ORTHOPAEDIC

Physical Therapy Practice

THE MAGAZINE OF THE
ORTHOPAEDIC SECTION, APTA

VOL. 21, NO. 3 2009

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Publication Title: *Orthopaedic Physical Therapy Practice* Statement of Frequency: Quarterly; January, April, July, and October
Authorized Organization's Name and Address: Orthopaedic Section, APTA, Inc., 2920 East Avenue South, Suite 200, La Crosse, WI 54601-7202

Orthopaedic Physical Therapy Practice (ISSN 1532-0871) is the official magazine of the Orthopaedic Section, APTA, Inc.

Nonmember subscriptions are available for $50 per year (4 issues). Opinions expressed by the authors are their own and do not necessarily reflect the views of the Orthopaedic Section. The editor reserves the right to edit manuscripts as necessary for publication. All requests for change of address should be directed to the La Crosse Office.

All advertisements which appear in or accompany *Orthopaedic Physical Therapy Practice* are accepted on the basis of conformation to ethical physical therapy standards, but acceptance does not imply endorsement by the Orthopaedic Section.

Orthopaedic Physical Therapy Practice is indexed by Cumulative Index to Nursing & Allied Health Literature (CINAHL).

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Letter to Editor and Author Response

I recently read "Continuous Infusion of a Local Anesthetic Through a Pain Pump Following Orthopaedic Surgical Procedures: Implications for Physical Therapy Outcomes" by Dr. Deanna Kloss.[1] I believe that Dr. Kloss described nicely the potential benefits that are important to physical therapists regarding the post-surgical use of in-dwelling pain pumps following orthopaedic surgery. However, I am concerned that she failed to thoroughly examine the potential complications that may be associated with this procedure. Specifically, the potential association between chondrolysis and pain pump catheters in shoulder surgery was not addressed. While Dr. Kloss presented fine evidence concerning potential benefits of pain pumps with regard to pain control and early rehabilitation outcomes, I believe that it is negligent to publish a paper about post-operative pain pump catheters which does not mention this major complication.

Dr. Kloss states that "toxic doses of bupivacaine can cause CNS or cardiac side effects."[1] She also lists several complications to include dislodgement, leaking, or clogging of the catheter, soft tissue necrosis, surgical wound infection, and cellulitis." [1] While this list of complications is fairly comprehensive, it fails to mention perhaps the most devastating complication of all, which is chondrolysis of the shoulder joint. The etiology, to include the possible link to pain pump catheters, as well as the treatment of chondrolysis remain unclear, but the prognosis is generally poor.[2]

In one case report, two patients suffered bilateral shoulder chondrolysis following arthroscopic shoulder stabilization procedures. Both of these patients were treated postoperatively with a pain pump with 0.5% bupivacaine. Based on these findings, Greis et al cautioned "against the use of continuous intraarticular infusion of bupivacaine into the shoulder through an indwelling catheter."[3]

Hanson et al reported on a cohort of 177 patients who underwent arthroscopic shoulder surgery. Out of 177 surgical patients, only 19 were given intra-articular pain pumps eluting bupivacaine and epinephrine. Of these 19 patients, 12 suffered chondrolysis of the shoulder following surgery. There were no reported cases of chondrolysis among patients who did not receive intra-articular pain pumps. As a result of these findings Hansen et al recommended "that the use of intra-articular pain pump catheters in combination with bupivacaine with or without epinephrine be avoided in all joints with an intact cartilage surface."[4]

Recently, Dragoo et al demonstrated that 0.25% and 0.5% bupivacaine, which are solutions commonly used in pain pumps, are toxic to chondrocytes when applied for greater than 48 hours. Additionally, they found that all anesthetics containing epinephrine were toxic to cartilage.[5] Another in vitro study found that "human and bovine chondrocytes exposed to 0.25% bupivacaine had a time-dependent reduction in viability, with longer exposure times resulting in higher cytotoxicity."[6]

Compared to the shoulder, there does not appear to be a strong association between chondrolysis and the use of pain pumps in the knee, but there is a case that shows a possible link between chondrolysis of the knee and a single bolus of bupivacaine injected percutaneously. This case involved a patient who suffered chondrolysis of the knee following a single injection of bupivacaine given after a microfracture surgery.[7] The reason for the lack of chondrolysis in the knee is unknown, although authors have suggested that it is possibly a result of increased joint space and increased articular cartilage thickness compared to the shoulder joint.[3]

It is true that a cause and effect relationship cannot be established from the associations described in these few case series. However, there does seem to be a correlation between intra-articular pain pump use and development of chondrolysis of the shoulder. Due to the severity of this complication, it is important to exercise the utmost caution and consider other methods of pain control, especially in the shoulder, until the effects of intra-articular pain pump catheters are more clearly understood.

Sincerely,
Scott D. Carow, DPT

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AUTHOR RESPONSE

I would like to thank Dr. Scott Carow for bringing to light the potential complication of chondrolysis with the use of intra-articular pain pumps following surgery. When performing my review of the literature, I searched specifically for titles on the use of postoperative pain pumps, which were abundant. Although they all listed some potential complications, there was no mention of chondrolysis in any of this research, and therefore, I did not look further into in vitro studies or studies using intra-articular injections of bupivacaine. As Dr. Carow mentioned, the evidence on this issue remains unclear. There are pros and cons to almost every treatment option, and it is important for physicians and all members of the treatment team to be aware of these when making treatment decisions. I thank Dr. Carow for his contribution and for bringing this to our attention.

Sincerely,
Deanna M. Kloss, PT, DPT

President's Corner

James J. Irrgang, PT, PhD, ATC

Moving Forward

As we enter the summer, the rhetoric regarding health care reform is heating up. In fact, by the time you read this, major health care may have been passed and signed by President Obama. We are all familiar with the issues – there are 44 to 47 million uninsured Americans, health care costs are 17% of the gross national product and rising, and only 50% of individuals receive the recommended standard of care. While there is agreement that something needs to be done, there is much disagreement on what or how health care should be reformed.

At PT09 in Baltimore, Newt Gingrich was the featured speaker at the opening ceremony and he offered suggestions for health transformation (not health care transformation) that included changes in individual rights; responsibilities and expectations of behavior; maximizing cultural and societal patterns for a healthy community; an effective, efficient, and productive health delivery system; and financing of health care. From his perspective, the key is to reach individuals before they are patients with an emphasis on wellness and prevention and if acute care is needed to provide the right care at the right time.

As physical therapists and physical therapist assistants, we should unite to promote health care reform that benefits the patients we currently serve as well as the individuals we could potentially serve. Major themes of health care reform[1] that are of interest to the profession include:

- Prevention and chronic care management
- Enhancement of primary care
- Training and infrastructure of the workforce
- Health information technology
- Comparative effectiveness research

The major themes of APTA's principles for health care reform are consistent with the above and include:

- Ensuring that rehabilitation is an essential element of the benefits package and is provided by licensed health care professionals.
- Eliminating existing payment policies, such as the Medicare Therapy Cap, that impede patient access to physical therapists.
- Developing a national strategy that will ensure that an adequate health care workforce exists to meet the needs of patients.
- Enhancing the efficiency and effectiveness in delivering health care to patients at the right time and place.
- Addressing issues of referral for profit.

As health care coverage is expanded to an increasing number of individuals, access will become more of an issue, as is seen in some countries that have adopted universal health care. The current primary care physician workforce is inadequate to meet these needs. Physical therapists are uniquely prepared and trained to serve as the point of entry for patients with musculoskeletal complaints. The role of physical therapists as primary care providers in the military is a successful model that should be more generally adopted. However when working to achieve a greater role as primary care providers, I believe that we must work in concert with as opposed to in opposition to other health care professionals including primary care physicians, orthopaedic surgeons, physical medicine and rehabilitation physicians, nurse practitioners, occupational therapists, and athletic trainers among others. Rather than being perceived as competitors we need to be perceived as collaborators, as professionals that can facilitate and enhance the quality of care to individuals with musculoskeletal conditions.

Chronic conditions, such as osteoarthritis, low back pain, diabetes, and obesity are becoming more pervasive. These conditions limit an individual's mobility and quality of life and contribute greatly to rising health care costs. Physical therapists are the provider of choice to identify and provide interventions for mobility impairments, activity limitations, and participation restrictions associated with chronic conditions. Rather than focusing on dependency, physical therapists empower individuals with chronic conditions to take control of their condition to enhance their mobility and quality of life. The physical therapist's role in primary and secondary prevention and wellness needs to be a component of health care reform.

Fraud and abuse contributes greatly to increasing health care costs. Health care practitioners are rewarded for providing more care, not better care. Referral for profit arrangements only contribute to the potential for fraud and abuse. We must advocate for the elimination of referral for profit and conflicts of interest on the federal and state level in order to reduce the potential for fraud and abuse and to limit the growth of health care costs.

While there may be differences among us on the extent of health care reform, now is the time for the entire profession to become involved in the debate and to offer solutions to ensure access to affordable care provided by physical therapists and physical therapist assistants. You are encouraged to contact your legislators to advocate for issues that are of importance to the profession – let them know how physical therapy can be a part of the solution to improve the health of America.

To provide physical therapists with an opportunity to interact directly with the Representatives and Senators in Washington DC, the Orthopaedic Section is planning to co-sponsor a Capital Hill Day with the American Academy of Orthopaedic Manual Physical Therapists on Thursday, October 15, 2009. We hope that you will join us in this event to advocate for physical therapy. Additional information concerning the event will be posted on the Orthopaedic Section Web site and will be distributed via Osteoblast, the Orthopaedic Section's monthly electronic newsletter.

The APTA Web site has a great array of information that you can access to help prepare you to advocate for the profession and you are encouraged to check it frequently. Additionally the Orthopaedic Section will continue to post useful links and notices about issues related to health care reform on its Web site.

I hope that you have an enjoyable and safe summer.

REFERENCE

1. From "Health Care Reform 2009" presented by Justin Moore, Vice President Government and Payment Advocacy, American Physical Therapy Association at the Component Leadership Meeting, June 7, 2009, Baltimore, MD.

A Randomized Trial Comparing Manual Physical Therapy to Therapeutic Exercises, to a Combination of Therapies, for the Treatment of Cervical Radiculopathy

John Ragonese, PT, OCS

ABSTRACT

Study Design: Randomized clinical trial. **Objectives:** To determine which treatment method will produce superior outcomes for patients with cervical radiculopathy: manual physical therapy, therapeutic exercises, or a combination of manual physical therapy and therapeutic exercises. **Background:** There are many different interventions that are commonly used to treat patients with cervical radiculopathy. Many of these interventions include cervical traction, mobilization and manipulation techniques to the cervical and thoracic spine, strengthening exercises directed at the cervical and thoracic musculature, and pain modalities. There have been few randomized and blind studies that have examined the effectiveness of any of these interventions for use with patient's suffering from cervical radiculopathy. **Methods and Measures:** Thirty patients with cervical radiculopathy were randomized into 3 treatment groups, one group received only manual physical therapy interventions, a second received only therapeutic exercises, and the third received both manual physical therapy techniques and therapeutic exercises. Each patient was seen 3 sessions per week for 3 weeks. The patients were then re-evaluated by a therapist who was blinded as to which treatment group each patient received. Self report measures of pain and function using a numeric pain rating scale (NPRS) and the Neck Disability Index (NDI), along with goniometric measurements of active cervical rotation were used as outcome measures. Results were analyzed using independent groups ANOVA. **Results:** Significant differences in treatment effects were observed for the reduction of pain and an increase in score on the NDI, with the group receiving the combination of manual techniques and exercises demonstrating the greatest improvements. All three groups demonstrated equal improvements in active cervical rotation. **Conclusion:** When treating patients with a diagnosis of cervical radiculopathy, an approach that combines manual therapy and therapeutic exercise appears to be superior to treatment when compared to either intervention alone.

Key Words: cervical radiculopathy, neck pain, manual physical therapy, therapeutic exercises

INTRODUCTION

Cervical radiculopathy is a common clinical condition that is seen in many outpatient physical therapy clinics. The average annual incidence rate of cervical radiculopathy is 83 per 100,000 for the entire population, with an increased prevalence occurring in the fifth decade of a person's life.[1-3] Cervical radiculopathy is defined as a disorder of the cervical nerve root, most often the result of compression or inflammatory response from a space-occupying lesion, such as a herniated disc or osteophyte.[1-5] The location and pattern of the patient's symptoms will be dependent upon the level of the nerve root affected, and can include sensory and/or motor changes.[1-4,6] Patients with cervical radiculopathy may have complaints of neck pain along with complaints of pain, numbness, tingling, and weakness into the upper extremity that may result in functional limitations and disability.[1-4,7] Many of these patients will seek out or be referred to physical therapy for treatment. The main objectives of treatment are to relieve pain, decrease the neurological signs, improve the patient's function, and prevent recurrences.[1,4,7] There have been many physical therapy interventions that have been proposed to treat this problem, and are currently in routine clinical use. These treatments include cervical traction, joint mobilization/manipulation, therapeutic exercises, and pain modalities.[1] There have been few randomized and blinded studies; however, that have attempted to examine the effectiveness of any of these interventions for use with patient's suffering from cervical radiculopathy.[1-4,7]

METHODS

Thirty patients who were referred to the Outpatient Physical Therapy Department at Loyola University Medical Center with a chief complaint of neck and/or upper extremity symptoms (either distal or proximal to the elbow) were enrolled in this study. Patients were identified as possibly eligible for participation during their initial evaluation by a physical therapist, who approached the patient regarding participation, and obtained written consent. This study was approved by the Institutional Review Board at Loyola University Medical Center, Chicago, IL.

Inclusion Criteria

Inclusion criteria for our study included the presence of 4 positive examination findings; positive Spurling test, positive distraction test, positive upper limb tension test for median nerve bias, and ipsilateral cervical rotation less than 60° (Appendix A). It has been shown that the presence of these 4 positive findings strongly indicates the presence of cervical radiculopathy, with a positive likelihood ratio of 30.3 and specificity of 99%.[3,4,6]

Exclusion Criteria

Patients were excluded from participation if they had any current medical condition that placed their rehabilitation outside of routine practice such as current fracture, history of rheumatoid arthritis or osteoporosis, current bilateral upper extremity symptoms, evidence of central nervous system involvement or history of cervical or thoracic surgery.

