1) daily actions; (2) participation in leisure activities, hobbies, and games; and (3) increased anxiety, stress, pressure, and/or anxiety. It is interesting to note that the exercise group continued to report difficulties related to job functioning specifically. The control group, on the other hand, reported that their shoulder injury had a more global impact on their lives affecting their functions, quality of life, and roles expected of them as individuals in society (disability). A decline in disability and quality of life in the control group is of particular relevance, as disability is considered the end product of the disablement process.[9] Disability is preventable, and an undesired outcome from any injury.

Participants in the exercise group were given a home exercise program focusing on isolated, open-chain exercises for muscles identified as weak in the painful shoulder at the time of initial evaluation. However, the expectation was that exercise would be completed on both shoulders, and the participants were informed to exercise both shoulders at the time the exercise program was provided. No changes were observed in the uninvolved side among these exercise group participants. A study by Giannakopoulos et al[17] reported that isolated exercises significantly improved the weak side in individuals with rotator cuff deficits. However, in order to achieve strengthening in the stronger side, participants had to engage in more complex training protocols such as closed kinetic chain activities. This may explain why the uninvolved side did not have significant changes in muscle strength in our exercise group participants. In addition, as a muscle becomes stronger, in order to see changes in muscle strength, exercise may need to progress from isolated, open-chain to complex, closed-chain activity. Perhaps significant changes could have been observed among our participants if exercises were advanced at the mid-point of the study.

Limitations

The number of participants included in statistical analysis is very low (n = 9) in the present study. In addition, due to the location of the study, there were no female participants (the ratio of male to female workers was approximately 8:1). Blinding to the intervention by either the physical therapist or participants did not occur and may have been a bias to the study. In an attempt to limit this bias, no data collection sheets were kept at the facility, and the on-site physical therapist and participants had no access to previous data until the completion of the study. Finally, participants volunteered to be in the study, and this might not be representative of the general industrial work force. Therefore, generalizing these results to all individuals with shoulder problems should not be done. Additional studies are needed to provide sound empirical basis for the use of home exercise programs as a secondary intervention for 'at risk' employees in the industrial setting, without providing additional physical therapy interventions. The resources devoted to training 'at risk' individuals in a specific exercise program can be less costly than the cost of treatment once an injury occurs. However, difficulties may arise with monitoring exercise compliance, since compliance is based solely on self-report. In addition, participants may engage in other activities outside of the workplace that are not reported. These activities can not only cause further injury to damaged tissue, but can be counterproductive to an exercise prescription.

Future Studies

Including a greater number of participants, increasing the number of female participants, improving adherence to exercise logs, and monitoring outside activities may help create a more robust study for future researchers. While the present study examined the use of individualized exercise programs for participants with shoulder injuries, additional studies could look at other body areas prone to injury (low back, wrist, hand, etc.). In addition, greater gains may be achieved in exercises that are progressed from isolated, open-chain activity to more closed-chain and complex activities. Finally, the participants in this study were given an individualized exercise prescription based on deficits identified at the time of evaluation. Comparisons of standardized exercise prescriptions with individualized prescriptions may provide some additional cost saving benefits. Providing a standardized program as a preventative measure could reach a larger number of participants in a shorter period of time, and hopefully reduce the incidence of cumulative trauma disorders.

CONCLUSIONS

Although this study had only 3 findings that showed a statistically significant difference between an exercise and control group (two strength measures and one measure of disablement), a number of trends were observed that may show efficacy for a home exercise program in "at risk" populations. Home exercise participants showed a slight trend toward increased strength in 70% of the muscles tested in the painful shoulder compared to only a 40% strength improvement in the control group. In addition, the exercise group had a slight trend for improvement in 87.5% of disablement measures for the shoulder compared to an improvement of 50% in these same measures in a control group. These trends provide limited support for the use of home exercise programs as a secondary intervention for individuals in an industrial setting.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the assistance of the Oakland University Research Committee for providing a grant for this project; Ronald Gellish, MS, for statistical analysis; and all of the participants in the study.

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Identifier #: ______________________ **D.O.B.:** ______________________ ☐ **M** ☐ **Initial**

☐ **3 month**

Date of Injury: ______________________ **Date Injury Reported:** ______________________ ☐ **F** ☐ **6 month**

Disability of the Industrial Worker

Instructions: Please answer each statement with one response by placing an "X" or "✓" that most closely describes your problem(s) within the past 24 hours. Each problem has possible descriptors under each. Not all descriptors may apply to you but are given as common examples.

ANSWER QUESTIONS BELOW ABOUT YOUR SHOULDER ONLY!

1 – No Problem.
2 – I have the problem(s), but it does not affect me.
3 – The problem(s) slightly affects me.
4 – The problem(s) moderately affects me.
5 – The problem(s) severely affects me.

		No Problems 1	Does Not Affect 2	Slightly Affects 3	Moderately 4	Severely Affects 5
Q1	**Pain** – "Do I have pain in my shoulder"?	☐	☐	☐	☐	☐
Q2	**Motion** – "Do I have impaired motion"? (in shoulder) **Ex.** Decreased range/ease of motion, flexibility, and/or increased stiffness	☐	☐	☐	☐	☐
Q3	**Muscular Functioning** – "Do I have impaired/decreased muscle function"? (in shd) **Ex.** Decreased strength, power, endurance, and/or increased fatigue	☐	☐	☐	☐	☐
Q4	**Stability** – "Do I have impaired stability?" **Ex.** The shoulder feels loose or gives way	☐	☐	☐	☐	☐
Q5	**Changing Directions** – "Do I have difficulty with changing directions in activity?" **Ex.** Painting, rotating at the shoulder	☐	☐	☐	☐	☐
Q6	**Daily Actions** – "Do I have difficulty with daily actions that I would normally do?" **Ex.** Lifting, carrying, getting dressed, reaching overhead	☐	☐	☐	☐	☐
Q7	**Maintaining Positions** – "Do I have difficulties maintaining the same position for a long period of time?" **Ex.** Raising/holding arms up, or sleeping	☐	☐	☐	☐	☐
Q8	**Skill Performance** – "Do I have difficulties with performing skills that are required for my job?" 1) **Ex.** Reaching for torque guns, carrying, lifting parts/tools, using tools	☐	☐	☐	☐	☐
Q9	2.) **Ex.** Coordination, agility, precision & balance (lining up engine parts, calibrating equipment)	☐	☐	☐	☐	☐
Q10	**Participation in Activities** – "Do I have difficulty with participating in activities?" 1) **Ex.** Participating in leisure activities, hobbies, and games (non-sport)	☐	☐	☐	☐	☐
Q11	2) **Ex.** Participating in my sporting activities	☐	☐	☐	☐	☐
Q12	**Overall Fitness** – "Do I have difficulty maintaining my fitness level?" **Ex.** Conditioning, weight lifting & cardiovascular endurance	☐	☐	☐	☐	☐
Q13	**Well Being** – "Do I have difficulties with the following…?" 1) Increased uncertainty, stress, pressure, and/or anxiety	☐	☐	☐	☐	☐
Q14	2) Altered relationships with friends, family and/or anxiety	☐	☐	☐	☐	☐
Q15	3) Decreased overall energy	☐	☐	☐	☐	☐
Q16	4) Changes in my mood and/or increased frustration	☐	☐	☐	☐	☐

Appendix 1. Disability Index Survey (Modification of the Disablement in the Physically Active Scale)

APTA Orthopaedic Section Receives Foundation Service Award

The Foundation for Physical Therapy is proud to announce that the APTA Orthopaedic Section will be the recipient of the 2011 *Premier Partner in Research Award*. The award was presented to the Orthopaedic Section at the Foundation's "National Treasures Gala" on June 9, 2011, during APTA's Annual Conference at the Gaylord National Hotel in National Harbor, Maryland.

"It is with great pleasure that we honor the Orthopaedic Section with this award and recognition. The Section has been a long-standing Foundation supporter, providing critical financial contributions not only for our annual-giving research grant program, but also for previous large initiatives such as the establishment of clinical research centers and the clinical research network. Orthopaedic Section - congratulations to you and your membership!" said Foundation Board of Trustees Chair, William G. Boissonnault, PT, DPT, DHSc, FAPTA, FAAOMPT.