STUDY PROCEDURES

Consenting patients were randomized into 3 treatment groups by opening an opaque envelope containing information about group assignment. Patients were randomized into 3 treatment groups using a block size of 30. Ten patients randomized to group 1, received manual physical therapy alone (see interventions for details), 10 randomized to group 2, received only therapeutic exercises (see interventions for details), and 10 patients randomized to a third

[1]Senior Physical Therapist at the Outpatient Rehabilitation Department at Loyola Medical Center in Chicago, IL
[2]Adjunct Faculty Member at Midwestern University, Programs in Physical Therapy in Downers Grove, IL

group, received a combination of manual physical therapy and therapeutic exercises. Each patient was treated 3 times per week for 3 weeks. At the end of 3 weeks, an evaluating therapist, who was blinded to which treatment the patients had received, reassessed the patients by repeating the baseline evaluation.

Consenting patients were evaluated by a physical therapist. All of the patients first completed self-report measures and a medical history form. The therapist then recorded their medical history, which included the location, duration, and nature of the patient's current symptoms. The physical therapy evaluation was standardized and consisted of a postural assessment, neurological assessment (dermatomes, myotomes, and reflexes), cervical and thoracic range of motion, segmental mobility testing of both physiological and accessory movements of the cervical and thoracic spine, and evaluation of the deep neck flexor and scapulothoracic muscle strength.[1,5,6,8-10]

Self-report measurements were collected at the initial and final evaluations, and included The Neck Disability Index (NDI) and The Numeric Pain Rating Scale (NPRS). Both of these have been used in other studies and reports dealing with cervical radiculopathy and have been shown to be reliable and valid.[1,6,7]

INTERVENTIONS

After the initial evaluation, all patients were randomly assigned to 1 of 3 groups. The patients in each group were treated by a physical therapist that was not the evaluator. This therapist followed the appropriate protocol for all of the patients within the same group. The 3 groups are as follows:

1. Manual Physical Therapy Group

Each patient received a standardized protocol consisting of the following techniques.

Cervical lateral glides

Patients were placed in the supine position with the head and neck cradled by the therapist off the edge of the table. The therapist performed a lateral translation of the vertebral segment to facilitate opening of the facet on the side of the symptoms (ie, a right to left side glide would increase opening on the left facet). The translational movements were oscillatory and at the end range of translation (grade 3-4) as described by Maitland. The mobilizations were performed for approximately 30 to 45 seconds at each segment of the cervical spine. Recent evidence has suggested that cervical mobilization is not segment specific,[1,6,11,12] so all patients received the lateral glide techniques for all segments C2 through C7 at each session (Appendix B).

Thoracic mobilizations

The patient was placed in the prone position with the head and neck in a neutral alignment. The therapist performed a posterior to anterior mobilization of the vertebra using the pisiform technique over the spinous process as described by Maitland. The mobilization technique was oscillatory and at the end range of translation (grade 3-4). The location of mobilization was based upon the segmental mobility assessment completed by the evaluation therapist and targeted at the hypomobile segment. Each targeted segment was mobilized for 30 to 45 seconds each.[1,6,12]

Although we were unable to locate evidence for the use of thoracic spine mobilization techniques for patients with cervical radiculopathy, there have been articles demonstrating an association between thoracic spine mobility and neck/shoulder pain. These articles have shown that thoracic spine mobilization/manipulation can decrease pain in patients with neck pain.[1,13,14,15] Based on these findings, it would be reasonable that a physical therapist would consider the use of thoracic spine mobilization/manipulation techniques for patients with cervical radiculopathy.

Neural dynamic techniques for the median nerve

The patient was placed in the supine position with the affected upper extremity as close to the therapist as possible. The therapist, using a technique described by Magee, placed the patient's affected arm into shoulder abduction, external rotation, wrist and hand supination, extension, finger extension, and the elbow into as much extension as possible prior to eliciting symptoms. The therapist then performed a "sliding" technique as described by Butler. As the therapist placed the patient's elbow into greater extension, he/she reduced the amount of wrist, hand, and finger extension. This technique was performed in a slow and oscillatory manner. As the patient's symptoms improved, the therapist then progressed to a "tension" technique as described by Butler. This technique requires that the wrist, hand, and fingers remain in full extension as the elbow is moved into a position of full extension.[8,16]

2. Exercise Group

Each patient received the following standardized therapeutic exercise program instructed, monitored, and progressed by the physical therapist. The program was done only during the physical therapy sessions and no home program was prescribed.

Deep neck flexor strengthening

The patient was placed in the supine position. The patient was instructed to slowly nod the head in order to flatten the curve in his/her neck without pushing the head into the mat table. Each contraction was held for 10 seconds and for 10 repetitions. The therapist monitored and gave proper feedback to ensure that the patient was using the deep flexor muscles rather than the sternocleidomastoid muscles[1,5,6] (Appendix B).

Lower and middle trapezius strengthening

The patient was placed in the prone position with the head and neck in a neutral alignment. The arms were placed in 90º of abduction for the middle trapezius and approximately 120º for the lower trapezius. The arms were in full external rotation. The patient performed a horizontal abduction movement with the therapist monitoring and providing feedback to ensure that the scapula remain in a depressed and adducted position. The patient performed 15 repetitions for 2 sets. Dumbbell weights were added at the therapist's discretion as the patient progressed[17] (Appendix B).

Serratus anterior strengthening

The patient stood facing the wall with his/her hands against the wall approximately shoulders width apart. The patient performed a "push up plus" movement by pushing away from the wall until the elbows were fully extended and the scapula were fully protracted. The therapist monitored and gave feedback as necessary[1] (Appendix B).

3. Combined Therapeutic Exercises and Manual Physical Therapy Group

Patients in this group received the same protocols for the above 2 groups at each session.

BASELINE AND OUTCOME MEASURES

The patient completed the Neck Disability Index (NDI) and the Numeric Pain Rating Scale (NPRS) at the initial session, once per week, and at the final session. Both of these outcome measures have been used in past studies and in reports dealing with cervical radiculopathy and

have been shown to be reliable and valid.[1,6,7] The patient also was assessed initially, weekly, and at the final session using the 4 inclusion criteria tests described earlier. Measurement of active cervical rotation using a goniometer was also done at these intervals.

DATA ANALYSIS

Data was entered into a STATA Version 10.1 (College Station, TX) database. Descriptive statistics were applied in order to determine whether randomization was successful. In other words to see if patients assigned to the treatment groups were similar with respect to baseline disability level, age, etc. Study groups were compared with respect to continuous outcome measures using ANOVA testing and a nonparametric Kruskal Wallace test for ordinal data. Multivariate regression techniques were also applied in order to investigate possible influences of patient characteristics on study outcomes. All tests were considered significant at the $p < .05$ level of significance.

RESULTS

Treatment Group Effects for Pain

Each patient completed The Numeric Pain Rating Scale, in which they rated their current pain on a scale between 0 and 10, with 0 being the rating for no pain and 10 being the worst pain imaginable. This form was completed at initial visit, once per week, and at the final reassessment. Patients in each treatment group had their scores averaged together in order to determine an average score for each group at the initial visit, once per week, and at the final visit. The results showed that all three groups demonstrated significant improvements in pain, with the combination group showing significantly, greatest results when compared to the other 2 groups as determined by ANOVA (Figure 1, Table 1). There was also no significant difference found between the severity of initial pain and the amount of improvement. The results of this study support the notion that even patients suffering from severe pain due to cervical radiculopathy may also benefit from physical therapy interventions.

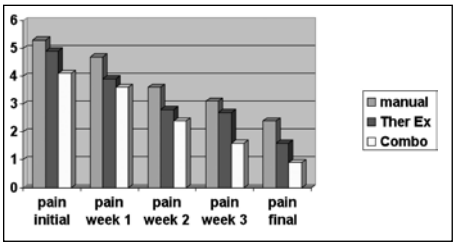

Figure 1. Treatment Group Effects for Pain

Table 1. Treatment Group Effects for Pain (mean ± SD)

	Manual	Ther Ex	Combo
Pain initial	5.3 ± 1.6	4.9 ±1.4	4.1 ± 1.5
Pain week 1	4.7 ± 1.8	3.9 ± 1.8	3.6 ± 1.5
Pain week 2	3.6 ± 1.9	2.8 ± 2.2	2.4 ± 1.2
Pain week 3	3.1 ± 1.9	2.7 ± 2.1	1.6 ± 1.5
Pain final *	2.4 ± 1.1	1.6 ± 1.5	0.9 ± 1.2
*P<0.01			

Treatment Group Effects for Neck Disability Index (NDI) Scores

The NDI contains 10 items, 7 related to activities of daily living, 2 related to pain, and 1 related to concentration. Each item is scored from 0-5 and the total score is expressed as a percentage, with the higher scores corresponding to greater disability. This form was completed at the initial visit, once per week, and at the final reassessment. Patients in each treatment group had their scores averaged together in order to determine an average score for each group at the initial visit, once per week, and at the final visit. The statistical results from the ANOVA showed that all three groups demonstrated significant improvements in function, with the combination group again showing the greatest results compared to the other 2 groups (Figure 2, Table 2).

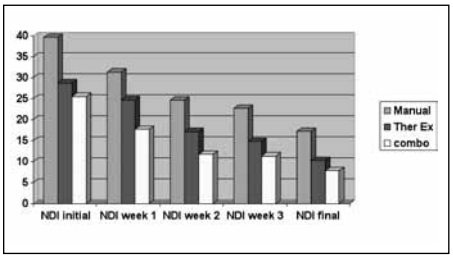

Figure 2. Treatment Group Effects for Neck Disability Index (NDI) Scores

Table 2. Treatment group effects for NDI scores (mean ± SD)

	Manual	Ther Ex	Combo
NDI initial *	39.6 ± 17.2	28.7 ± 13.3	25.5 ± 10.9
NDI week 1*	31.3 ± 14	24.7 ± 12.2	17.7 ± 7
NDI week 2**	24.6 ± 13	17.1 ± 10.6	11.7 ± 5.4
NDI week 3*	22.7 ± 13.4	14.7 ± 9.5	11.3 ± 5.7
NDI final*	17.2 ± 10.3	10.2 ± 7.1	7.8 ± 5.5
*P<0.05 **P<0.01			

Treatment group effects for cervical rotation range of motion

Cervical rotation range of motion measurements were taken by a physical therapist using a standard goniometer. Measurements were taken at the initial and final visits, as well as once per week for each patient. Patients in each treatment group had their measurements averaged in order to determine an average measurement for each treatment group at the initial and final visits, as well as at weeks 1, 2, and 3. When comparing cervical rotation range of motion measurements, all of the patients demonstrated statistically significant equal improvements in cervical rotation range of motion regardless of treatment group (Figure 3, Table 3).

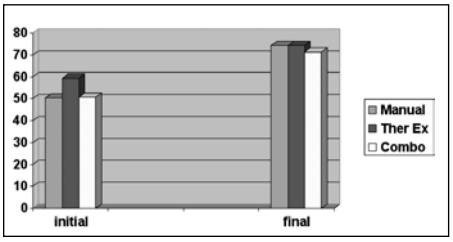

Figure 3. Treatment Group Effects for Cervical rotation range of motion (measured in degrees of motion)

Table 3. Treatment group effects for cervical rotation range of motion (measured in degrees of motion) (mean ± SD)

	Initial Visit	Final Visit
Manual	50.5 ± 2.27	74.3 ± 3.58
Ther Ex	59.4 ± 2.11	74.4 ± 4.12
Combo	50.7 ± 1.89	71.4 ± 3.67

Treatment group effects on the inclusion criteria tests

Patients in all three treatment groups did improve (positive at initial visit and negative at the final visit) on the inclusion criteria tests, (Spurling's, distraction, upper limb tension test for the median nerve), but no significant differences between the three treatment groups were found.

Effects of a patient's age on the treatment of cervical radiculopathy

Patients were separated into 3 age groups: < 50 years, 50-65 years, and > 65 years. There were no effects of age found for either pain or NDI scores.

Effects of a patient's gender on the treatment of cervical radiculopathy

Male subjects had lower pain scores than the women in this study, even though there

were no age differences between men and women. The NDI scores were not significantly different, although there was a trend for men to have lower NDI scores than women (Table 4).

Table 4. Gender effects on pain and NDI scores (mean ± SD)

	Male (N=11)	Female (N=19)
Pain initial	4.4 ± 1.3	4.9 ± 1.6
Pain week 1	3.2 ± 1.6	4.8 ± 1.7
Pain week 2*	2 ± 1.2	3.4 ± 1.9
Pain week 3	2.0 ± 1.5	2.7 ± 2
Pain final *	0.9 ± 0.8	2.1 ± 1.5
NDI initial	27.4 ± 17.2	33.4 ± 15.3
NDI week 1	20.9 ± 10.4	26.5 ± 13.2
NDI week 2	13.8 ± 9.8	19.9 ± 11.5
NDI week 3	12.6 ± 8.5	18.2 ± 11.7
NDI final	7.8 ± 6.8	13.9 ± 9

***P < 0.05**

LIMITATIONS OF STUDY

There are a few areas in which this study may be improved upon. With only 30 patients, such a small sample size resulted in a low statistical power. Also although several sources have cited the significance of the cluster of 4 clinical tests in indicating the presence of cervical radiculopathy,[3,4,6] not all of the patients had verification of radiculopathy via imaging or diagnostic tests. Finally although all of the therapists providing the treatments for these patients were trained on each of the manual techniques in order to standardize the manual interventions, there was a lack of standardization with regard to measuring the consistent delivery of treatment (ie, glides etc) from one therapist to another.

CONCLUSIONS

There has been recent research supporting the effectiveness of physical therapy interventions for the treatment of patients with cervical radiculopathy. Many of theses studies and reports have identified successful outcomes using interventions such as manual therapy, therapeutic exercises, cervical traction, and pain modalities. There have been few randomized and blind studies that have attempted to compare the effectiveness of one of these commonly used interventions over another. The purpose of this study was to determine which treatment method would produce superior outcomes for patients with cervical radiculopathy. We also wanted to determine whether baseline severity and demographic characteristics could predict eventual treatment outcome in a patient with cervical radiculopathy. The results of this study suggest that a multimodal treatment approach using a combination of manual therapy and strengthening exercises is superior to treatment by either intervention alone. This study also suggests that patients with increased severity of symptoms at baseline, increased age, and lower initial functional scores may also benefit from physical therapy interventions and may result in near equal outcomes for those patients who have less severe initial symptoms/signs.

ACKNOWLEDGEMENTS

I would like to thank several people who without their assistance this project would not have been possible. Thank you to Steven Gnatz, MD and Mary P. Fitzgerald, MD for their assistance with the IRB and project proposal. Thank you to Lara Dugas, MD for her assistance with the data analysis. A special thanks to Eileen Huffman, PT; Georgia Nicolaidis, PT; Maureen Gies, PT; Steven Jovanovich, PT, OCS; and Christopher Cook, PT for their assistance with treating all of the patients and data collection. Finally I would like to thank Gunjan Silky Sharma, MD and Saurabh Shivpuri for assisting with additional data collection.

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Appendix A. Inclusion Criteria

Spurling's Test: The patient is seated with the therapist standing behind him/her. The patient's head and neck is passively side bent towards the side of symptoms. The therapist then applies a compressive force on the patient's head in a caudal direction. A positive test is a reproduction of the patient's symptoms.

Neck Distraction Test: the patient is positioned supine. The therapist cradles the patient's head and neck by holding the occiput and chin. The therapist then applies a distraction force. A positive test yields a reduction or elimination of symptoms.

Upper Limb Tension Test for Median Nerve Bias: The patient is supine and the therapist passively places the patient's upper extremity in a position of scapular depression, shoulder abduction, shoulder external rotation, forearm supination, wrist and finger extension, and elbow extension. A positive test is (1) reproduction of symptoms, (2) greater than a 10º difference in elbow extension compared to the non-symptomatic side (3) An increase in symptoms with contralateral cervical sidebending or a decrease in symptoms with ipsilateral sidebending.

Cervical Range of Motion: The patient is seated. Cervical rotation is measured with a standard goniometer. A positive result is ipsilateral cervical rotation less than 60º.

Appendix B. Manual Physical Therapy Techniques

Cervical Lateral Glides

The patient is supine with the therapist cradling the patient's head and neck. The therapist performed a lateral translation of the vertebral segment to facilitate opening of the facet on the side of the symptoms (ie, a right to left side glide would increase opening on the left facet). Oscillatory translational mobilizations of the neck are performed at the end range at a grade III and IV, as described by Maitland.[14] The mobilizations are performed for approximately 30-45 seconds at each motion segment of the spine.

Thoracic Passive Accessory Mobilizations

The patient is prone with the cervical and thoracic spine in neutral alignment. The therapist applies a force through the patient's spinous process in an anterior to posterior direction. Oscillatory mobilizations are performed at the end range at a grade III and IV, as described by Maitland. [14] The mobilizations are performed for approximately 30-45 seconds at the motion segments that were determined to be hypomobile during the initial evaluation.

Median nerve mobilizations

The patient is placed in the supine position with the head tilted away from the involved side and the affected upper extremity as close to the therapist as possible. The therapist places the patient's affected arm into shoulder abduction, external rotation, wrist and hand supination, extension, finger extension, and the elbow into as much extension as possible prior to eliciting symptoms. The therapist then performs a "sliding" or "flossing" technique as described by Butler, as the therapist brings the patient's elbow into greater extension; he/she reduces the amount of wrist, hand, and finger extension. This technique is performed in a slow and oscillatory manner.

Deep neck flexor strengthening

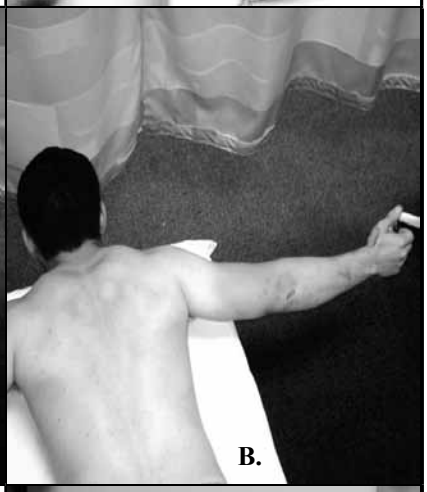
The patient is supine. He/she slowly nods the head and flattens the curve of the neck without pushing the head into the treatment table. The therapist monitors the patient's sternocleidomastoid muscles to ensure minimal activation during the deep neck flexion movement. The contraction is held for 10 seconds and repeated for 10 repetitions.

Lower and middle trapezius strengthening

The patient is positioned prone and abducts his/her shoulder with scapular depression, adduction, and upward rotation. For the lower trapezius activation the shoulders are abducted to approximately 120°-140°. For the middle trapezius activation, the shoulders should be abducted to approximately 90°. The shoulder must also be placed in full external rotation. The exercise is performed 15 repetitions for 2 sets each.

A. Exercise position for strengthening lower trapezius.

B. Exercise position for strengthening middle trapezius.



Serratus anterior push up plus

The patient stands facing a wall with the arms approximately shoulders width apart. The patient then performs a push up plus exercise. The therapist monitors to make sure that the patient fully protracts his/her shoulders. The exercise is repeated 15 repetitions for 2 sets.

Call for Candidates

Dear Orthopaedic Section Members:

The Orthopaedic Section wants you to know of two positions available for service within the Section opening up in February, 2010. If you wish to nominate yourself or someone else, please contact the Nominating Committee Chair, G. Kelley Fitzgerald, at kfitzger@pitt.edu. **Deadline for nominations: September 1, 2009**. Elections will be conducted during the month of November.

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- **President:** 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 2010.

- **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 2010.

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Is core stabilization really effective for back pain? By Steve Hoffman

If you prescribe core stabilization exercises to your back patients (i.e. tummy tucks, abdominal bracing, abdominal hollowing, dead bug, planks, wobble boards, balls, etc., etc.), you probably have noticed that they do not yield the outcomes many researchers and clinicians had hoped that they would.

This article explains why this is the case, and proposes an alternative to these commonly taught and prescribed core stabilization exercises.

First a little background on core training. Although core training has become very popular since the late 1990's, no standard has yet emerged. In the mid 1990's, Richardson and Jull noted some anecdotal success with core training. [1] Some subsequent small studies showed promising results too. [2,3] However, since then, there have been a limited number of larger controlled studies comparing core training with other forms of exercise. Some of the recent studies have shown results that are not as favorable. [4-7]

- In a 2006 review of evidence regarding the use of core stabilization exercises, Rackwitz et al concluded that "segmental stabilizing exercises are more effective than treatment by GP, but they are not more effective than other physiotherapy interventions." [8]
- Later, Cairns et al concluded after a well designed multi center random controlled trials with 97 patients that "There was no additional benefit of adding specific spinal stabilization exercises to a conventional physiotherapy package for patients with recurrent LBP (low back pain)."[4]

This evidence could either mean that (1) core stability as we know it, *is just a myth,*[9] or that (2) the specific core stability exercises studied are not optimized to achieve the desired core stabilization.

Not surprisingly, it appears that the stability model, as is widely known, may already be in decline.[10,11]

All the above listed core stabilization exercises (tummy tucks, abdominal bracing…) are inconsistent with some of the most important principles in motor learning and training. The most important are the similarity and specificity principles.[12] Basically they state that we become better at repeating what we do (good or bad).[13,14] Another way to say it: "practice does not make perfect, rather, practice makes permanent." Practice a bad movement and it will become a bad habit. Alternatively, practice a good movement and it will become a good habit.

With regard to core stabilization exercises, one needs to first recognize the fact that core stability is very movement specific. It is a three-dimensional concept and function. A person may lack core stability in one movement, and have no deficiency in core stability for other movements. Thus, prior to embarking on core stabilization exercises, one needs to first identify which specific movement has deficiency in core stability. One method to test for lack of core stabilization is to manually apply external stabilization to the specific area, and evaluate if this alone will immediately relieve symptoms such as pain or limited range of motion.[15]

If I lack core stability in bending forward while in an upright weight bearing position, then would it help me to exercise any other movement? (i.e. tummy tucks while lying on my back, abdominal bracing while lying on my tummy, ball exercises on my back or tummy, etc., etc.)

Obviously, a skilled pianist that is deficient in playing a particular song would not consider practicing other songs that he or she has already mastered as a technique to becoming good at playing the particular deficient song.

Similarly, once a movement with deficient core stability is identified, it would be inefficient to exercise other movements that are unrelated.

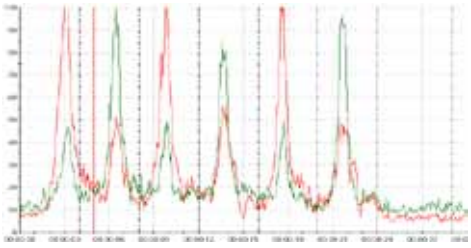
Now that we have established the importance of exercising the particular movement that is deficient, the next question is how to exercise it.

Before the skilled pianist starts to practice a new song in full earnest, she first has to make sure that she is playing it correctly, otherwise, it does not matter how much she practices, as she will never know how to play the song correctly.

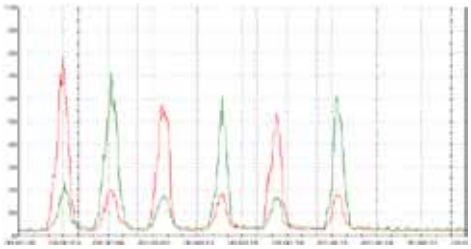
Similarly, before we embark on core stability exercises, we need to first be sure that the movement is correct. In other words, pain-free and with correct muscle activation patterns.

Therefore, in order for core stabilization exercises to even have a chance at achieving the desired outcomes, they must first of all be done (1) in the exact position and direction in which the patient has a problem (i.e. upright and weight bearing when applicable), and equally importantly, (2) the CNS must be firing the muscles correctly while in movement, prior to embarking on exercises. This ensures that during these core stabilization exercises, the CNS learns to fire the muscles correctly rather than incorrectly.

The following graphs show sEMG data for left and right paraspinal muscles while a subject is performing spinal rotations to the left and right (3 times in each direction) before and during an ATM®2 session.



Baseline – Paraspinal Muscle Activation during spinal rotations. Left paraspinal (red) peaks with left rotations and right paraspinal (green) peaks with right rotations



On ATM2 – Paraspinal Muscle Activation during spinal rotations. Left paraspinal (red) peaks with left rotations and right paraspinal (green) peaks with right rotations.

Based on the above data, when using the ATM2, the following changes in CNS muscle activation patterns are apparent:

1. Paraspinal muscle activity at rest is reduced from about 10 micro volts to about 2-3 micro volts (70-80% reduction).
2. Jittering (signal noise) in the paraspinal muscles is significantly reduced.
3. Percentage difference between left and right (red & green) at peek rotations is increased from under 60% to almost exactly 70%.
4. Percentage difference between left and right at rest is close to zero (normal) compared to about 30% prior to ATM2.

As can be seen in the above sEMG data, using the ATM Concept and an ATM2 system you can immediately and effectively alter the CNS muscle activation patterns in the position and direction in which the patient has a deficient movement. With sEMG, you have undisputable, specific, objective, and documentable real-time evidence that the ATM2 is normalizing muscle activation patterns. This is at the root of core stabilization exercises, and this explains the immediate pain relief and increases in range of motion you can achieve with the ATM2 for almost all back, neck, pelvis, hip, knee and shoulder patients.

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Comparison of Preoperative and Postoperative Functional and Psychosocial Outcome Measures in a Patient with Acute Noncontact Knee Dislocation: A Case Report

Meghan K. Dunn, SPT[1]
Steven Z. George, PT, PhD[2]

ABSTRACT

Introduction: Many athletes experience psychological and emotional challenges related to stress associated with serious injuries. Traditionally, impairment based measures have been used to determine an athlete's readiness to return to sport. The purpose of this case report was to describe the use of physical impairment in conjunction with patient reported functional and psychosocial outcomes measures preoperatively and postoperatively in the treatment of an athlete with multiple ligament disruption following acute noncontact knee dislocation. **Case Description:** Patient was a 17-year-old male referred to physical therapy following acute noncontact knee dislocation sustained during a football game, resulting in ruptured anterior cruciate ligament (ACL), torn medial collateral ligament (MCL), and medial meniscal tear. Patient underwent ACL reconstruction with meniscal repair 6 weeks following injury. Patient reported functional and psychosocial outcome measure forms including the International Knee Documentation Subjective Knee Form (IKDC), the Tampa Scale for Kinesiophobia-11 (TSK-11), the Pain Catastrophizing Scale (PCS), the Modified Self-Efficacy for Rehabilitation Outcomes Scale (MSER), and the Knee Activity Self-Efficacy Scale (KA-SES) were administered at set intervals throughout rehabilitation. Physical impairments including pain, circumferential girth, range of motion (ROM), and strength were measured throughout rehabilitation. Prior to beginning rehabilitation, the patient possessed moderate amount of fear associated with moving the involved extremity and decreased self efficacy in relation to activities specific to rehabilitation. The patient also had extreme limitation performing any activity due to knee pain, swelling, and instability. **Outcomes:** Likely meaningful improvements in IKDC and TSK-11 and improvements believed to be meaningful in PCS, MSER, and KA-SES scores preoperatively and postoperatively. Improvements in patient reported functional and psychosocial outcomes measures were congruent with improvements in ROM, strength, and pain. **Discussion:** Improvements in patient reported functional and psychosocial outcome measures potentially increase the likelihood of returning to preinjury level of physical activity, including sports. Future research should address which factors alone and in combination predict return to preinjury activity level, including sports.

Key Words: traumatic knee dislocation, rehabilitation, kinesiophobia, self-efficacy, pain catastrophizing

INTRODUCTION

Knee dislocation is defined as the complete disruption of the tibiofemoral articulation, such that the articular surfaces are no longer in contact.[1] This is considered a medical emergency due to the possible compromise of the neurovascular structures in the popliteal fossa. Immediate recognition of vascular disruption is crucial and necessary to determine if the lower extremity has been compromised.[2] The mechanism of injury typically involves a contact or collision force resulting in hyperextension, hypervarus, or hypervalgus of the knee.[1] Knee dislocation involves injury to multiple soft tissue stabilizing structures, often resulting in multidirectional instability.[2] Associated injuries may involve the collateral and cruciate ligaments, menisci, articular cartilage, and neurovascular structures, further complicating the evaluation and management of the patient with a traumatic knee dislocation.[2]

Due to the fact that many knee dislocations spontaneously reduce and subsequently are not recognized as true knee dislocations, annual prevalence is difficult to measure.[2] Although a rare injury, the incidence of knee dislocation is rising due to increased popularization and institution of athletics.[1,3] According to the National Collegiate Athletic Association Injury Surveillance System, internal derangement injuries of the knee accounted for 17.8% of injuries occurring during men's fall collegiate football games and 12.0% of injuries during men's fall football practices between the years of 1988-1989 through 2003-2004.[4] "Knee internal derangement" was defined as any isolated or combination of injuries involving the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), collateral ligament, or meniscus.[5] It is unknown what percentage of internal derangement injuries occurred secondary to knee dislocations. Moreover, it has been reported that knee dislocations account for < 0.02% of all orthopaedic injuries.[6,7]

Prior to the mid 1970s, conservative, nonsurgical management of knee dislocations consisted of closed reduction followed by a period of immobilization.[7-9] With advancements in surgery, ligament reconstruction is now recommended for the patient with knee dislocation.[2] Goals of surgical intervention for this diagnosis include improving stability, retaining range of motion (ROM), and achieving knee function that allows the patient to return to daily activities.[2] According to Rihn et al,[2] simultaneously repairing the ACL, PCL, and any collateral or meniscal injuries is the most reliable method for restoring ligamentous stability, knee motion, and overall function.