Since 2008, the Foundation has presented the Premier Partner in Research Award to honor generous and long-standing contributions from organizations that have made a substantial difference by supporting the Foundation and its mission of funding physical therapy research.

The Orthopaedic Section has been a generous donor to the Foundation, donating nearly $1 million since the Foundation's inception in 1979. In 2007, the Section made a $500,000 pledge towards its endowment fund. The endowment has funded research grants awarded to the following investigators: Julie Fritz, PT, PhD, ATC,University of Pittsburgh (2002); Margaret Schenkman, PT, PhD, University of Colorado Health Sciences Center (2001); Timothy Flynn, PT, PhD, OCS, Regis University (2000); James J. Irrgang, PT, PhD, ATC, FAPTA, University of Pittsburgh (2000); Kathleen Kline Mangione, PT, PhD, GCS, Arcadia University (2000); and Philip McClure, PT, PhD, Arcadia University (1999).

Formed in 1974 under the leadership of Stanley Paris, PT, PhD, FAPTA, the Orthopaedic Section is the APTA's largest Section and serves as an advocate and major resource for practitioners of orthopaedic physical therapy. In 1979, the Section, along with the APTA Sports Physical Therapy Section, founded the *Journal of Orthopaedic and Sports Physical Therapy* (JOSPT), a monthly, peer-reviewed publication for physical therapists and other health care professionals specializing in musculoskeletal and sports-related practice.

"The Orthopaedic Section is proud and honored to accept this prestigious award. The Orthopaedic Section recognizes the importance of research to further the practice of orthopaedic physical therapy. As such, the Section leadership, including all past-presidents and members of the Board of Directors, has demonstrated long-standing commitment and financial support of the Foundation to foster the Foundation's mission of funding physical therapy research. Through the establishment of the Orthopaedic Physical Therapy Research Endowment, the Orthopaedic Section looks forward to continued financial support of the Foundation's mission," said Section President James J. Irrgang, PT, PhD, ATC, FAPTA.

The Foundation for Physical Therapy was established in 1979 as a national, independent nonprofit organization dedicated to improving the quality and delivery of physical therapy care by providing support for scientifically-based and clinically-relevant physical therapy research and doctoral scholarships and fellowships.

Contributions to the Foundation for Physical Therapy are tax-deductible and can be made online at Foundation4PT.org. For more information, E-mail foundation@apta.org or call 800/875-1378.

Call for Candidates

Dear Orthopaedic Section Members:

The Orthopaedic Section wants you to know of three positions available for service within the Section opening up in February, 2012. If you wish to nominate yourself or someone else, please contact the Nominating Committee Chair, Joshua Cleland, at joshcleland@comcast.net. **Deadline for nominations: September 7, 2011**. Elections will be conducted during the month of November.

Open Section Offices:

- **Treasurer:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2012.
- **Director:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2012.
- **Nominating Committee Member**: Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Business Meeting at CSM 2012.

Be sure to visit http://www.orthopt.org/policies_and_covers_mbr.php for more information about the positions open for election!

2011 House of Delegates Report

The 2011 House of Delegates took place in National Harbor, MD June 5-8, 2011. The debate in the House of Delegates this year was rich in thought with a significant amount of depth and breadth around each of the motions considered. The 2011 HOD was visionary in their thoughts and discussion potentially setting the profession on a new path for success with an uncertain health delivery system. This document is meant to provide information on activities of the 2011 House of Delegates. It is a summary of actions, not a verbatim record of motion language. Verbatim minutes for the HOD will be available in September. These are some of the HOD highlights.

- **RC 3-11 Physical Therapist Responsibility and Accountability for the Delivery of Care – Packet II - PASSED**
  A new position that will become effective July 1, 2012, states that APTA recognizes and supports physical therapists' abilities to use appropriate support personnel, including but not limited to the physical therapist assistant, when directing and supervising selected aspects of physical therapy intervention.
- **Refer RC 4-11 through RC 12-11 to the Board of Directors – Packet II - PASSED**
  RC 4-11 through RC 12-11 were referred to the Board of Directors to review the current model of the physical therapist (PT), the physical therapist assistant (PTA), and the physical therapy aide as the only participants involved in delivery of physical therapy services and identify potential models of delivery that:
  - describe patients and the care management required;
  - identify participants that could support the PT in potential new models;
  - are consistent with potential new payment models;
  - identify strategies for success; and
  - investigate changes to the education and scope of work of the PTA.

  A task force that shall include House and Board members, component representatives, other experts, and APTA staff, will be appointed to conduct the review. Any necessary motions will be submitted to the 2012 House of Delegates.
- **RC 15-11 Amend: Transparent Disclosure of Physical Therapy Benefits by Health Insurance Companies – Packet I - PASSED**
  Amends Accurate Transparent Disclosure of Physical Therapy Benefits by Health Insurance Companies (HOD P06-08-13-17) to indicate that APTA supports:
  - health insurance policies that provide coverage for physical therapy services and full representation of the details of that coverage;
  - legislation that would limit the patient's/client's financial responsibility to less than the actual amount paid by the insurance; and
  - change in legislation that would require development and use of consistent terminology regarding physical therapy coverage, written in "plain language."
- **RC 16-11 Reducing the Burden of Current Copayment Systems – Packet I - PASSED**
  Charges APTA to help chapters pursue options for changes in insurance policies and/or legislation with the goal of reducing the financial burden of current copayment systems on patients/clients receiving care from physical therapists.
- **RC 17-11 The Role of Physical Therapy in Hospice and Palliative Care – Packet I - PASSED**
  Creates a new position stating that APTA endorses the inclusion of physical therapy care in hospice and palliative care, and outlines concepts to be included in hospice and palliative care—such as continuity of care, appropriate and adequate access to physical therapy services, and an interdisciplinary approach to care.
- **RC 18-11 Plan to Promote the Role of Physical Therapy in Hospice and Palliative Care – Packet I - PASSED**
  Charges APTA to develop a plan to promote the concepts outlined in The Role of Physical Therapy in Hospice and Palliative Care, with a report to the 2012 House of Delegates.
- **RC 19-11 The Physical Therapist's Role in Concussion Management – Packet I - PASSED**
  Creates a position that APTA recognize that concussions should be evaluated and managed by a multidisciplinary team of licensed health care providers, and that physical therapists are an integral part of the multidisciplinary team. An individual suspected of having a head injury should be removed from participation in organized activity for assessment of concussion. Physical therapists or other licensed health care providers should evaluate the individual and determine clearance for return to participation.
- **RC 20-11 Principles of Governance – Packet II - PASSED**
  A new position stating that governance entities in the American Physical Therapy Association (APTA) will:
  - have defined roles and responsibilities that minimize duplication of efforts;
  - emphasize collaboration and cooperation among the governance entities;
  - maximize member inclusiveness and engagement; and
  - be transparent and open in their deliberations and decision making processes.

  As the voice of the profession, the primary role of the governance entities of the association will be that:
  - the House of Delegates has the predominant role in setting policy and provides leadership and direction to the profession;
  - the Board of Directors has the sole fiduciary responsibility for and provides leadership and direction to the association;
  - APTA staff implements the decisions of the House and Board and manages the association;
  - sections serve as a key resource for content knowledge; and
  - chapters focus on jurisdictional scope of practice and payment issues; and,

(continued on page 166)

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

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

Orthopaedic Practice (OP) is interested in having readers serve as book reviewers. Previous experience is recommended but not required. Timeliness in meeting publication deadlines is required. Invitation is only open to Orthopaedic Section members. Successful completion of each review results in the reviewer retaining a free copy of the textbook.