Traditionally, impairment based measures of knee function have been used to determine an athlete's ability and/or readiness to return to his or her preinjury level. Recent research suggests that some athletes will experience psychological, emotional, and behavioral problems, often related to stress associated with serious injuries.[10] Social factors, associated injuries, and psychological hindrances, such as fear of reinjury may influence an athlete's return to sports.[11,12] These factors must be taken into account, in conjunction with traditional measures of function, during evaluation, rehabilitation, and return to sport. Patient reported functional and psychosocial outcome

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measures are potentially useful tools for clinicians to utilize to gauge changes in symptoms, function, activity, fear of pain, fear of movement, fear of reinjury, and self efficacy. The purpose of this case report is to describe the use of physical impairments in conjunction with patient reported functional and psychosocial outcome measures preoperatively and postoperatively in the treatment of an athlete with multiple ligament disruption following acute noncontact knee dislocation.

CASE DESCRIPTION

History

Patient S was a 17-year-old male referred to physical therapy for treatment of ruptured anterior cruciate ligament (ACL), torn medial collateral ligament (MCL), and medial meniscal tear following acute noncontact knee dislocation. The patient reported the initial injury occurred 11 days prior while competing in a football game. The patient reported that he was running and planted his right lower extremity while cutting, resulting in the right knee "buckling" and dislocating. The patient was found on the field positioned supine with the right hip in external rotation, the right knee in approximately 80° of flexion and the right foot externally rotated. Obvious deformity was noted with the tibial plateau positioned lateral to the femoral condyles. Following on the field reduction, the pedal pulse was reported to be intact and strong. The right lower extremity was immobilized, in addition to application of ice, and the patient was transported to the emergency department. Patient S reported radiographs were taken and revealed no signs of fracture. Patient S primarily complained of "stiffness" of the right knee. Patient S reported current use of Celebrex, Tylenol, and employing ice and elevation for inflammation and pain control. The patient reported he was scheduled to undergo ACL reconstruction in approximately 6 weeks. Past medical history was remarkable for right hamstring tear approximately 5 months prior to current injury.

Tests and Measures

At the time of the initial evaluation, patient S was given a packet of patient reported functional and psychosocial outcome measure forms to complete including the International Knee Documentation Committee Subjective Knee Form (IKDC), the Tampa Scale for Kinesiophobia-11 (TSK-11), the Pain Catastrophizing Scale (PCS), the Modified Self-Efficacy for Rehabilitation Outcomes Scale (MSER), and the Knee Activity Self-Efficacy Scale (KA-SES). The IKDC was found to be a valid, reliable, and responsive knee specific measure of symptoms, function, and sports activity.[13,14] The IKDC has a high value of internal consistency (coefficient alpha = 0.92), indicating the questions consistently measure the underlying constructs of symptoms, function, and sports activity in patients diagnosed with a variety of knee dysfunctions.[13] The IKDC has been found to demonstrate high levels of test-retest reliability (r = 0.94).[13] The minimal detectable change for the IKDC score is 12.8 points.[14] The Tampa Scale for Kinesiophobia (TSK) is a 17-item measure that assesses fear of movement/reinjury.[15] The TSK, originally developed for use in chronic low back pain patients, demonstrates good internal consistency, test-retest reliability, responsiveness, and concurrent and predictive validity.[15] The TSK-11 is a shortened version of the original TSK that possesses similar properties of the original TSK, and offers the advantage of conciseness.[15] The TSK-11 demonstrates good internal consistency (coefficient alpha = 0.79), test-retest reliability (ICC = 0.81), responsiveness (SRM = -1.11), and concurrent and predictive validity.[15] A reduction of 4 points on the TSK-11 increases the likelihood of correctly identifying an important reduction in fear of movement/reinjury.[15] The PCS has been used as a self report measure of catastrophizing ideation, and may be useful in identifying patients susceptible to heightened physical and emotional distress in response to aversive stimulation.[16] The PCS demonstrates satisfactory internal consistency (coefficient alpha = 0.87) and test-retest correlations (r = 0.75).[16] In a study by Sullivan,[17] the 50th percentile cut-off score for the PCS was 20. The MSER is a modified version of the Self-Efficacy for Rehabilitation Outcome Scale (SER) developed by Waldrop et al.[18] The original SER assesses patients' beliefs about their ability to perform activities typical of physical rehabilitation for knee and hip surgery.[18] The KA-SES is a modified version of the Knee Self-Efficacy Scale (K-SES) originally developed by Thomee et al.[19] The K-SES measures the patient's perceived self-efficacy as it relates to the present physical performance or function and future physical performance or prognosis of the knee.[19] The original K-SES possesses good consistency, reliability, and good face, content, construct, and covergent validity.[19] Patient S was informed that he would be asked to fill out these forms every 2 weeks to measure change and track progress; patient consented.

Clinical impairment measures included pain, circumferential girth, ROM, and strength. Pain was measured using an 11 point scale (0-10) with 0/10 pain indicating absence of pain and 10/10 pain indicating the worse possible pain. Circumferential measurements of both knees were taken using a standardized tape measure and at landmarks as described below. Active and passive range of motion (ROM) measurements of both knees were taken using a goniometer and standardized goniometric techniques. Extension past 0 was recorded as a negative number. Strength of both knees was measured using standardized manual muscle testing techniques.

EXAMINATION

Preoperative Examination

Six weeks prior to surgical intervention, the patient ambulated into the clinic weight bearing as tolerated on the right lower extremity, wearing a full length leg brace, and using bilateral axillary crutches. Visual inspection of the right knee revealed severe joint effusion, as compared to the left. Structural examination of the right knee revealed tenderness to palpation along the medial joint line. Patellar mobility was found to be normal bilaterally. Circumferential measurements of both knees were taken using a standardized tape measure at the following landmarks: the middle of the gastrocnemius belly, the mid-patella, 5 centimeters (cm) proximal to the patella, and 15 cm proximal to the patella. The patient's skin was marked with an ink pen and measurements were taken above the ink mark for consistency. The following circumferential measurements were recorded: mid gastrocnemius: right 41 cm, left 41 cm; mid patella: right 45cm, left 40.5 cm; 5 cm proximal to the patella: right 54.5cm, left 50.0cm; 15 cm proximal to the patella: right 60 cm, left 61 cm. Active/passive ROM measurements revealed the following: knee flexion: right 60/65°, left 125/131°; knee extension: right 10/8°, left -3/-3°. Ligamentous testing revealed positive valgus stress test and positive Lachman's test in the right knee. Strength testing was deferred at the time of the initial physical therapy examination. Pain at the time of the initial evaluation was reported at 1/10; pain at its worst was reported to be 4/10.

Postoperative Examination

Two days following ACL reconstruction with meniscal repair, the patient ambulated into the clinic nonweightbearing on the right lower extremity, wearing a full length leg brace locked at 0° and using bilateral axillary crutches. Circumferential measurements of the right lower extremity were taken using a standardized tape measure at the following landmarks: 4" distal to the patella, the mid-patella, and 4" proximal to the patella. The following circumferential measurements were recorded: 4" distal to the patella: 41 cm, the mid-patella: 46 cm and 4" proximal to the patella: 54 cm. Active ROM measurements revealed the following: right knee flexion: 45°, right knee extension: 10°. It is noted that circumferential and active ROM measurements parallel measurements recorded at the time of the initial preoperative examination. Flexibility testing revealed right ankle dorsiflexion: -2°, and right hamstring flexibility limited to 50°. Strength testing was deferred at the time of the postoperative physical therapy examination.

EVALUATION

Diagnosis

Subjective history and examination findings were consistent with the medical diagnosis of ruptured ACL, torn MCL, and medial meniscal tear following acute noncontact knee dislocation. Preoperative examination revealed deficits in ROM and strength, as well as severe effusion and the patient had extreme limitation performing any activity due to knee pain, swelling, and instability. Postoperative examination revealed expected deficits in ROM and strength, as well as severe effusion. Based on the patient reported functional and psychosocial outcome measures, the patient also had extreme limitation performing any activity due to knee pain, swelling, and instability. The patient possessed moderate amount of fear associated with moving the involved extremity and decreased self efficacy in relation to activities specific to rehabilitation.

Prognosis

Patient S was an extremely motivated, young, and previously physically active individual with goals and future aspirations of returning to his prior level of physical activity, including return to contact football. In addition, his positive attitude and extremely low levels of pain catastrophizing ideation contributed to his rehabilitation potential. Low preoperative PCS scores were suggestive that this patient would not have high probability of elevated pain complaints after surgery.[20] Due to the nature of his injury, paired with the desire to return to higher level functioning, surgical intervention was warranted. Goals of surgical intervention for patient S included improving stability, retaining full range of motion (ROM), improving knee strength, and achieving knee function that allows him to return to higher level activities, including sports. The injuries sustained by patient S were serious; however, his positive qualities deemed him a candidate for successful rehabilitation. Based on clinical judgment, patient S was expected to need physical therapy services twice a week for 4 weeks preoperatively as well as 2 to 3 times a week for 14 to 24 weeks postoperatively. According to the *Guide to Physical Therapist Practice,*[21] patient S was expected to demonstrate optimal joint mobility, motor function, muscle performance, ROM, and higher functioning over the course of 1 to 8 months, or 6 to 70 visits (Pattern 4I).

INTERVENTION

Preoperative Intervention

Prior to surgical intervention, patients are expected to meet a series of conditions including normal knee ROM equal to that of the opposite knee, reduced effusion, normal gait, and good leg control.[22] Obtaining full ROM prior to surgery reduces the likelihood of motion problems postoperatively.[22] Preoperative rehabilitation is also beneficial to the patient because the patient becomes familiar with exercises he or she will be performing postoperatively.[22] Goals for rehabilitation included retaining right knee ROM, improving right lower extremity flexibility and strength, minimizing effusion and minimizing gait abnormalities.

Patient S completed a total of 9 physical therapy sessions over a 5 week period prior to surgical intervention. The preoperative program is shown in Table 1. At visit one, progressive knee rehabilitation was initiated, including gentle ROM, stretching, and strengthening. Patient S was instructed in quadriceps setting (quad sets), seated hamstring stretch, active assisted heel slides, ankle plantar flexion and dorsiflexion, and ankle resistance band exercises. Following therapeutic exercise, high voltage galvanic electrical stimulation (HVGS) was administered to minimize joint effusion. Electrical stimulation parameters included frequency of 4 pulses per second (pps) for a total of 6 minutes, and 100 pps for a total of 6 minutes, with intensity set to patient tolerance, for a total duration of 12 minutes. Patient was given a written home exercise program (HEP) to include therapeutic exercises and instructed to perform these exercises 2 to 3 times per day. Patient was also given a green resistance band to use for performing 4-way isotonic ankle exercises at home.

At visit 2, patient S reported "feeling better," with no new reports of right lower extremity pain. Straight leg raises, adductor ball squeezes, seated hip flexion, and seated knee flexion were implemented to progress lower extremity strength and mobility. Following therapeutic exercises, HVGS was administered for 12 minutes total, as described previously and with application of cold pack.

At visit 3, patient S reported no new complaints of pain. Standing hamstring curls, standing heel and toe raises, and hamstring setting were implemented for progressive strengthening and lower extremity weight acceptance. Patient S complained of right knee "tightness" with exercises involving right knee flexion. From visits 3 through 9, following therapeutic exercises, HVGS was administered for 10 minutes at a frequency of 100 pps, with intensity set to patient tolerance, with application of a cold pack to the right knee.

At visit 4, the patient reported "feeling better" and had no new complaints of pain. Therapeutic exercises from visits 1 through 3 were performed. In addition, the stationary bicycle was incorporated to improve and maintain right knee ROM. The patient was instructed to attempt complete revolutions on the bicycle, using the right lower extremity to tolerance in regards to pain and stiffness. Patient S was instructed that he could begin with incomplete revolutions with the right lower extremity and progress to complete revolutions as tolerated for a total of 10 minutes. Passive range of motion was also employed to improve right knee flexion and extension. Patient S was able to tolerate therapeutic exercises without increase in symptoms.

Intervention remained constant through visit 7, with the exception of implementation of PROM only at visits 4 and 5. At visit 7, gentle active assisted ROM exercises were implemented using a lower extremity leg press machine. Patient was instructed to use bilateral lower extremities to extend the knee against moderate elastic resistance and to use the right lower extremity when assuming the flexed position, allowing the machine to aid in increasing flexion of the right knee. The patient was instructed to

Table 1. Preoperative Program

	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6	Visit 7	Visit 8	Visit 9
Quad Sets	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	HEP	HEP
Hamstring Stretch	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec
Heel Slides	1 x 10	2 x 10	2 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10
Ankle Pumps	2 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	HEP	HEP
Ankle w/ band	1 x 10 Green	3 x 10 Green	3 x 10 Blue	3 x 10 Blue	3 x 10 Blue	3 x 10 Blue	3 x 10 Blue	3 x 10 Blue	3 x 10 Blue
SLR		3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10 1 #
Adductor Squeeze		2 x 10	3 x 10	3 x 10 with bridge	3 x 10 with bridge	3 x 10 with bridge	3 x 10 with bridge	3 x 10 with bridge	
Seated Hip Flexion		2 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10 1 #
Seated Knee Flexion		2 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10 1 #
Standing Hamstring Curls			3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10 1 #
Standing Heel/Toe Raises			3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10
Hamstring Sets			3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	3 x 10	
Stationary Bicycle				L8 10 min	L8 10 min	L8 10 min	L8 10 min	L8 10 min	L8 10 min
Leg Press							L4 10 x 10 sec	L4 2 x 10	L5 2 x 2 min
PROM				X	X				
HVGS	X	X	X	X	X	X	X	X	X
Cold Pack	X	X	X	X	X	X	X	X	X

Patient S completed a total of 9 physical therapy sessions over a 5 week period prior to surgical intervention.
Ankle w/ band= four way ankle exercises including resisted planter flexion, dorsiflexion, inversion and eversion
SLR= straight leg raises
PROM= passive range of motion knee flexion and extension
HVGS= high voltage galvanic electrical stimulation

perform these exercises slowly and controlled, without impulsivity. Patient S reported "stiffness" with right knee flexion exceeding 90°.