If you are interested, please contact Michael Wooden, Book Editor for OP at: michael.wooden@physiocorp.com

Primary Care for the Physical Therapist: Examination and Triage, 2nd Edition, Elsevier, 2011, $77.95
ISBN: 9781416061052, 418 pages, Hard Cover

Editor: Boissonnault, William G., PT, DPT, DHSc, FAAOMPT, FAPTA

Description: All chapters in this new edition of a book on the role of physical therapists in primary care have been updated or expanded, and several new chapters have been added, to meet the needs in the field prompted by the expansion of direct access in physical therapy. This edition has several returning contributing authors along with many new ones, to provide the most up-to-date information there is in the area of primary care physical therapy. The original book was published in 2005. **Purpose:** Because direct access in physical therapy has expanded over the past several years and continues to advance, the purpose of this book has changed since its first edition. Initially, the book was intended to "provide information designed to help prepare physical therapists to assume a significant role in the primary care delivery model" with a major emphasis on examination and triage related to the physical therapist's potential role. This new edition is intended to "promote a significant role in the primary care practice model for physical therapists, with major emphasis on the examination, triage, and interdisciplinary health care components related to the physical therapist's potential role." With the increasing growth of primary care and direct access in physical therapy, this edition also has a key focus on recognizing red flags early on in order to facilitate consultation with the appropriate health care practitioner. As more therapists become patients' initial contacts for their musculoskeletal conditions, there is a growing need for practitioners to become efficient at differentiating symptoms that have a musculoskeletal cause from those that present as a musculoskeletal issue, but have another origin. **Audience:** The book is designed for students, residents, fellows, and experienced clinicians. It is well organized and written, making it easy for readers at any level of experience to read and understand. The editor is a leading authority in this area, and has written several books and taught numerous seminars on medical screening and differential diagnosis. **Features:** The first of the book's three sections provides a foundation, explaining the various models of primary care physical therapy currently in place, diagnostic information including reliability, validity, and likelihood ratios, cultural competence, pharmacology considerations, and how to be effective during a patient interview. The second section, on examination/evaluation, has 10 chapters organized in the way that clinicians would typically gather information. The first two chapters describe symptom investigation, first by body region and then by symptom, helping readers in evaluating a given area as thoroughly as possible. The third section is dedicated to topics in special populations such as pediatric/adolescent, obstetric, and geriatric, and includes new chapters on health and wellness and the 9 conditions physical therapists do not want to miss. Both are great additions as the field continues to move into the direct access model, where prevention and life-long health and well-being are important facets of care. All chapters are well referenced with the most up-to-date-research. Throughout the book, tables, graphs, and pictures help illustrate the material. Other helpful features include appendixes after several chapters with forms for clinicians to use and/or adapt for medical screening, surveys and testing materials on specific topics, case scenarios, and glossaries of terms. The only minor shortcoming is that all of the illustrations are black and white. Color illustrations would highlight key areas better and improve readability. However, the lack of color does not detract from the wealth of knowledge in this book. **Assessment:** This is an important update and a valuable addition to the field. Written by experts, it offers the best and most comprehensive information available on primary care for physical therapists and complements other books in this area. Because of how well organized and written it is, this book would be an essential addition to the personal libraries of clinicians at any level, as well as a popular required text in physical therapy programs.

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Complementary Therapies in Rehabilitation: Evidence for Efficacy in Therapy, Prevention, and Wellness, 3rd Edition, Slack Incorporated, 2009, $61.95
ISBN: 9781556428661, 409 pages, Hard Cover

Editor: Davis, Carol M., DPT, EdD, MS, FAPTA

Description: This is the third edition of a book designed to present the latest research and evidence behind a wide assortment of complementary therapies used in rehabilitation. The first edition was published in 2003 and the second edition was published in 2008. **Purpose:** The purpose is to explain the role of 18 different complementary or alternative therapies in patient care and provide the scientific rationale and evidence behind these techniques. This book provides readers with a way to examine many complementary therapies to either improve their own knowledge or use as a starting point to learn new techniques they might want to incorporate into their practice. **Audience:** Rehabilitation practitioners who work with patients are the intended audience. Many of the case studies point out the effect of the different techniques on different systems. The editor has been involved in the teaching, research, and practice of physical therapy and complementary therapies for many years. **Features:** In covering the science that supports complementary therapies, the book has 4 chapters on different types of bodywork, 6 chapters on mind/body work, and 7 chapters on energy work. Chapters are succinct and well written, and most include at least one case study. The chapters on biofeedback and yoga are especially well written. However, some of these case studies are not very well prepared or fail to stay on topic. For example, in the chapter on Reiki, the patient's knee pain is the only objective measure offered and part of the follow-up statement includes that the patient had met a "special female friend." **Assessment:** Overall, the book is well written. Some of the illustrations are professional as in the Pilates chapter and others are less so as in the chapter on Qi Gong. The book is useful for the amount of information it presents and the number of topics it covers. This edition includes updates on randomized control trials, energy techniques, reviews of evidence, and the latest summary of findings relating to energy medicine.

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(Kaiser Permanente)

Assessment and Treatment of Muscle Imbalance: The Janda Approach, Human Kinetics, Inc., 2010, $64
ISBN: 9780736074001, 297 pages, Hard Cover

Authors: Page, Phillip, MS, PT, ATC, CSCS; Frank, Clare C., DPT; Lardner, Robert, PT

Description: This book offers readers a resource on the work and theories of Vladimir Janda's approach to muscle imbalance, an approach that looks closely at how the sensorimotor system affects movement and syndromes that are chronic in nature. **Purpose:** According to the authors, the intent is to "provide a practical, systematic approach to implementing Janda's theories in everyday clinical practice." In the United States, there is little available written information on his concepts, nor are they widely taught, so a book like this is very useful. **Audience:** According to the authors, the book is designed for health care providers who treat patients with musculoskeletal conditions as well as experts in the exercise field. Although this group would benefit from the book as a resource, physicians who treat patients with musculoskeletal conditions would not find this as useful since movement analysis is not as familiar to them, and experts in the exercise field may have a few struggles with the scientific basis component of the theories as well as with soft tissue assessment, as palpation of tissues is outside of their scope. **Features:** The book covers the scientific rationale, functional evaluation, and treatment of muscle imbalances. The last part of the book goes through different pain syndromes in the body to help readers put it all together. Specific topics include research on the transverse abdominus for spinal stabilization, trigger points, and dry needling. The authors do a nice job incorporating research into many of the topics to update Janda's concepts with evidence-based practice. Throughout the book there are pictures, charts, and tables to help readers better understand and visualize key concepts. The sections of the book are structured in a way that clinicians can integrate the information. All the chapters are well organized and easy to follow with many references; a full list of references at the end of the book spans 41 pages. However, there are not as many recent references as one would expect. Additionally, some of the terminology used in discussing trigger points, ie, related to spasm and hypertonicity, are a bit confusing. This, however, should not limit readers from adding this book to their collection. Overall, it provides a lot of useful information that is different from the typical treatment approaches taught in most physical therapy schools and it can only help give clinicians insights that may help them treat their patients. **Assessment:** Overall, this book provides unique and useful information. It is different in that it does not have a biomechanical perspective, which is how many therapists are trained. It offers a perspective that will supplement therapists' knowledge.

Michelle Finnegan, DPT, OCS, MTC, FAAOMPT
(Bethesda Physiocare)

Movement System Impairment Syndromes of the Extremities, Cervical and Thoracic Spines: Considerations for Acute and Long-Term Management, Elsevier, 2011, $74.95
ISBN: 9780323053426, 547 pages, Hard Cover

Editor: Sahrmann, Shirley A., PT, PhD, FAPTA

Description: This book represents the latest effort to describe movement system syndromes of the cervical and thoracic spines and extremities, from the perspective of the kinesiopathological model and concepts of staging based on tissue impairments. This is a companion to the author's "Diagnosis and Treatment of Movement Impairment Syndromes" (Elsevier, 2002) and an update of concepts. The previous book covered movement impairment syndromes of the lumbar spine and pelvis, hip, and shoulder girdle. **Purpose:** The stated purpose is to describe parts of the movement system and processes that result in musculoskeletal pain syndromes, promote the importance of using diagnostic labels for movement system dysfunction, develop an appreciation for movement system syndromes as a part of a progressive condition related to lifestyle, describe the importance of alignment and movement patterns of painful regions, describe the effect of movements of other body regions on painful areas, and to promote monitoring the development and function of the movement system throughout the life span. **Audience:** The book is written for students, residents, and experienced clinicians in physical therapy. It is most appropriate for clinicians and health care practitioners who work with patients/clients who have musculoskeletal dysfunction. The authors are the originators of the movement system impairment philosophy and model. **Features:** The authors introduce broader concepts and updates underlying movement system syndromes and a method of staging rehabilitation. The rest of the book deals with the specific movement systems of the cervical and thoracic spine, hand and wrist, elbow, knee, and foot and ankle. Each chapter follows a consistent format: introduction of constructs, alignment considerations, normal movements and muscle actions, movement system syndromes identified with specific descriptions, special tests, and treatment of each syndrome. Each chapter concludes with a case study including history, alignment, movement analysis, diagnosis and staging, treatment, and functional instructions. Each movement syndrome has a helpful summary of findings and key concepts in an adjoining appendix. Readers also have access to additional resources online with links to video simulations, end of chapter references linked to Medline, and printable versions of the appendixes. The book includes color photos of all of the movement system syndromes and excellent figures of complex concepts. **Assessment:** This is excellent resource for all clinicians and health care practitioners who deal with patients with musculoskeletal system problems. This book summarizes the large body of work developed by Dr. Sahrmann and her associates and is an important contribution to the care of these patients. The format of this book is an improvement over the author's previous book.

Timothy John McMahon, MPT
(Mercer University College of Pharmacy and Health Sciences)

2011 HOUSE OF DELEGATES REPORT

(continued from page 163)

   - APTA supports collaborative governance between the House and the Board.

- **RC 21-11 Recognition of Physical Therapy as a Distinct, Self-Determined Profession – Packet II - PASSED**
  Charges APTA to advocate for physical therapy to be recognized as a distinct, self-determined profession, and that efforts should include pursuing appropriate opportunities to eliminate the terms "allied," "allied health," and "ancillary" when used in association with or classifying the profession of physical therapy and the physical therapist, with a report to the 2012 House of Delegates.
- **RC 22-11 Beyond Vision 2020 – Packet II - PASSED**
  Charges APTA to review and revise Vision Sentence for Physical Therapy and Vision Statement for Physical Therapy to look beyond 2020 and clearly articulate the profession's commitment to society. Concepts to consider while reviewing and revising the vision should include enhancing collaborative relationships to achieve cost-effective care, advancing health policy that supports the vision, engaging in innovative models of care, and promoting wellness and prevention, with an interim report to the House of Delegates by 2012 and introduction of a revised vision to the House of Delegates by 2013.

Respectfully submitted by,
Joe Donnelly, PT, DHS, OCS
Practice Committee Chair

Congratulations

to the 2011 Honors and Awards Recipients

Each year, APTA honors outstanding member achievements in the areas of overall accomplishment, education, practice and service, publications, research, and academic excellence. Award recipients were recognized in June with a celebration and reception during APTA's Annual Conference and Exhibition held in National Harbor, MD.

The Orthopaedic Section, APTA would like to congratulate our members who were recently selected for these honors and awards. This year's winners include:

Catherine Worthingham Fellows of APTA
Michael T. Cibulka, PT, DPT, MHS, OCS, FAPTA
Christopher M. Powers, PT, PhD, FAPTA
Jan K. Richardson, PT, PhD, OCS, FAPTA
Michael L. Voight, PT, DHSc, SCS, OCS, ATC, FAPTA

Mary McMillan Lecture
Gail M. Jensen, PT, PhD, FAPTA

Signe Brunnstrom Award for Excellence in Clinical Teaching
Jonathan Scott Straker, PT, MS, SCS, ATC

Lucy Blair Service Award
Robert H. Rowe, PT, DPT, DMT, FAAOMPT

Marilyn Mofatt Leadership Award
Babette S. Sanders, PT, DPT, MS

Outstanding PT/PTA Team Award
Kimberly R. Schramm, PT, DPT, ATC, CLT
Tanya K. Powell, PTA, BS

Chattanooga Research Award
Kristin J. Carpenter, PT, DPT
John D. Childs, PT, PhD, MBA
Joshua A. Cleland, PT, PhD
Julie M. Fritz, PT, PhD, ATC
Paul Glynn, PT, DPT, OCS, FAAOMPT
Paul E. Mintken, PT, DPT
Julie M. Whitman, PT, DSc, OCS, FAAOMPT

Jules M. Rothstein Golden Pen Award for Scientific Writing
G. Kelley Fitzgerald, PT, PhD, OCS, FAPTA

Jack Walker Award
William G. Boissonnault, PT, DPT, DHSc, FAAOMPT, FAPTA

Eugene Michels New Investigator Award
James Elliott, PT, PhD

MARY MCMILLAN SCHOLARSHIP AWARDS
PT Student Scholarship
Jacob I. McPherson, SPT

PTA Student Scholarship
Chris Garland, SPTA

MINORITY SCHOLARSHIP AWARD
PT Student Scholarship
Mohamed Mohamed, SPT

OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

GREETINGS OHSIG MEMBERS!

OHSIG Bulletin Board

Did you receive the OHSIG E-mail blast from OHSIG Communications Chair, Sandy Goldstein? We are excited about the opportunity we have for an active communication link with OHSIG members, via the Electronic Bulletin Board. This is for members only! It's a great place to ask questions of your colleagues and share ideas. The link is https://www.orthopt.org/message_boards.php. Login is required.

For those of you who have not used an asynchronous communication (not all users have to be online at the same time) platform before, you can use the Online Bulletin Board whenever:

- you want to mail a single message to other OHSIG members, and
- when you want to communicate ideas or thoughts for brainstorming or discussion.

GUIDELINES:

1. All members will see your messages.
2. Be courteous.
3. Keep message clear and goal directed.
4. Messages should be related to Occupational Health.
5. We will be unable to accept postings pertaining to advertisements or employment opportunities.

Please make every effort to use correct grammar, punctuation, spelling, and sentence structure.

Most of all, have fun! This is a benefit of belonging to the OHSIG. We hope you will use it!!

Petition for Specialization in Occupational Health PT

We expect a response to our Petition any day from ABPTS. ABPTS met mid-May, and indicated we would receive a summary after the meeting. More to follow.

Work Rehab Guidelines Update

Mary Fran Delaune, from the Department of Practice, notified the OHSIG, that APTA's BOD voted to rescind the Occupational Health Guidelines as Board documents with the SS as written. In essence these are now in the purview of the Orthopaedic Section. APTA staff will continue to review for policy/position agreement before updates move onto the APTA Web site.

The following documents were rescinded:

- Occupational Health Guidelines: Physical Therapist In Occupational Health (BOD G03-01-17-59)
- Occupational Health Physical Therapy Guidelines: Evaluating Functional Capacity (BOD G10-08-01-01)
- Occupational Health Physical Therapy Guidelines: Legal And Risk Management Issues (BOD G02-02-16-21)
- Occupational Health Physical Therapy Guidelines: Physical Therapist Management of the Acutely Injured Worker (BOD G03-01-17-56)
- Occupational Health Physical Therapy Guidelines: Work Conditioning And Work Hardening Programs (BOD G03-01-17-58)
- Occupational Health Physical Therapy Guidelines: Work-Related Injury/Illness Prevention and Ergonomics (BOD G03-01-17-57)

SS: This recommendation is consistent with and supports the Vision for the Future of APTA Governance, adopted by the Board of Directors (Board) at its November 2010 meeting, which identifies the primary role of sections to serve as key resources for content knowledge. The decision for the Board to serve as the body to approve these documents was made at a time when the Board approved all documents prior to their being posted on the APTA Web site, which is no longer common practice. Staff will continue to work in conjunction with content experts to review and update these documents as necessary. The documents will still be available for APTA member access as they will be housed on the APTA Web site as part of the evidence-based document initiative.