Intervention remained unchanged through visit 9. At visit 9, patient S reported no new complaints. Strengthening exercises were progressed by increasing resistance for improving muscle strength and endurance.

Postoperative Intervention

The challenge of postoperative rehabilitation for multiligament knee injuries is to restore dynamic mobility of the knee joint while maintaining the integrity of the reconstructed static restraints.[1] The role of the physical therapist is to increase function of dynamic restraints and joint motion without compromising reconstructed passive restraints.[1] Returning to prior level of function is the goal of all knee dislocation patients, whether athletic or not.[1] Following surgical intervention, the goals for rehabilitation included regaining full right knee ROM, minimizing effusion, normalizing functional gait, improving right lower extremity flexibility and attaining functional muscle strength.

Patient S followed a specific postoperative protocol provided by the referring orthopaedic surgeon (Appendix 1). The postoperative protocol included 5 phases: Phase I- Maximum Protection (weeks 0-4), Phase II- Progressive Stretching and Early Strengthening (week 4-6), Phase III- Advanced Strengthening and Proprioception Phase (weeks 6-12), Phase IV- Strengthening and Plyometric Phase (weeks 12-20), and Phase V- Return to Sport Functional

Program (weeks 20-24). Patient S completed a total of 30 physical therapy sessions over a 20 week period following surgical intervention. The postoperative program is shown in Table 2. The postoperative protocol followed by patient S is similar to that of published protocols.[1,23,24] The strength exercises prescribed in the postoperative protocol were similar to those prescribed in the strength training group of a randomized clinical trial (RCT) conducted by Risberg et al,[23] which included strength exercises based on American College of Sports Medicine recommendations. Compared to similar protocols, the protocol followed by patient S was aggressive in early weight bearing, early ROM goals, early closed kinetic chain (CKC) activities, early stationary bicycle use, and early functional activities. Common goals for postoperative rehabilitation protocols included regaining early ROM, maximizing quadriceps control, minimizing gait deviations, recognizing and treating problems (pain, swelling, stiffness, muscle shutdown), and returning to sports as early as possible.[1]

Table 2. Postoperative Program

	Phase I Maximum Protection (weeks 0-4)	Phase II Progressive Stretching and Early Strengthening (weeks 4-6)	Phase III Advanced Strengthening and Proprioception Phase (weeks 6-12)	Phase IV Strengthening and Plyometric Phase (weeks 12-20)
Quad sets	2-3 x 10	3 x 10		
Heel Slides	2-3 x 10	3 x 10		
Hamstring Stretch	3 x 30 sec	3 x 30 sec	3 x 30 sec	3 x 30 sec
Gastroc Stretch	3 x 30 sec	3 x 30 sec WB	3 x 30 sec WB	3 x 30 sec WB
Ankle Pumps	3 x 10 with band	3 x 10 with band		
SLR (flex, ext and add)	2-3 x 10 progress to 1-2 lbs.	3 x 10 progress to 3-4 lbs.	3 x 10 progress to 5 lbs.	
Prone extension stretch	2 min			
Sitting Knee Flexion	2-3 x 10	3 x 10	2 x 10	
Sitting Hip Flexion	2-3 x 10 progress to 1-2 lbs.	2-3 x 10 progress to 4 lbs.	3 x 10 progress to 5 lbs.	
Standing Hamstring Curls	3 x 10			
Standing Heel Raises	3 x 10	3-4 x 10	4 x 10	
Stationary Bicycle	10 min	10 min	10 min	10 min
Single Leg Stance (with brace)	3 x 30 sec progress to foam	3 x 30 sec on foam	3 x 30 sec on foam progress to mini tramp	
Standing SLR	2-3 x 10 with band			
Seated Hamstring Curls	3 x 10 with band	3 x 10 with band	3 x 10 progress to 40 lbs on machine	4 x 10 with 35 lbs. on machine
TKEs	3 x 10 with band	3-4 x 10 with band	4 x 10 with band	3 x 15 with band
Protected Mini Squats	2 x 10	2-3 x 10	2-4 x 10 progress to ULE	
Leg Press	BLE 2 x 10 40 lbs. (end of phase)	BLE 2 x 20 40-45 lbs.	BLE 4 x 10 50 lbs RLE 3 x 10 progress to 20-40 lbs	RLE 4 x 10 progress to 45-50 lbs.
Ladder Drills		1 x 10	1 x 10	1 x 10
LAQ Eccentric		1 x 10 progress to 3 lbs.	1 x 10 progress to 35 lbs. on machine	4 x 10 with 40 lbs. on machine
Lunges			6 x 20 feet	3 x 10 with 5-10 lbs.
Rocker Toss			5 x 10 with 4 lb. ball	4 x 10 with ball
Trampoline March			1 x 2.5 min	
Treadmill			6 min walking progress with resistance	6 min walking
Quick Step ups/downs				8" step 3 x 10-15
Balance Disk				3 x 1 min
Wall Squats				3 x 10
Wall Squat and Hold				3 x 1 min
Side Stepping				5x
Skipping				5x
Trampoline Jog (last visit)				3 min
PROM	X	X	X	
HVGS	X	X		
Cold Pack	X	X	X	X

Patient S completed a total of 30 physical therapy sessions over a 20 week period following surgical intervention.
SLR= straight leg raises
TKE= terminal knee extension against resistance band
LAQ= long/full arc quadriceps
PROM= passive range of motion knee flexion and extension
HVGS= high voltage galvanic electrical stimulation

Following the initial evaluation, treatment for patient S consisted of initiation of progressive knee rehabilitation. Patient S was given a written HEP to include these exercises and was instructed to perform these exercises 2 to 3 times per day.

Phase I (maximum protection phase) included postoperative weeks 0-4. Phase I includes protecting the reconstructed graft, controlling pain and inflammation, and initiating active and passive knee ROM, functional gait training, lower extremity strengthening, patellar mobility activities, and proprioception activities. According to Johnson[25] early mobilization of the knee prevents motion loss often seen after prolonged avoidance of movement. At visit 2, PROM to 90° for improved right knee flexion and extension was implemented, with emphasis on full knee extension. Use of axillary crutches was discontinued 2 weeks postoperatively, with continued use of full length leg brace. The full length leg brace was kept locked in 0° of extension for ambulation for 4 weeks postoperatively. According to Kvist et al,[26] CKC exercises may decrease shear forces at the tibiofemoral joint through muscle co-contraction and joint compression. During weeks 2 through 4, basic CKC activities were introduced. During Phase I, active/passive ROM, basic strengthening and flexibility, gait training, proprioceptive activities, and modalities for pain and inflammation control were emphasized.

Phase II (Progressive Stretching and Early Strengthening) included postoperative weeks 4 to 6. Phase II includes restoring full ROM, controlling pain and inflammation, normalizing gait, progressing strengthening and proprioception activities and initiating stationary cycling, treadmill walking, unilateral closed kinetic chain strengthening, and core strengthening. Therapeutic exercise and closed kinetic chain exercises were progressed as tolerated by patient S, per subjective report. During phase II, active/passive ROM, flexibility, progressive strengthening including open and closed kinetic chain, gait training, proprioceptive activities emphasizing neuromuscular control and modalities for pain and inflammation control were emphasized.

Phase III (Advanced Strengthening and Proprioceptive Phase) included postoperative weeks 6 through 12. Phase III includes pain and inflammation control, weaning from brace, progressing walking program, and initiating gym strengthening program. Use of full leg brace followed physician's orders and was discontinued at week 8. Use of functional knee brace was implemented at week 10. Proprioceptive activities were progressed and treadmill walking, resisted treadmill walking and trampoline marching were implemented to improve and challenge functional gait and agility. During phase III, stationary cycling for ROM, flexibility activity, progressive resisted exercises, gait training, initiation of low level agility activity, proprioception activity, and modalities for pain and inflammation control were emphasized.

Phase IV (Strengthening and Plyometric Phase) includes weeks 12 to 20. Phase IV includes implementing a full gym strengthening program and advancing proprioception and beginning plyometric progression. Therapeutic exercises were progressed per patient tolerance, per subjective report. Lunges were implemented to progress strengthening and challenge neuromuscular control. Low level agility activities were progressed to mid/high level agility activities including quick step ups/downs and balance disk activities. In addition, light plyometrics, including side stepping, skipping, and trampoline jog were introduced. During Phase IV, cardiovascular activity, ROM, flexibility activity, progressive resisted exercises, gait training, mid/high level agility activity, light plyometric activity, proprioception activity, initiation of jogging program, and modalities for pain and inflammation control were emphasized. No cutting drills were initiated due to nature of injury. Mid/high level agility activities and light plyometric activities were continued until discharge at week 20. Patient S was to continue to perform higher level functional and sport specific activity with the certified athletic trainer at the high school for full return to sport activity. This may include addressing Phase V of the postoperative protocol, which emphasizes implementing sports specific drills, advanced plyometrics, sports test for return to play and ultimately return to sport, with physician's guidance.

OUTCOMES

Scores on the IKDC, TSK-11, PCS, MSER, and KA-SES were recorded at the time of the initial preoperative evaluation (IE), weeks 2 and 4 preoperatively and weeks 0, 2, 3, 7 11, 18, and 20 postoperatively (Table 3). Knee ROM scores were recorded at the time of the IE, weeks 2 and 5 preoperatively and at weeks 0, 2, 4, 6, 8, 12, and 20 postoperatively (Table 4). Pain, on numerical 11 point rating scale, was recorded at the time of the IE preoperatively and weeks 2 and 12 postoperatively (Table 4).

Preoperative Outcomes

At the time of IE, patient S scored a 20.69 on the IKDC, a 33 on the TSK-11, a 4 on the PCS, a 64 on the MSER, and a 35 on the KA-SES. There is no IKDC normative data for persons under the age of 18; however, a male between the ages of 18-24 with an IKDC score of below 48.4 is ranked in the 5th percentile for his age/gender.[27] Based on the score of 22 as half of max score, the initial score of 33 on the TSK-11 indicates moderate to high level of fear of movement/reinjury. The initial score of 4 on the PCS indicates very low levels of pain catastrophizing ideation, based on a study by Sullivan et al,[17] in which the 50th percentile cutoff score was 20. Based on a score of 50 as half of the maximum score on the

Table 3. Preoperative and Postoperative Functional and Psychosocial Outcome Measure Scores

	Pre-Op IE	Week 2	Week 4	Week 0 *	Week 2	Week 3	Week 7	Week 11	Week 18	Week 20
2000 IKDC	20.69	53.01**	54.02	40.23	13.25	44.58**	50.57	73.50**	89.65**	95.40%
TSK-11	33	23**	17**	23	20	18	18	18	11**	11
PCS	4	3	0	1	5	0	1	0	0	0
MSER	64	90	91	34	30	32	42	59	no data	100
KA-SES	35	43	50	97	88	96	97	98	96	98

* The authors of this paper believe that these scores were likely affected by anesthesia and pain medication, and were therefore discarded in the analysis.
** Indicates significant minimally detectable change as compared to prior recorded score.
IKDC= International Knee Documentation Committee Subjective Knee Form
TSK-11= Tampa Scale for Kinesiophobia 11 point version
PCS= Pain Catastrophizing Scale
MSER= Modified version of the Self-Efficacy for Rehabilitation Outcome Scale (SER)[18]
KA-SES= Modified version of the Knee Self-Efficacy Scale (K-SES)[19]

MSER and KA-SES, the score of 64 on the MSER indicates moderate levels of self efficacy in performing activities typical of physical rehabilitation of the knee, and a score of 35 on the KA-SES indicates low levels of self efficacy in relation to performing physical activities.

The minimal detectable change for the IKDC score is ±12.8 points.[14] In addition, if a patient has a change score of 20.5, it is likely that this patient would perceive his condition to be improved.[14] Significant improvements for patient S' IKDC scores were observed between the IE and week 2 preoperatively, with a difference of 32.3 points. There was on overall improvement in IKDC score of 33.3 from initial evaluation to surgical intervention. Based on these scores, it is likely that patient S perceived his condition to be improved. However, when compared to the closest cohort for age/gender matching (male/18-24 years of age) he remained in the 5th percentile.[27]

A reduction of 4 points on the TSK-11 increases the likelihood of correctly identifying an important reduction in fear of movement/reinjury.[15] Significant improvements were seen between the IE and week 2 and between week 2 and week 4. Patient S had an overall reduction in 16 points preoperatively, indicating patient S possessed decreased fear of movement/reinjury.

Patient S also demonstrated a reduction in level of pain catastrophizing ideation, as measured on the PCS. Based on a study done by Sullivan et al,[16] we can be 95% confident that a score change of 10.1 points represents a true change in pain catastrophizing ideation in males. Patient S had an overall improvement of 4 points, which suggests the change was not meaningful. However, a final preoperative score of 0 indicated that the patient did not possess any pain catastrophizing.

Due to the fact that the MSER and KA-SES are modified from the original versions, standardized measures of change are not available. However, it is our opinion that improvement of 27 points from IE to week 4 and a final score of 91 at week 4 on the MSER represent an important change from moderate to high levels of self efficacy in regards to performing activities typical of physical rehabilitation of the knee. In addition, it is our opinion that an improvement of 15 points from IE to 4 weeks and a final score of 50 at week 4 on the KA-SES represent an important improvement from low to moderate levels of self efficacy in regards to physical performance or function and future physical performance or prognosis of the knee.

At week 5, the patient's active ROM had increased by 61° overall (flexion and extension). Patient S' strength improved to 4+/5 in knee flexion and extension prior to surgery. At three weeks, patient S had decreased effusion as measured circumferentially at the following landmarks: mid gastrocnemius: 40.5 cm; mid patella: 43 cm; 5 cm proximal to the patella: right 47.5 cm; 15 cm proximal to the patella: 56.5 cm.

Postoperative Outcomes

Following the postoperative physical therapy examination (post-op day 2), patient S scored a 40.23 on the IKDC, a 23 on the TSK-11, a 1 on the PCS, a 34 on the MSER, and a 97 on the KA-SES. The authors of this paper believe these scores were likely influenced by anesthesia and pain medication and were therefore discarded. Accordingly, the forms were administered at week 2 and patient S scored a 13.25 on the IKDC, a 20 on the TSK-11, a 5 on the PCS, a 30 on MSER and an 88 on the KA-SES. The 13.25 on the IKDC places him below the 5th percentile when compared to the closest cohort for age/gender matching (male/18-24 years of age).[27] The 20 on the TSK-11 indicates moderate levels of fear of movement/reinjury. The score 5 on the PCS indicates very low levels of pain catastrophizing ideation. The score of 30 on the MSER indicates low levels of self-efficacy in performing activities typical of physical rehabilitation. Alternatively, the patient's score of 88 on the KA-SES indicates higher levels of self-efficacy in relation to performing physical activities.