Occupational Informational Development Advisory Panel (OIDAP)

We thank Karen Jost, Associate Director of Payment Policy & Advocacy, APTA for the summary of the meeting she attended May 4-5, 2011, related to OIDAP.

Occupational Information Development Advisory Panel
Meeting Summary – May 4-5, 2011
Baltimore, MD

This Federal Advisory Committee is charged with providing independent advice and recommendations on plans and activities to replace the Dictionary of Occupational Titles used in the Social Security Administration's (SSA) disability adjudication process. Specifically, SSA is creating an occupational information system (OIS) tailored specifically to meet their program needs.

Following is a summary of activities at their recent meeting May 4-5, 2011, in Baltimore, MD:

- Three new panel members were introduced. John W. Creswell, PhD, Professor of Educational Psychology at the University of Nebraska-Lincoln; Timothy J Key, MD, Medical Director of the State of Alabama Employees Injury Compensation Trust Fund; Juan I Sanchez, PhD, professor and Knight-Ridder Byron Harless Eminent Chair in the Department of Management and International Business, Florida International University.
- Panel Chair Mary Barros-Bailey, PhD, reviewed the OIDAP 2010 Annual Report and panel activities to date in 2011. She emphasized the Panel's belief that the OIS must adhere to scientific integrity principles to enable SSA

to meet its burden of proof and to be legally sound. She noted that SSA was taking steps to implement recommendations of the panel, including collaboration with other federal agencies, recruiting/hiring scientific staff, implementing a business process, and completing an R&D plan for the project.

- Project Director Sylvia Karman (SSA) reported on the status of several project activities, noting that a final report on job analysis methodologies is due in late June 2011 and a final report on training, recruiting, and certifying job analysts is due in late August 2011. Project staff shared the results of the international OIS survey.
- Staff from the Bureau of Labor Statistics, Department of Labor (O*NET), and the Census Bureau provided information about the systems they use to collect employment information.
- SSA staff presented results from an Occupational and Medical-Vocational Claims Review Study designed to identify the primary occupational, functional, and vocational characteristics of disability insurance (DI) and social security insurance (SSI) adult applicants whose claims were approved or denied at the initial or hearing levels at step 4 or 5 of SSA's sequential evaluation process. They noted that a substantial majority of the jobs held by claimants have been unskilled (22.4%) and semi-skilled (40.4%) jobs that required a relatively short time (< 1 to 6 months) to learn, and the 75% of the jobs were associated with light to medium strength requirements.
- Director Karman and project staff reviewed the Content Model and Disability Evaluation Constructs (DEC) Inventory that is underway. They noted that the review will be shared with the panel and SSA OIS Development Workgroup for comments.
- Three panel subcommittees provided brief status reports with no new content for discussion.

The next quarterly meeting of the Panel will be by teleconference July 27, 2011 from 10 am to 2 pm EDT.

WCPT

Dee Daley is attending the World Confederation of Physical Therapy (WCPT) in Amsterdam later this month. Look for a summary of her visit/presentation in the next OHSIG Update!

Need Authors

If you are interested in submitting an article for OPTP, please let us know.

Member Involvement

If you have suggestions, questions, or comments, you can contact any of the BOD members. We'd love to hear from you! You can find the officer listing on the Orthopaedic Section Web site, under Special Interest Groups.

Professional Regards,
Margot Miller, PT
OHSIG President

HEALTH PROMOTION, FITNESS, AND WELLNESS

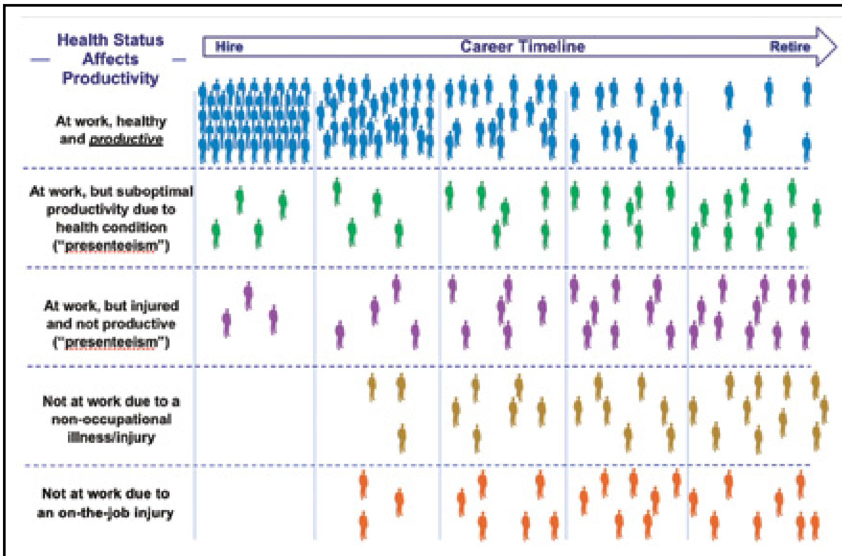
By Margot Miller, PT

An article, "Workplace Wellness Programs Can Generate Savings" in Health Affairs, reported the following:

> "Amid soaring health spending, there is growing interest in workplace disease prevention and wellness programs to improve health and lower costs. In a critical meta-analysis of the literature on costs and savings associated with such programs, we found that medical costs fall by about $3.27 for every dollar spent on wellness programs and that absenteeism costs fall by about $2.73 for every dollar spent. Although further exploration of the mechanisms at work and broader applicability of the findings is needed, this return on investment suggests that the wider adoption of such programs could prove beneficial for budgets and productivity as well as health outcomes."[1]

There is a bigger than ever focus today on health promotion, fitness, and wellness in an attempt to target the increasing health care costs, absenteeism and productivity at work, and general lifestyle. The evidence is everywhere: the Internet, newspapers, journals, and magazines. In "Workplace Clinics: A Sign of Growing Employer Interest in Wellness," the authors discussed the recent resurgence of workplace clinics.[2] Employers have faced relentless growth in health care spending and view workplace clinics as a means to contain medical costs, improve worker productivity, as well as enhance their reputation as an "employer of choice." And consider Healthy People 2010, the federal health promotion and disease prevention agenda developed to promote healthy lifestyles for America.[3,4] Healthy People 2010 was designed to increase the quality and years of healthy life and eliminate health disparities among various populations. Healthy People 2010 contains 467 objectives to improve health, organized into 28 focus areas, many of which are central to a physical therapist's practice scope including arthritis, osteoporosis, heart disease and stroke, chronic back conditions, obesity, occupational health and safety, injury prevention, physical activity and fitness, to name a few.

Prevention encompasses promoting health, fitness, and wellness through education and providing appropriate guidance to prevent or delay the progression of pathology. Preventive care not only focuses on general health; preventive care aims at minimizing the impairments and functional limitations arising from conditions affecting an individual's quality of life. Examples of preventive care we can provide include screenings for potential health problems, education, and appropriate activities to promote health, fitness, and wellness. Screening may include identification of children with potential developmental delays, identification of ergonomic risk factors at the workplace, or identification of factors putting older adults at risk for falls. Activities that promote general health include prepartum and postpartum exercise classes, classes for older adults to enhance balance and flexibility, cardiovascular condition-



Promoting musculoskeletal wellness improves workforce availability

Diagram reprinted with permission from WorkWell Systems, Inc.

ing for individuals at risk for obesity, and classes to prevent back pain through exercise and proper body positioning/techniques. An important component of the preventive care is the education and instruction designed to minimize or eliminate risk. Examples include recommendations to increase functional performance, whether they are related to the individual's activities of daily living, work, or leisure.

An increased level of physical fitness enables us to better withstand physiological stressors and extreme demands made on the body. Those with higher fitness levels are less vulnerable to illness and recover from injury and disease more readily than those who are physically inactive or sedentary. A daily regimen of 30 minutes of moderate level activity, ie, brisk walking, provides proven health benefits and powerful preventive measures for increased health, fitness, and well-being. Since wellness is an active process of becoming aware of and making choices toward a healthier balance, therapists can help individuals make better choices to improve their fitness and wellness.