Patient S exhibited meaningful improvements in IKDC score between weeks 2 and 3, weeks 7 and 11, and weeks 11 and 18 (Table 3). Based on these scores, it is likely that patient S self-report of function was improved. Patient S' score at discharge was 95.4, placing him in the 40th percentile, when compared to closest age matched cohort.[27] According to Anderson et al,[27] scores of 100 on the IKDC are ranked in the 60th percentile.

Meaningful improvements in TSK-11 scores were noted between weeks 11 and week 18 (Table 3). Based on these scores, it is likely patient S' fear of movement/reinjury decreased throughout the course of rehabilitation. The PCS scores for patient S remained low throughout rehabilitation (Table 3), and he did not report any pain catastrophizing ideation at the conclusion of rehabilitation.

It is our opinion that an overall increase of 70 points on the MSER and 10 points on the KA-SES are clinically important changes. Based on a score of 50 as half of the maximum score, patient S' overall score of 100 on the MSER, and 98 on the KA-SES indicates that he possessed a high degree of self efficacy in performing activities specific to physical rehabilitation and physical performance of the knee.

Patient S met ROM goals typical of this type of injury as described by Medvecky et al.[1] At discharge, patient S demonstrated full ROM in the right knee as compared to the left. In addition, patient S demonstrated 5/5 muscle strength in right knee extension and flexion.

DISCUSSION

The purpose of the case report was to describe the use of physical impairments in conjunction with patient reported functional and psychosocial outcome measures preoperatively and postoperatively in the treatment of an athlete with multiple ligament disruption following acute noncontact knee dislocation. Following 39 physical therapy visits, patient S demonstrated normal active and passive ROM, effusion, and strength of the right knee in comparison to the left knee. He further demonstrated improvements that were likely to be meaningful in IKDC and TSK-11 scores and had improvements that we believed to be meaningful in PCS, MSER, and KA-SES scores.

Previous research has suggested that some athletes will experience psychological, emotional, and behavioral problems, often related to stress associated with serious injuries.[10] This

Table 4. Preoperative and Postoperative ROM and Pain Measures

	Pre-op IE	Week 2	Week 5	Week 0	Week 2	Week 4	Week 6	Week 8	Week 12	Week 20
R Knee Flex†	60	100	116	45	83	109	122	129	132	135
R Knee Ext†	10	6	5	10	8	0	4	0	0	0
Pain***	1				0				2	

†Measured in degrees
***Measured using 11 point scale (0-10)

is an important factor in considering possible appropriateness of patient discharge to return to sports. In a study conducted by Kvist et al,[11] patients who returned to preinjury level of activity had less fear of reinjury due to movement than patients who did not return to a preinjury level, as measured by the TSK-11.[11] Specific to our case, improvement in TSK-11 scores demonstrates that patient S possessed a decreased degree of fear of movement/reinjury and this decrease of fear could improve his probability of returning to previous activity levels. When compared with IKDC scores, we can see that patient S had improved report of his symptoms, function and sports activity as his fear of movement decreased, demonstrating an inverse relationship.

The low pain intensity reported throughout rehabilitation could potentially be related to low levels of pain catastrophizing ideation. This is consistent with findings of Pavlin et al[20] which suggest that elevated preoperative PCS scores can potentially be used to predict increased postoperative pain. Pavlin et al[20] concluded that identification of patients prone to catastrophizing prior to surgery may serve as a basis for initiating prophylactic therapy before surgery, with the potential for decreasing excessive reported pain.[20] Patient S had a preoperative PCS score of 0, suggesting low risk for elevated postoperative pain. According to Sullivan et al[28] catastrophizing contributes to poor pain related outcomes. Patient S had very low levels of pain catastrophizing ideation postoperatively, indicating low risk for additional therapy aimed at pain reduction. Low levels of pain catastrophizing ideation could also potentially be related to good pain management throughout rehabilitation.

Improvements in self efficacy scores were consistent with the findings of Thomee et al[29] in which men and patients with a higher baseline physical activity level obtained higher preoperative scores. In the same study, younger patients with recent injury had higher self efficacy scores.[29] Patient S' self efficacy scores improved continuously throughout rehabilitation. This may be related, in part, to patient S' lack of significant pain, low pain catastrophizing ideation, and low fear of movement/reinjury. According to Thomee et al,[29] patient perceived self efficacy appears to be an important factor associated with subjective physical function and quality of life. While patient S' self efficacy improved gradually, his levels of pain catastrophizing dropped almost immediately. Improvement in self efficacy was accompanied by improvement in IKDC measures of symptoms, function, and sports activity. Patient S' low pain catastrophizing ideation, low fear of movement/reinjury, and high levels of self efficacy potentially increase the likelihood of returning to preinjury level of activity, including sports.

The overall improvement in functional and psychosocial outcome measures can also potentially be related to improvements in physical impairments of ROM and strength. Patient S met ROM goals typical of this type of injury as described by Medvecky et al,[1] demonstrating full ROM in the right knee, as compared to the left, at discharge. According to IKDC criteria for the evaluation of ROM in the reconstructed knee compared with that of the opposite knee, patient S received a 'normal' IKDC rating, indicating his postoperative knee extension and flexion were within 2° and 5° respectively as compared to the uninvolved knee.[22] According to Shelbourne et al,[22] patients who maintained full ROM postoperatively fared significantly better in subjective and objective tests. In addition to possessing full ROM in the right knee, patient S demonstrated 5/5 muscle strength in right knee extension and flexion.

Future research should address the question, "What physical and patient reported functional and psychosocial factors can be used to determine a patient's readiness to return to preinjury activity level?" Research would be directed towards standardizing the use of functional and psychosocial outcome measures in patients with knee injury with associated surgical intervention. The authors of this case report propose a prospective study in which patients who are referred to physical therapy would complete baseline patient reported functional and psychosocial outcome measures including the IKDC, TSK-11, PCS, MSER, and KA-SES. Patients would then complete the forms at subsequent, predetermined intervals. Rehabilitation would follow standardized postoperative recommendations for uniformity. Patient reported outcome measures could then be compared with physical impairments to determine which factors alone and in combination predict return to preinjury activity level, including sports.

This case report supports the use of patient reported functional and psychosocial outcome measures to gauge changes in symptoms, function, activity, fear of pain, fear of movement, fear of reinjury, and self efficacy. In clinical practice these outcome measures can be used as a means to help determine patient readiness to return to preinjury activity level. In my opinion, the IKDC, TSK-11, and PCS are recommended for immediate use due to the fact that there are established values for detectable change or comparable normative values. I would like to see additional research aimed at establishing values for detectable change in the MSER and KA-SES. However, they are currently useful for describing the patient's level of self efficacy.

ACKNOWLEDGEMENTS

The authors would like to thank Art Collier, primary physical therapist and clinical instructor, and Matt Glogowski, certified athletic trainer, for their knowledge, guidance, and instruction in the care of this patient. The primary author would also like to thank Steven George, PT, PhD for his guidance and mentorship in the process of writing and editing this case report.

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Appendix 1. Postoperative Protocol (provided by referring orthopedic surgeon)

Phase I- Maximum Protection (Weeks 0-4): Weeks 0 to 2:
- Ice and modalities to reduce pain and inflammation
- Elevate the knee above the heart for 3 to 5 days
- Use crutches for 10-14 days to reduce swelling, the patient may discontinue with crutches when they can ambulate without a limp
- Progress to WBAT in brace locked in full extension for 4-6 weeks
- Initiate patella mobility drills
- Begin passive/ active knee range of motion to 90 of knee flexion and strong emphasis on full knee extension
- Quadriceps setting focusing on VMO contraction
- Multi-plane open kinetic chain straight leg raising
- Gait training

Weeks 2 to 4:
- Begin open and closed kinetic chain resisted cord multi-plane hip strengthening as acute inflammation resolves
- Proprioception training
- Manual PNF hip and ankle patterns
- May begin pool program when incision sites healed

Phase II- Progressive Stretching and Early Strengthening (Week 4 to 6):
Weeks 4 to 6:
- Gradually restore full range of motion with emphasis on extension/hyperextension
- Continue with ice and modalities as needed
- Normalize gait
- Open brace to 0 to 90 per physician's orders
- Initiate lower extremity stretching program
- Begin stationary bike, treadmill and/or elliptical trainer as strength and swelling will allow
- Begin closed kinetic chain strengthening progressing from bilateral to unilateral as tolerated
- Implement reintegration exercises emphasizing core stability
- Advance closed kinetic chain multi-plane hip strengthening
- Proprioceptive drills emphasizing neuromuscular control

Phase III- Advanced Strengthening and Proprioception Phase (Weeks 6 to 12):
Weeks 6 to 10:
- Modalities as needed to control swelling
- Wean out of brace weeks 6 to 8
- Advance time and intensity on cardiovascular program- no running
- Begin functional cord program

Weeks 10 to 12:
- Initiate gym-strengthening program- Progressing from bilateral to unilateral
- Leg press, squats, lunges, hamstring curls, ab/adduction, calf raises and leg extensions (0 to 30)
- May begin outdoor biking and conservative hiking

Phase IV- Strengthening and Plyometric Phase (Weeks 12-20):
Weeks 12 to 20:
- Implement a full gym strengthening program
- Begin pool running progressing to dry land as tolerated
- Advance proprioception and begin plyometrics progressing from bilateral to unilateral as tolerated

Phase V- Return to Sport Functional Program (Week 20 to 24):
- Follow-up examination with physician
- Implement sport specific multi-directional drills
- Implement interval functional program per physician approval
- Continue with aggressive lower extremity stretching, strengthening and cardiovascular training
- Advance plyometric program as tolerated
- Sports test for return to play

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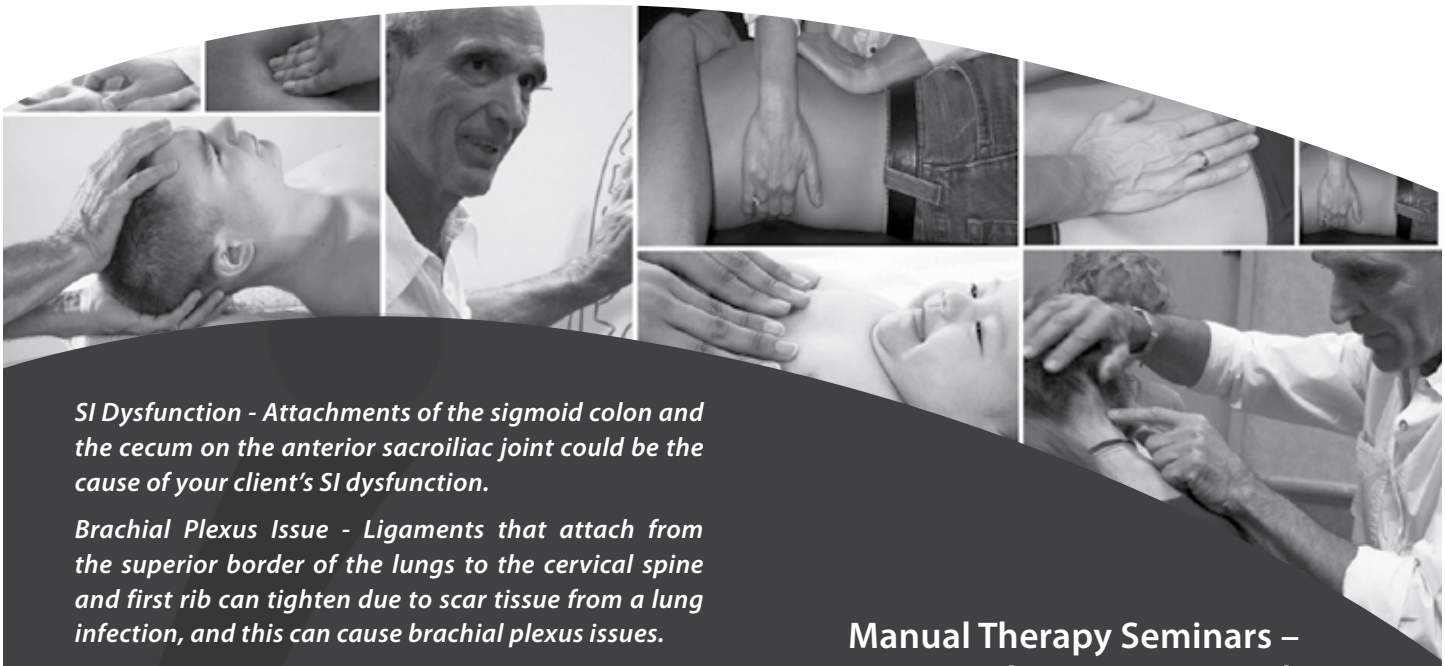

SI Dysfunction - Attachments of the sigmoid colon and the cecum on the anterior sacroiliac joint could be the cause of your client's SI dysfunction.

Brachial Plexus Issue - Ligaments that attach from the superior border of the lungs to the cervical spine and first rib can tighten due to scar tissue from a lung infection, and this can cause brachial plexus issues.

Low Back Pain - Scar tissue from an abdominal surgery can pull down on the kidney, thereby limiting its movement and causing a tightening of surrounding muscles and fascia. This can lead to decreased lumbar ROM and low back pain.

Musculoskeletal Disorder - Jean-Pierre Barral, RPT, DO, the Developer of Visceral Manipulation, has found that 90% of all musculoskeletal disorders have a visceral component.

CLINICAL STUDY*

The Effects of VM for Low Back Spinal Dysfunction

Gail Wetzler, R.P.T. studied the effects of Visceral Manipulation (VM) on low back pain in 30 patients. Some patients had previous manual therapy treatment, but it did not include VM. Wetzler treated patients with VM an average of 6-7 times. Results were measured via a pain scale the patient completed, neurological testing, and standard movement and strength tests of the low back. The results showed marked improvement in all but 2 of the cases across all tests. The conclusion was "low back spinal dysfunction may be more effectively and efficiently resolved with the addition of Visceral Manipulation into the treatment program."

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Research and Case Studies

Open Kinematic Chain Exercises (OKC) versus Closed Kinematic Chain (CKC) Exercises for Rotator Cuff Strengthening in a Healthy Female Population

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ABSTRACT

Background: According to Dutton, 50% to 75% of all musculoskeletal shoulder problems seen by clinicians are related to the rotator cuff.[1] There have been many theories on the best method for rehabilitating these injuries. **Purpose:** The purpose of this study is to compare strength gains using open and closed kinematic chain exercises to strengthen the rotator cuff complex. **Methods:** Subjects were randomly and evenly divided into the 3 groups: control group, OKC, and CKC. Each participant was required to measure her rotator cuff strength with the BTE PrimusRS™ machine prior to participation and upon completion of the 6 weeks of exercise. **Findings:** No statistical significance was found and did not indicate that one group achieved superior strength gains to the other. The power of this study was low increasing the likelihood of a type 2 error in interpreting the findings. **Clinical Relevance:** Both of the open kinematic chain and closed kinematic chain exercise protocols produced similar results.

Key Words: open kinematic chain, closed kinematic chain, rotator cuff strengthening

INTRODUCTION

Musculoskeletal injuries of the rotator cuff musculature have a high correlation to individuals participating in overhead activities. According to Dutton, 50% to 75% of all musculoskeletal shoulder problems seen by clinicians are related to the rotator cuff.[1] There are 3 common mechanisms of injury: compression, tensile overload, and macrotrauma. Compression is commonly due to a narrowing of the subacromial space or the presence of joint instability. Injuries due to tensile overload occur with hammering or throwing, more specifically during the deceleration phase of these activities. Macrotruama occurs when the external forces exceed the integrity of the tendon.[1] This injury is commonly seen in various populations including: overhead throwing athletes, swimmers, pitchers, boxers, and tennis players. Rotator cuff pathology can also occur due to poor posture, a fall on the shoulder, sudden strain due to lifting heavy loads, or repetitive stress. Rotator cuff injuries are frequently seen in individuals over the age of 40. A history of multiple corticosteroid injections in the area, prior shoulder dislocations, and/or smoking will also increase one's chance for rotator cuff pathology.[2] There have been many theories on the best method for rehabilitating these injuries. Surgical interventions are commonly a pertinent part to the rehabilitation program. However, the exercises that will be most efficient for strengthening postinjury or postsurgically are highly variable. The structures involved play a large role in determining the course of rehabilitation.

The supraspinatus is the most commonly injured rotator cuff muscle.[4,5] According to Neumann, the supraspinatus is "the most utilized muscle of the entire shoulder complex." This muscle provides static and dynamic stabilization of the glenohumeral joint and often has to withstand greater internal forces compared to other muscles of the rotator cuff. Determining how best to strengthen the rotator cuff complex seems plausible to maintain shoulder health.

The current study investigates 2 categories of exercises: open and closed kinematic chain movements. A closed kinematic chain (CKC) exercise is performed when the limb is fixed or maintains contact with a ground reaction force.[6] Closed kinematic chain exercise movements emphasize co-contraction of neighboring muscles rather than only requiring contraction of muscle groups crossing the moving joint as seen with open kinematic chain exercises. Co-contraction of the scapular stabilizers muscles allows for proper scapular positioning and dynamic stability of the shoulder complex. Some advantages of closed chain exercises include decreased joint forces in neighboring joints, decreased joint translation, and increased functionality.[6] Closed chain exercises have been shown to be useful for rehabilitation after shoulder surgery.[6] Joint surface approximation occurs more readily in closed chain exercises than in open chain exercises because more muscles are active. As a consequence there is less shear force on the glenoid surface and labrum. This joint approximation with axial loading during weight bearing is thought to cause an increase in joint congruency that in turn contributes to stability.[7]

Closed chain activity also simulates the normal proprioceptive pathways that exist in the throwing motion and allows feedback from the muscle spindles and Golgi tendon organs in their proper anatomical positions.[6] This is achieved by decreasing deltoid activation, which ultimately decreases the tendency for superior humeral migration if the rotator cuff is weak.[6] Closed chain activities begin with scapular stabilization. Patterns of retraction and protraction of the scapula are started in single planes and then progress to elevation and depression of the entire scapula and then finally involve selective elevation of the acromion.

When performing closed chain exercises the distal segment is not only fixed or stabilized on a support but motion at one joint effects motion at adjacent joints as well. Performing closed chain exercises also alters the motions that occur at that joint.[7] All weight bearing exercises have been suggested as being closed chain motions, but not all closed chain motions are performed in weight bearing positions.[7]

Some common upper extremity closed chain exercises include balance activities in quadruped, sitting press-ups, and prone push-ups. As mentioned, closed chain exercise has

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[2]Assistant Professor of Physical Therapy at Southwest Baptist University in Bolivar, MO

been shown to be useful in the acute stage of rehabilitation after shoulder surgery. They can be used as a progression of treatment for example, push-ups and scaption exercise.[6] Everyday activities that involve closed chain exercise can include activities such as pushing a grocery cart, pushing a stroller, pushing up from a seat, and bed mobility (scooting in bed).

Open kinetic chain exercises (OKC) are performed with the distal end of the moving segment free to move, having less of an impact on interconnected joint segments through joint approximation. Advantages of OKC include the ability to specifically target a joint, dynamic joint strengthening, and functional carry-over. Muscle activation occurs in the muscle/s that cross the moving joint, as opposed to closed chain which uses muscular stabilization to control joints/structures proximal and distal to the targeted joint.[7] It is this greater amount of control provided by OKC exercises that is thought to be beneficial in the early stages of rehabilitation.

Dynamic strengthening of the moving joint is thought to occur as a result of a brief period of co-contraction. When a high velocity OKC contraction occurs there is a period of co-contraction between the agonist joint raising and antagonist deceleration, though this effect is not evident with slow-velocity (<60°/sec.).[7] When using OKC exercises to target the shoulder, certain biomechanical effects take place. When the subject holds a weight, the shoulder must be dynamically stabilized. Such stabilization is more of an important factor for exercising in OKC as this position has a greater chance of leading to shoulder injuries, due to increase stress on ligaments and muscles created by the anatomical pulley of the shoulder complex. With shoulder elevation the deltoid muscle is the primary mover. The force couple created by the deltoid and shoulder musculature helps to stabilize the humeral head in the glenoid fossa. Such stabilization is less important when exercising in CKC.[8]

Both CKC and OKC have the potential for functional carry over. Functional activity of the shoulder predominantly occurs with the distal segment (hand) free to move in space. These motions can be easily duplicated. Rehabilitation can isolate control and strengthening of weak musculature and be progressed to simulate a functional pattern.[7]

There are disadvantages of OKC. Open chain exercises have adverse effects on unstable, injured, or recently repaired joints.[7]

As mentioned earlier OKC exercises can be beneficial by allowing targeted strengthening at a joint. This increased joint stress is a disadvantage to recently injured or unstable joints. Also, there is less proprioceptive and kinesthetic feedback during open chain activities. In a study by Lephart et al, those subjects with unstable shoulder kinesthesia improved to a greater extent with closed chain vs. open chain exercises.[9]

PURPOSE

The overall purpose of this research study is to determine the most effective kinematic chain to strengthen the rotator cuff complex. Specifically, this study was developed to determine which method of exercise, closed kinematic chain or open kinematic chain, was most efficient for strengthening. Prevalence of rotator cuff injury increases with age, so strengthening to maintain an appropriate balance can be an effective preventative measure.

Hypothesis

The closed kinematic chain exercise group will demonstrate higher gains in strength based on isometric read-outs from the BTE PrimusRS™ (BTE Technologies, Hanover, MD) than the open kinematic chain exercise and control groups. This is due to the stabilization/activation of the rotator cuff musculature with weight bearing through the upper extremities.

METHODS

Due to a lack of sufficient research on the female population, we chose to design our research study based around rotator cuff injuries in females. The age range was chosen as a sample of convenience. E-mails were sent out to all females in the Physical Therapy Department and posters were posted at the university recreation center and throughout the science department building.

After recruiting the necessary amount of subjects, the research group held a meeting in which the study was briefly explained to the volunteers. They were informed of the risks, benefits, and basic information about participating in a group exercise program. To limit any bias, the participants were not informed of the protocols or differences between the groups. To blind them from this information, the individuals were identified by a number and the groups were blinded to the activities of the other group. After verbal explanation, participants were given the informed consent to review and sign if they choose to participate.

After reviewing and signing the informed consent, subjects were randomly and evenly divided into the 3 groups. The researchers drew a group assignment card from a container holding all possibilities and paired it with a signed informed consent at random. The following were available in the container: treatment group A (control group), treatment group B, and treatment group C. Subjects did not know which group designation corresponded to which strengthened protocol. This ensured that the groups were evenly divided and that assignment was random. After being assigned to a group, the participants were notified of the time, date, place, and attire needed for the first group meeting. Prior to beginning the exercise routine, each participant was required to measure her current rotator cuff strength with the BTE PrimusRS™ machine. They signed up for a date and time to complete this measurement at a local hospital. The measurements were performed by a licensed Physical Therapist who had prior experience using this machine, but was not involved with the construction or implementation of this research study. The testing positions specific to each participant were documented in order to calibrate the machine for the final testing. This was to decrease any potential variables that could take place with successive measurements. Each participant was measured in internal rotation with arm at side, external rotation with arm at side, internal rotation with arm in 90º of abduction, and external rotation with arm in 90º of abduction of the dominant arm. All positions maintained 90º of elbow flexion. Specific instructions were read to the participants, which remained constant to decrease any chance for variables.

Each of the treatment groups (Group B & Group C) met in separate locations to

maintain the privacy of other groups' activity. Subjects were instructed not to discuss their treatment protocol with members from another group. During the first session, patients were given information on the remaining sessions. Upon completion of the 6 weeks of exercise, the participants were asked to have a final measurement of rotator cuff strength taken by the BTE PrimusRS™ machine. Information about each of the 3 groups is detailed below.

To maintain confidentiality, participants were assigned a number for identification purposes. All data for that individual was recorded according to her number. Only the primary investigator knew the names of the individuals, solely for the purpose of signing the Informed Consent Form. To eliminate potential bias or variables, the supervising therapist and guiding student therapist did not know the numbers given to each participant. When reporting the data, the individuals were referred to by the group (A, B, or C) they participated in. No other information was obtained or used in this study that may disclose the identity of the subjects to the public. Participants were all females with ages ranging from 18-35. At the beginning of the study there were 30 participants but two were lost during the course of the study, due to noncompliance, making the final participant number 28. The majority of the participants were right handed with only one being left handed.

Control Group (aka Group "A")

This group did not participate in group exercise. They were asked to not partake in any strengthening or exercise programs during the 6 weeks of the study. The participants were also asked to refrain from discussing the details of their group requirements with other individuals.

Open Kinematic Chain Exercise Group (aka Group "B")

The participants in this group met 3 times per week for 6 weeks. There were 6 exercises that were completed in 3 sets of 10 repetitions. The weight of the dumbbells were initially determined by using 75% of the strength readout, provided by the BTE PrimusRS™ machine, specific to each position. However, the participants had difficulty completing the full protocol at this weight percentage. The researchers met and decided to decrease the weight to 50% after the first session.

The exercises were chosen according to research by Blackburn[10] et al, Townsend,[11] and Mosely,[12] that is detailed by Donatelli.[13] These research studies used an electromyography machine to determine which muscles fired over 50% with certain exercises. There was at least one exercise for each of the 4 rotator cuff muscles included in the program we designed. A designated member of our research team was present to guide each participant of this group through their exercises, supervised by a licensed Physical Therapist. Current research shows that stretching does not provide significant benefits to the individual when performed before and/or after physical activity.[14-16] Therefore, this research study did not include guided pre- and post-stretches. Appendix B includes pictures of the Open Kinematic Chain Exercise Program.

Closed Kinematic Chain Exercise Group (aka Group "C")

The participants in this group met 3 times per week for 6 weeks. There were 6 exercises that were completed in 3 sets of 10 repetitions. The participants used unaltered body weight for resistance. These 6 exercises were chosen according to the Visual Health Information software program.[17] This program denotes the primary muscle used for the given exercise. A designated member of our research team was present to guide each participant of this group through their exercises, supervised by a licensed Physical Therapist. Current research shows that stretching does not provide significant benefits to the individual when performed before and/or after physical activity.[14-16] Therefore, this research study did not include guided pre- and post-stretches. The exercises performed are depicted below. Appendix C includes pictures of the Closed Kinematic Chain Exercise Program.

RESULTS

The test retest reliability was determined using Cronbach's alpha revealing 0.64 for external rotation at 90º and 0.75 for external rotation at the side. Internal rotation at 90º was 0.87 and at the side was 0.82.

Levene's Test of Homogeneity of Variances revealed equal distribution among the 4 groups. A 2 way ANOVA was used to compare the means of 3 groups across 4 different assessments completed using the BTE PrimusRS™. No statistical significance was found indicating that no group achieved superior strength gains to another.

The power of this study was low, making a greater likelihood for a type 2 error. A larger sample size would have helped to increase the power of this study. Also, the BTE PrimusRS™ measurements were taken in open chain, not closed chain. The chosen exercises were biased towards internal rotation strengthening versus external rotation strengthening.

DISCUSSION

The results of our study did not support our initial hypothesis that there would be a significant strength gain difference in the open vs. closed kinematic chain groups. This study could have possibly produced more significant results if the sample size were larger. Our sample size although small did complete all exercise sessions and made up any sessions that were missed due to scheduling conflicts. The subjects did this by scheduling an appointment so that all sessions could be supervised by their appointed group supervisor. There may have been increased subject variations, which were enhanced due to the smaller sample size. These variables could have been: the age range of our subjects, hormonal variables, testing equipment, and the type of exercises in general. Although there was a designated age range, a majority of the participants were very close in age. Specific ages were not recorded; however, there were a couple individuals that were outliers in comparison to the majority. This could have had an effect on the study in that the sample size was small. Hormonal variations between the participants were not considered which might have accounted for some of the variability. The researchers excluded this on purpose to make the research study less invasive to the subject. By doing this we avoided blood draws and more complex chemical studies and lab work on our test subjects. Another variable may have been the equipment that we chose to test the pre- and post-strength measurements. As stated above the BTE PrimusRS™ machine tested subjects in an open chain manner. This machine was the most objective and noninvasive way that we could feasibly find to measure the muscle activity after our strengthening program. A way to measure these specific muscle groups using a closed chain type of exercise would have been ideal; however, at the time of this study such a method was not known to the researchers. Although the exercises were chosen based on EMG activation studies, they were more heavily weighted on internal rotation versus external rotation. We were limited in the number and amount of external rotation exercises and based our exercises on equipment that might be readily available in a typical outpatient physical therapy clinic.