Regular exercise can prevent many of the chronic diseases in our society, including diabetes, heart disease, hypertension, and obesity. As therapists, we see examples of this every day in the patients/workers we see, where the "therapy" part of the problem is linked with a chronic disease that influences their progress and recovery. By taking a proactive approach that includes education and promotion of fit, healthy lifestyles, physical therapists can ensure workers remain in peak condition both on and off the job, throughout their lifespan.

The ultimate goal is to help people function optimally, enable them to remain healthy throughout their lives, reducing the likelihood of injury during work, home, and leisure activities. Physical therapists can help individuals establish and maintain safe, effective, and enjoyable health and fitness programs. Looking more broadly, occupational health physical therapists can assist employers in lowering health care costs, increasing worker productivity and morale, while decreasing absenteeism and turnover by providing prevention/fitness and wellness programs. Musculoskeletal injuries and illnesses decrease workforce health status and account for more health care spending than any other single health condition.[5] Musculoskeletal injuries are the largest single category of workplace injury, accounting for 28% of all occupational injuries.[6] Musculoskeletal injuries significantly contribute to the imbalance between hours paid and hours worked resulting in a significant decrease in workforce productivity, as illustrated in the diagram to the left.

Add to this an aging workforce. Physical therapists with expertise in occupational health become a valuable partner for employers by providing services to maintain optimum health and productivity for workers throughout the entire work cycle. Prevention services such as functional job analysis, ergonomics, preventive care and preventive screens, education, job coaching, preventive stretching, job specific strengthening, etc will decrease incident rate, decrease recordable injuries, decrease claim volume per 100 workers, decrease lag time in reporting, decrease medical claims cost, decrease productivity loss, and mitigate risk. Services can be provided on an as needed basis or through an onsite clinic at the worksite, if the employee base is large enough. Onsite prevention and wellness services create a culture of healthy productive workers, as well as a stay at work mentality.

In summary, as the health care paradigm shifts from one emphasizing illness to one stressing health, function, quality of life, and well-being. Physical therapists with expertise specific to occupational health are in a prime position to work with employers to influence the health, fitness, and wellness of their workforce.

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Margot Miller, PT, is Vice President Provider Solutions for WorkWell Systems, Inc. She is president of the Occupational Health SIG of the Orthopaedic Section, APTA. She can be reached at mmiller@workwell.com or 866-997-9675.

PERFORMING ARTS

SPECIAL INTEREST GROUP

PRESIDENT'S MESSAGE

President: Julie O'Connell, PT, ATC
joconnell@athletico.com
Vice President: Lisa Donegan Shoaf, PT, DPT, PhD
ldshoaf@vcu.edu
Nominating Committee Chair: Kendra Gage, PT, DPT
kgage@athletico.com
Research Chair: Shaw Bronner, PhD, PT, OCS
sbronner@liu.edu

Greetings from the PASIG!!! We have a call for nominations for Chair of our Research Committee. We would like to thank Shaw Bronner for her excellent job as Research Chair over the last several years. She will be stepping down at the end of this year. If you are interested in this position or would like to nominate someone for this position, please contact our Nominating Committee Chair, Kendra Gage at kgage@athletico.com.

The PASIG needs members to complete our membership survey in order to update your profile. This is a valuable resource for colleagues who may have traveling artists in need of physical therapy while on tour. You can fill this out online at the following address once you've logged in as an Orthopedic Section member:

https://www.orthopt.org/surverys/membership directory.php

We are excited about our updates to the PASIG Web site. There is a wealth of information available including monthly citation blasts, officer directory, member directory with an advanced search, meeting minutes, an updated list of clinical affiliations, performing arts glossaries, information regarding the PASIG student scholarship, and a technical report from the PASIG practice analysis.

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

PERFORMING ARTS CONTINUING EDUCATION OPPORTUNITIES

Performing Arts Independent Study Couses
Orthopaedic Section Independent Study Course.
20.3 Physical Therapy for the Performing Artist
Monographs are available for:
- Figure Skating (J. Flug, J. Schneider, E. Greenberg)
- Artistic Gymnastics (A. Hunter-Giordano, Pongetti-Angeletti, S. Voelker, TJ Manal)
- Instrumentalist Musicians (J. Dommerholt, B. Collier)

Orthopaedic Section Independent Study Course.
Dance Medicine: Strategies for the Prevention and Care of Injuries to Dancers
This is a 6-monograph course and includes many PASIG members as authors.
- Epidemiology of Dance Injuries: Biopsychosocial Considerations in the Management of Dancer Health (MJ Liederbach)
- Nutrition, Hydration, Metabolism, and Thinness (B Glace)
- The Dancer's Hip: Anatomic, Biomechanical, and Rehabilitation Considerations (G. Grossman)
- Common Knee Injuries in Dance (MJ Liederbach)
- Foot and Ankle Injuries in the Dancer: Examination and Treatment Strategies (M. Molnar, R. Bernstein, M. Hartog, L. Henry, M. Rodriguez, J. Smith, A. Zujko)
- Developing Expert Physical Therapy Practice in Dance Medicine – (J. Gamboa, S. Bronner, TJ Manal)

**Contact the Orthopaedic Section at: www.orthopt.org
Or call 1-800-444-3982**

FOOT & ANKLE

SPECIAL INTEREST GROUP

REMEMBERING OUR COLLEAGUE

It is with great sadness that I learned of Joe Reed's passing. Joe was one of the first physical therapists who provided foot care and foot orthoses, especially for patients with peripheral neuropathy. I first met Joe in 1976 when I was stationed at the US Public Health Service Hospital in Staten Island, New York. Joe taught me and many others how to make foot orthoses and shoe modifications for the diabetic patients. He truly was a pioneer in the development of foot orthoses for diabetic and Hansen disease patients. Any physical therapist who specializes in the foot and ankle, especially those with an interest in foot orthoses, should know they have Joe Reed to thank for being one of the pioneers and leader in this area of PT specialization.

Tom McPoil, PT, PhD, ATC, FAPTA

HOOKED ON EVIDENCE

by David Scalzitti, PT, PhD, OCS

Twelve clinical scenarios related to foot and ankle conditions have been added to APTA's Hooked on Evidence Web site (www.hookedonevidence.com). These scenarios are for management of patients with ankle sprains, ankle fractures, Achilles tendon injuries, overuse injuries, plantar fasciitis, and forefoot pain. The scenarios can be accessed in the Hooked on Evidence Web site by clicking the link titled Search Clinical Scenarios. From the first drop down box on this page, one would then select Musculoskeletal and then select from among the various conditions (eg, sprains, tendon injuries, heel pain). Each scenario includes a description of a typical patient with a condition and links all of the studies of physical therapy interventions currently in the database that are applicable to the scenario.

The work of J.W. Matheson, PT, DPT, SCS, OCS; Stephanie Albin, PT, OCS; Ann Dennison, PT, DPT, OCS; Rob Roy Martin, PT, PhD; and Evan Nelson, PT, DPT, in the development of these scenarios is greatly appreciated.

JOSEPH K. REED, JR.

1919 - 2011

Joseph K. Reed, Jr., aged 91, died in Pensacola on April 29, 2011.

During WWII, Mr. Reed served on the Coast Guard troop transport Samuel Chase, and was working in the ship's engine room on D-Day. After serving in the war, he earned a bachelors degree in health education from West Chester State University, a physical therapy certificate from the University of Kansas, and a Masters of Education from Boston University.

Mr. Reed was a physical therapist with the Veterans Administration and later with the United States Public Health Service (USPHS). He retired from USPHS with the rank of captain after 25 years of service. While with USPHS, Joe developed custom footwear for the management of neuropathic foot problems due to Hansen disease (leprosy). His footwear designs have proved to be beneficial to diabetic patients as well. He worked at HD treatment centers in Hawaii, Louisiana, and after his retirement, Ethiopia. Joe was a talented, creative, and caring physical therapist who unselfishly mentored many professionals in the art of shoe and orthotic fabrication.

Joe and his wife, Shirley, retired to Pensacola in 1984 where he volunteered with many charities including the Salvation Army, Loaves and Fishes, Baptist Hospital and Manna Food Pantries, and Habitat for Humanity. Mr. Reed was named the Outstanding Senior Volunteer of Escambia County in 1998. Both Joe and Shirley were avid bicyclists. In the course of cycling throughout the United States, England, Austria, Switzerland, France, and Italy, they logged over 19,000 miles.

Mr. Reed was preceded in death by his parents Bertha and Joseph K. Reed, Sr. and his siblings Rebecca Battin and William Reed. He is survived by his wife of 60 years, Shirley Reed; his children Diann Fulmer (Richard) of Humble, TX and Susan Reed of Philadelphia, PA; and his grandson Sgt. Jason Voth, USMC, currently serving in Afghanistan.

IMAGING

SPECIAL INTEREST GROUP

Did you hear? The Orthopaedic Section has a new Imaging Special Interest Group (SIG)! The role of imaging is a growing part of physical therapy practice. Imaging is integral to the field of orthopaedic physical therapy whether you are a clinician, educator, policy maker, or researcher. Additionally, physical therapists who successfully incorporate imaging into their practice will be better positioned in the integrated health care delivery system. Since 2007, the Orthopaedic Section has had an Imaging Educational Interest Group whose main goal was programming at CSM. Based on a needs assessment, the Orthopaedic Section Board of Directors determined the timing was ideal to upgrade the group to a Special Interest Group. Imaging is poised to help take the practice of physical therapy to a higher level. The goal of your Imaging Special Interest Group will be to provide support, education, and resources to help physical therapist optimally integrate imaging into their practice.

Imaging SIG Officers
Douglas M. White, DPT, OCS, President
Deydre Teyhen, PT, PhD, OCS,
Vice President/Education Chair
Wayne Smith, DPT, SCS, ATCr, Nominating Chair

Please contact any of us to share your thoughts, ideas, and suggestions as we move forward. So, what do we need? We need you! We need you to join and get involved with the Imaging SIG. Send an E-mail to Tara Fredrickson at tfred@orthopt.org to join the SIG. At CSM 2012 we will have 3 opportunities for you to get involved and help move the role of imaging forward for our profession.

Opportunity #1: Attend our educational programming at CSM. This year's programming is titled ***"From Protons to Progression of Exercise – How Can Conventional and Advanced MRI Applications Guide Exercise Prescription for Neck Pain?"*** This should be a great program provided by Dr. Jim Elliott from Northwestern University; Dr. O'Leary from The University of Queensland, Australia; and Dr. Cagnie from Ghent University, Belgium. It is sure to be a crowd pleaser and will really challenge our imagination on how imaging such as MRI can be used to augment and enhance what we do as physical therapists.

Opportunity #2: Join us for a ***Panel Discussion on: Ultrasound Imaging & Scope of Practice.*** Ultrasound imaging for musculoskeletal conditions started in the 1960s and has been rapidly expanding in use. Utilization of this technology shows significant promise within physical therapist practice, especially in its ability to augment the assessment of human movement. Ultrasound imaging can be used to provide additional information on the status of body structures to aid in clinical management, and as a treatment adjunct to facilitate motor function and quality of motion. More specifically through this technology, physical therapists can assess muscle length, depth, diameter, cross-sectional area, volume and potential angles, changes in these features, tissue movement and deformation, impact on other body structures, and resulting function. This panel discussion will focus on how physical therapists can use ultrasound imaging within the context of their scope of practice to evaluate tissue morphology and function to aid clinical evaluation to augment muscular assessment and rehabilitation strategies.

Opportunity #3: ***The Inaugural Imaging SIG Business Meeting*** at CSM. Please join us at our first Imaging SIG Business Meeting at CSM. We need your help in developing our mission statement, vision statement, and prioritizing our goals. We need your help in shaping the Imaging SIG to best meet the needs of those in the Orthopaedic Section.

Doug M. White, DPT, OCS
President, Imaging SIG

THE USE OF THERAPEUTIC ULTRASOUND FOR EQUINE INJURIES

By Jennifer Brooks, PT, MEd, CERP

The field of equine rehabilitation is in its early stages of potential in the United States. In contrast equine physical therapy is a well-established profession in Belgium, Sweden, England, Australia, and Canada. These equine practitioners are well aware of the positive effects that a variety of manual treatment approaches and modalities, such as therapeutic ultrasound (tUS), can offer and how tUS can benefit the horse in terms of healing, tissue extensibility, and pain relief. This therapeutic intervention is available in the USA to improve healing not only in humans, but also our 4-footed friends (dogs and horses).

Therapeutic ultrasound is a modality that many people have heard of and used regularly in human physical therapy. It is a comforting, mild heating, noninvasive modality used for promotion of healing tissues or prior to stretching of tight or adhered structures. Inaudible sound waves are absorbed primarily by collagen rich connective tissues such as ligaments, tendons, fascia, and scar tissue. Ailments such as tendon or ligament injuries, muscle spasm or tearing, joint swelling, open wounds, and even mild arthritis can benefit from application of tUS. Recent studies show tUS has beneficial effects on delayed bone healing.[1] Many of these ailments described above occur in horses. Now tUS is an available option for horse owners to consider when faced with an equine injury, and when they are searching for a method to promote healing of structures for faster recovery.

Therapeutic ultrasound results from a conversion of electrical energy traveling through a crystal mounted within the transducer head. The piezoelectric ability of the crystal causes it to contract and expand, generating a high frequency of sound waves of greater than 20,000 cycles per second, known as Hertz (Hz). Humans can hear sounds with frequencies between 16 – 20,000 Hz. Sounds with a frequencies greater than this are categorized as ultrasound.[2] Sound waves transmit energy by alternate compression and expansion of material. Ultrasound has a variety of physical effects described as thermal or nonthermal.[2] Thermal mode (continuous setting) has the ability to increase tissue temperatures, and is ideal for pre-stretching preparation of tight tissues. Nonthermal (pulsed setting) effects are ideal for the promotion of the healing of tissues and decreasing inflammation. Both methods of ultrasound (US) work due to the sound waves causing vibration of the tissues and cells, stimulating tissue metabolism. Increasing cell metabolism accelerates the healing process, increases circulation, and relieves pain. In a method called phonophoresis, medications are pushed transdermally into targeted tissues below the skin.

Horse owners have often been confused by the term "ultrasound" due to two different kinds of ultrasound used by equine practitioners. Therapeutic ultrasound described above, is ideally used to assist healing or heating of tissues, usually applied by physical therapists. Diagnostic ultrasound (dUS) customarily used by veterinarians is used to view internal tissue integrity. The method of dUS works in the same manner as tUS, with settings at higher frequencies of 3-7 MHz most commonly used for equine diagnositics.[3] Echoes are generated whenever the sound beam crosses a boundary between structures of differing acoustical impedance. Returning echoes generate electrical pulses that are electronically manipulated and displayed on a monitor for veterinarian and client viewing of involved structures.[3]

Applications of tUS are usually at 1 MHz or 3 MHz frequencies. Selection of the frequency will be dependent on the depth of the target tissue to be addressed (ie, a superficial structure of a flexor tendon vs. a deeper thicker structure such as a muscle tear). It is thought to affect target tissues as deep at 5 cm-6 cm.[2,4] For proper transmission of tUS into the horses' tissues, hair must be clipped and shaved down to the skin, followed by application of a gel medium to allow sound waves to penetrate through skin and underlying tissues. Determination of frequency, duration, and choice of pulsed or continuous applications depends on the nature of the injury, collagen composition of target tissue, point in time within the healing continuum, and the depth of the target tissue.[5] These are important elements for the equine physical therapist to consider when treating the horse. Tissue damage can occur with improper use and technique of tUS application such as periosteal pain.[6] There are many contraindications to consider, such as poor circulation, reduced sensation, and prolonged use over epiphyseal areas.[6] Therefore, horse owners should consider only qualified, credentialed, and licensed professionals when hiring practitioners to treat their horses with any modality or treatment. Benefits of tUS abound in terms of tissue physiology.

Used correctly, tUS can benefit the horse through:

- increased elasticity of collagen in tendons, joint capsules, and scar tissue;[5-7]
- increased motor and sensory nerve conduction velocities that assist in reducing pain;[5]
- altered contractive activity to skeletal muscle that reduces muscle spasm;[5]
- diminished muscle spindle activity, another factor in muscle spasm reduction; and[5]
- increased blood flow that can bring healing factors to site of injury and speeds up local metabolism.[5,6]

There is an abundance of research demonstrating the efficacy of tUS in the treatment of humans. A great deal of research has been performed on research animals (ie, mice, rats, and dogs) along with humans. Unfortunately, there are not abundant studies on equine subjects to draw from, due to the size and cost of maintaining these large animals for research purposes. Therefore, we can extrapolate the physiology of the horse to be similar to these other mammalian species in hopes that tissue response in the horse's tendons, ligament, bones, muscle, wounds, along with pain responses would be similar to research findings of these study specimens. However for validity purposes, it is best to look at the specific equine research to draw the best conclusions. The following are a few examples of specific tUS research conducted on equines.

Wound Healing: Therapeutic ultrasound works in several ways to accelerate the healing of injured tissue. Therapeutic ultrasound modulates the inflammatory response, increasing the healing process and the epithelization of the wound. A study done by Moreas et al[7] suggests that tUS properties can diminish the time required for equine wound healing. After 7 sessions of tUS, surgically induced lesions treated with tUS had approximately a 35% decrease in initial measurements indicating an increase of wound contraction as compared to controls.[7] Therefore, tUS is recommended in treatment of equine wounds.[7]

Tissue Extensibility: Tissue extensibility increases at higher settings, 1.2-2.0w/cm^2, of continuous tUS.[6] Moreas et al[7] suggest that tUS used in studies on horses with resultant tissue restrictions (scar) secondary to the wound healing process, increases cell permeability of the tissue's membranes, changes the cells' volume, and releases adherences due to the detachment of the collagen fibers. Draper[6] suggests that scar tissue can be softened if treated early with tUS.

Arthritis: Singh et al[8] studied a group of 8 donkeys induced with acute septic arthritis of their carpal joints. Four were treated with tUS for 10 minutes daily for 7 days and the other 4 were used as the control group with no treatment. Later, dissection of the carpal joint capsule and cartilage showed decreased alterations of smooth cartilage and decreased synovial membrane inflammation in comparison with the control group. The gross changes in the fibrous joint capsule and synovial membrane were much milder in the US treated animals. No calcium deposits were noted in the treated donkeys reflecting normalization of the joint capsule. From this study, they concluded that treatment with tUS in early onset of septic arthritis resulted in promotion of healing of joint tissue and articular cartilage, therefore preventing the development of degenerative joint disease.[8]

Pain, Muscle Spasm, and Scar: Mitchell and Richard[9] propose that tUS is helpful for pain and spasm reduction when used over the adjacent musculature of spinal dysfunction in horses.[9] Therapeutic ultrasound is the deepest source of heat available, penetrating 5 cm-6 cm deep into tissues.[6,10] This therapy can be very useful for back pain, especially for large muscle spasms and deeper scar tissue causing pain in the horse.[10]

A study done by Moraes et al[11] states that, tUS energy is capable of producing cellular changes by mechanical effects. Therapeutic ultrasound mechanism of action correlates with activation of fibroblasts and collagen, and stimulates blood flow. This in turn promotes anti-inflammatory properties for tissue relaxation and a decrease of local pain. "The treatment of tUS was crucial for local analgesia in these horses, as no other analgesic therapy was used. The use of tUS should be included in the treatment of acute pain in horses, since it is noninvasive and effective."[11]

Tendon Injuries: Tendonitis is a common problem that affects a substantial proportion of racing and performance horses. Superficial digital flexor tendonitis is a significant cause of lameness in horses, and tUS has been widely used to treat this injury. Guiomar et al[12] have conducted several studies looking at the efficacy of using tUS in healing tendons. One study evaluated the effects of tUS throughout the healing process in equine-induced tendonitis. One forelimb from each horse from the two different groups were randomly treated with tUS 3 times a week, until completing 15 days for the first group, and 60 days for the second group. Results suggest that tUS treatment time (3x/week for 5 weeks) was insufficient to improve the process of tendon repair. However, a protocol (3x/week for 60 days) was beneficial and supports the hypothesis that tUS enhances tendon healing over a longer period of time.[12] In conclusion they stated, "tUS accelerates tissue healing rate and promotes tendon regeneration."[12]

Guiomar et al[13] conducted another study to evaluate the effects of tUS on the healing process in equine-induced tendonitis with the purpose of detecting and measuring the organization of collagen fibers. Findings suggest that tUS is beneficial in equine tendons healing improving the arrangement, aggregation state, and molecular order of the collagen fibril.[13]

Bunchner and Schildboeck[14] looked at 3 experimental studies evaluating the effect of ultrasound therapy on equine tendon healing in tendon lesions employing contralateral tendons as untreated controls for clinical, sonographic, or histological investigation. They found improved clinical results of less degeneration and inflammation in the tendons treated with tUS as compared to controls.[14]

Magnetic therapy vs tUS: Many horse owners are curious if magnetic therapy could be beneficial to their injured horses. Chuit et al[15] conducted a study in 2003 on 4 clinically healthy adult horses. The study evaluated ultrasound and low and high intensity magnetic field therapeutic effects on repair of experimentally induced injury in the superficial digital flexor tendon of all 4 limbs of each animal. One limb served as the control, the second limb was treated with tUS, the third limb was treated with low intensity magnetics (LIM), and the fourth limb was treated with high intensity magnetics (HIM). On day 60, histomorphological biopsy results indicated no sign of intrinsic and extrinsic adhesions with regular and parallel collagen fiber bundles formation in ultrasonically treated limbs in all 4 animals. There was adhesion formation and inflammatory cells in both HIM and LIM. The high intensity static magnetic field regimen had higher occurrence of adhesion formation when compared with low intensity static magnet field. In comparison, US therapy is significantly more effective in the repair rate and better collagen arrangement when compared with low and high static magnetic field therapeutic regimens in SDFT injury.[15]

Contraindications and Dangers of Ultrasound: Although tUS is a relatively safe treatment modality, the dangers associated with tUS treatment are unacceptable temperature rise within the target area and/or collapse of cells leading to deep tissue necrosis and damage.[16] Therefore, it must be applied by licensed practitioners with care to avoid harming the patient in terms of hot spots or tissue damage. In the human, we have the luxury of patients verbally telling the practitioner if they feel any discomfort or are overheating. With the horse, practitioners must be attuned to pain behaviors that may indicate discomfort and therefore use the modality judiciously, in terms of lower intensities and correct application. Contraindications of tUS are to avoid use over malignancies, eyes, and reproductive organs. Do not use on patients who are pregnant, or have joint cement, a pacemaker, or thrombophlebitis.

Therapeutic ultrasound has much to offer equine clientele in terms of acceleration of tissue healing, disruption of adhesion formations, and heating tissues in preparation for stretching. Low intensity pulsed ultrasound (LIPUS) is showing promise in the area of bone healing.[6] More research has yet to be performed for possible efficacious treatment of diagnosis of bucked shins, splints, and fracture healing acceleration.

Mary Bromiley, PT,[16] world-renowned author, lecturer, equine enthusiast, and practitioner states the following in regards to the use of tUS in equine rehabilitation, "Machine therapy, such as tUS, on its own is far from satisfactory. If it is possible to incorporate a rehabilitation program at the same time as the use of machines, the result will be far superior to the "tUS machine only" cases. Unfortunately, irreversible changes can occur in the recipient, should an inappropriate therapy be selected or used by an untrained nonprofessional. Following a diagnosis made by a veterinary surgeon, physical therapy ought to become a useful adjunct to veterinary medicine, but this can only occur if the varied therapies are administered by a qualified person, correctly trained in the use of therapy apparatus, who also possesses an in-depth knowledge of the equine and of the demands of the individual equine disciplines."[16]

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