According to the pre- and postexercise strength measurements, the patients had a larger increase in internal rotation strength. The researchers attribute this to the greater number of exercises that stressed the internal rotation movements versus external rotation movements. To create optimal stability and balanced strength gains, the exercises should be chosen to equally emphasize internal and external rotation movements.

We were unable to find data to support the reliability of the BTE PrimusRS™ strength measurements. Our data showed that the machine had a strong reliability for internal strength measurements, but the external strength measurement reliability was only moderate. Although we were trying to differentiate between internal versus external strength gains, the BTE PrimusRS™ was only able to measure in an open chain position. Increased stability occurs with the closed chain position and measuring in the open chain position could hinder the ability to fully measure the strength gained in the closed chain position.

As mentioned previously, each exercise group was supervised by an individual familiar with the exercises. However, the exercise supervisor may not have corrected all improper techniques during all exercise sessions due to multiple test subjects performing the exercise protocol simultaneously.

CONCLUSION

The strength gains between the two exercise groups were not statistically different when calculated. Thus, this research study did not find significant results in regard to the strengthening benefit of open kinematic chain versus closed kinematic chain exercise protocols. However, we feel this design warrants further study using a larger sample size. This would reduce the possibility of a type two error, which we acknowledge as a study limitation. There were also variables unaccounted for that could have led to the lack of significant findings. These variables included classifying prior level of function, age range, hormonal variables, and closer exercise supervision. In addition, a method of measuring strength of these particular muscles in both an open and closed kinematic chain fashion may have also led to different findings. Future studies may want to consider overcoming these limitations.

In conclusion, we cannot state that either exercise protocol was superior to the other for specifically strengthening the muscles of the rotator cuff.

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Appendix A.

"You will be asked to perform a set of 3 maximal contractions. The armature will not move. You will be instructed to push/pull in the desired direction as hard as you can for 3 seconds and will have a 5 second rest between repetitions. Keep your body in the starting position (no bobbing and weaving) to prevent substitution. We will repeat this with each position of the testing. Do you have any questions?"

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Appendix B. Open Kinematic Chain Exercise Program

The following exercises will be completed in 3 sets of 10 repetitions.

1. Military Press (subscapularis, supraspinatus)*	
2. Horizontal Abduction: External Rotation (infraspinatus, teres minor)*	
3. External Rotation (teres minor, infraspinatus)*	
4. Horizontal Abduction: Internal Rotation (infraspinatus, teres minor)*	
5. Scaption: Internal Rotation (subscapularis, supraspinatus)*	
6. Extension with External Rotation (teres minor)*	

Appendix C. Closed Kinematic Chain Exercise Program

The following exercises will be completed in 3 sets of 10 repetitions.

1. Push-up (infraspinatus)* - can be modified with a knee down position	
2. Balance Board Rotations	
3. Rocker Board – Performed with rolling stool while participant kneeled on high/low table	
4. Ball "X"	
5. Wall Push-up	
6. Ball Walkout	

Hyperbaric Oxygen Therapy in the Treatment of Musculoskeletal Disorders: A Literature Review

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ABSTRACT

Background and Purpose: Physiologic effects of hyperbaric oxygen therapy (HBOT) are hyperoxygenation and hyperoxia. When breathing 100% oxygen at a pressure at 2-3 ATA (atmosphere absolute) there is an increase in oxygen dissolved in the plasma and vasoconstriction. Increased dissolved oxygen in the plasma leads to tissues receiving enough oxygen to remain viable without the use of hemoglobin-bound oxygen, which is unable to reach injured tissue. The purpose of this literature review is to determine the effect of HBOT on musculoskeletal disorders that physical therapists commonly manage in today's health care marketplace.

Key Words: hyperoxia, cluster headaches, chronic pain

INTRODUCTION

As physical therapists, we acknowledge not only the need to further solidify our role as musculoskeletal experts within the market place, but also the importance of constantly adapting in an evolving health care environment. It has been suggested that future health care will emerge as a market-based competition that emphasizes value-centered physical therapy care, which focuses on preserving the quality of the patient-therapist relationship.[1,2] Hart & Dobrykowski further stated that improvement in the value of rehabilitation is dependent upon decreasing resource utilization (visits, duration, cost) and increasing the quality of treatment interventions (unit of functional improvement).[3] In addition, it has also been reported that clinicians with an advanced certification, such as board-certified orthopaedic clinical specialists provided more efficient care in terms of improved resource utilization.[3] Orthopaedic clinical practice has seen the emergence of advanced treatment interventions that emphasize highly skilled manual therapy and specific neuromuscular/functional exercise clinical applications. The question that follows is how hyperbaric oxygen therapy (HBOT) can be used in specific patient conditions in order to not only enhance overall clinical practice, but improve patient-centered outcomes in the current consumer-driven health care environment.

BACKGROUND

Hyperbaric oxygen therapy is currently approved by the Undersea and Hyperbaric Medical Society for the treatment of 13 indications: air or gas embolism, carbon monoxide poisoning which may or may not be complicated by cyanide poisoning, clostridal myositis and myonecrosis (gas gangrene), crush injury/compartment syndrome and other acute traumatic ischemias, decompression sickness, enhancement of healing in selected problem wounds, exceptional blood loss (anemia), intracranial abscess, necrotizing soft tissue infection, osteomyelitis (refractory), delayed radiation injury (soft tissue and boney necrosis), skin grafts and flaps (compromised), and thermal burns. The current literature includes studies of treatment of more than 100 different indications worldwide, including delayed-onset muscle soreness, chronic wounds, fibromyalgia, and edema.[4] Hyperbaric oxygen therapy is defined as inhalation of 100% oxygen in a pressure chamber of greater than one absolute atmosphere (pressure at sea level). Typical average duration of therapy is 30 to 120 minutes.[5]

BENEFITS AND CONTRAINDICATIONS OF HBOT

There are a number of benefits provided by HBOT, both physiological and mechanical.

Physiological Benefits

The physiological effects of HBOT are hyperoxygenation and hyperoxia, meaning to combine with oxygen and an excess of oxygen in the body respectively.[6] At one absolute atmosphere (1 ATA) sea level, 97% of the oxygen in arterial blood is transported by hemoglobin, and the remaining oxygen remains in dissolved form in the blood plasma.[5] However, when breathing 100% oxygen at a pressure level of 2-3 ATA, there is an increase in the oxygen dissolved in the plasma. Increased dissolved oxygen in the plasma leads to tissues receiving enough oxygen to remain viable without the use of hemoglobin-bound oxygen. Oxygen bound in the hemoglobin has been shown to lack the necessary properties to be absorbed into injured tissue secondary to sympathetically induced vasoconstriction caused by the inflammation process.[7]

Mechanical Benefits

The mechanical benefits of HBOT are related to Boyle's law--the inverse relationship of pressure to volume. This principle is applied in the treatment of conditions including arterial gas embolism and decompression sickness that are bubbles of gas in the lungs or blood which cause pain and disability.[5] Hyperbaric oxygen therapy can reduce these bubbles and drive the rest of the gas into physical solution, while the excess of oxygen clears the inert gas from the bubble.[8]

Contraindications

Patient contraindications of treatment with HBOT are claustrophobia, pneumothorax, emphysema, and upper respiratory infections. Some side-effects of HBOT include barotrauma of the middle ear, which is the most common side-effect; and oxygen toxicity, which is rare in occurrence, but a major concern. Hyperbaric oxygen therapy could cause central nervous system toxicity secondary to exposing the body to high levels of oxygen for a short period of time under high pressure. Although this is a major risk, long-term treatment results are good.[8]

TREATMENT EFFECTS OF HBOT ON MUSCULOSKELETAL DISORDERS

The main objective of this research is to review HBOT and its treatment effects on musculoskeletal disorders, specifically: delayed-onset muscle soreness, acute ankle sprains, crush injuries, Complex Regional Pain Syndrome, and chronic pain management.

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HBOT and Treatment of DOMS

Delayed-onset muscle soreness (DOMS) is considered to be the swelling, pain, and stiffness in a muscle or muscle group experienced in the days following strenuous exercise. Although DOMS has varying symptoms, one of the most common symptoms is decreased joint range of motion, which has an impact on athletic performance.[9] Studies have been performed to try to prevent and/or to reduce these symptoms by applying HBOT. Staples et al performed a study involving 2 phases: Phase I was conducted to determine the effect of HBOT versus delayed HBOT, delayed meaning placebo treatment given for the first 24 hours, on quadriceps torque after exercise-induced DOMS. Quadriceps torque, or the mean maximal torque, was determined by the subjects performing 3 submaximal contractions and one maximal contraction followed by a brief rest. Then, the patients would perform 4 maximal contractions and the mean maximal torque was determined by the average of the last 3 maximal contractions. Phase II was conducted to determine the effect of placebo treatment vs. HBOT treatment on quadriceps torque after exercise-induced DOMS. The HBOT in this study was applied at 2.0 ATA at 100% oxygen for one hour, given at 0, 24, and 48 hours after exercise, and HBOT stimulation was applied at 1.2 ATA and 21% oxygen for one hour, given at 72 and 96 hours after exercise. The delayed HBOT group was treated under the same parameters; however, the stimulation treatment only was provided at 0 and 24 hours after exercise and then was followed by HBOT at 48, 72, and 96 hours after exercised induced DOMS. Staples et al found no significant difference in pain scores (using a visual analog scale) for the HBO treatment group, the delayed HBOT group, the sham treatment group, or the control group. However, the study did show improved quadriceps torque recovery when HBOT was delivered within the first 20 minutes following exercise.[7]

Bennett et al conducted a systematic review of 4 studies involving DOMS and HBOT. Results of the review showed no significant improvement in the speed of recovery, or significant differences in swelling or muscle strength after HBOT was used to treat DOMS. Due to the similarity of the results in this review it is suggested that the difference in the injured muscles or muscle groups studied does not affect study results.[9]

HBOT and Treatment of Ankle Sprains

Research has been conducted on the use of HBOT for other health conditions, in addition to self-induced musculoskeletal disorders. One such pathology is ankle sprains. A main symptom of an acute ankle sprain is edema. Edema increases tissue pressure and can cause hypoxia in tissues. Hyperbaric oxygen therapy has been used to treat edema due to its capability to increase oxygen partial pressure, meaning the amount of dissolved oxygen in the blood and blood plasma, in the injured tissue and cause vasoconstriction, thus delivering oxygen to the injured tissues. Borromeo et al studied this effect in acute ankle sprains and assessed the length of a full recovery. Subjects were given HBOT, given at 2.0 ATA and 100% oxygen for 90 minutes for the initial treatment and 60 minutes for the remaining treatments, along with a standardized treatment regimen. A standardized treatment program was formed by two programs where all participants went through program one and progressed to program two when they could perform the first without pain. Program one includes weight bearing progression from axillary crutches with posterior splint to Ezy-Wrap Ankle Stirrup without axillary crutches, open-chain mobility and stability exercises for plantar and dorsiflexion, and closed-chain balance exercises. Program two consisted of weight bearing as tolerated and closed-chain exercises for mobility, stability, and balance.

The control group was given placebo HBOT at 1.1 ATA and 21% oxygen with the same restriction as the experimental group for time and number of sessions along with the same standardized treatment program. Main outcome measures were the time of recovery, range of motion, edema, and pain levels. Results showed no significant difference between the treatment group when compared to the placebo-controlled group. A strength of this study was the fact that edema was measured using volumetric displacement. This technique allowed measurement to the closest millimeter the amount of water displaced from the volumeter when foot, ankle, and the lower third of the leg were inserted. This is also a strength because it to decreased assessor measurement error and increased intra/inter-rater reliability. Results of this study revealed no significant difference in edema reduction between the HBOT group and the placebo group.[10]

HBOT and Treatment of Crush Injury

Past studies have judged the effect of HBOT on other more severe musculoskeletal disorders. The HBOT increases the partial pressure of oxygen in an injured tissue, eliminating the need to employ oxygen-saturated hemoglobin. It has been shown that increasing oxygen to an injured area will accelerate the healing process.[7]

Applying this theory, Bouachour et al studied the effect of HBOT vs. placebo on 36 patients with crush injuries. Although the location of the injury was not taken into consideration for this study, all crush injuries were graded a level II or III. The treatment group was delivered 100% oxygen twice daily at an ATA of 2.5 for 90 minutes. This study showed an increase in wound healing with the HBOT group, especially in older patients (over 40 years old). Another significant improvement was the lower rate of patient need for a repeat or second surgery recorded among the treatment group. However, one note of caution must be stated about these findings. Although this study had statistically significant results, one has to take into consideration the fact that the surgical procedures and mechanism/location of injuries were not consistent; therefore, the greater rate of healing may not be solely accounted for by HBOT.[6]

HBOT and Treatment of CRPS

Complex Regional Pain Syndrome (CRPS) is a difficult disorder to treat. A range of interventions have been studied and applied to relieve patient symptoms. Kiralp et al performed a study using HBOT to reduce pain and swelling in individuals with CRPS of the wrist/hand. The healing benefits of HBOT for this disorder stem from its ability to increase the partial pressure of oxygen in tissues--which in turn enhances the formation of collagen, the growth of fibroblasts, and the phagocytic capabilities of hypoxic leukocytes (white blood cells in an oxygen deprived environment). All of these processes decrease the promotion of fibrosis tissue, which is the physiopathological mechanism of CRPS. This study applied 2.4 ATA of HBOT for 90 minutes in 15 treatment sessions over a period of 45 days. Patients in the control group breathed normal air from the room. A significant improvement was seen in the HBOT group compared to the control group in wrist circumference, pain scores, and wrist range of motion.[11]

In addition to these findings, Yildiz et al reported on 3 studies that used HBOT to treat CRPS; all recorded reduction in pain and symptoms in treatment groups versus control groups.[5]

HBOT and Treatment of Chronic Pain

Chronic pain is a common disorder that at times is a challenge to treat, especially in instances where its origin is difficult to diagnose. New interventions are constantly being tested.

Yildiz et al discussed HBOT in the treatment of chronic pain relating to headaches--both migraine, defined as episodic headaches with symptoms often limited to one side of the head usually accompanied by visual disturbances and nausea, and cluster which are attacks of severe pain around and above one eye ranging for 15 minutes to 3 hours.

Migraine headaches

These studies discussed by Yildiz at al performed on subjects with migraine headaches all recorded successful trials, with regard to achieving a lessening of symptoms and decrease in pain. Fife and Fife recorded symptoms accompanying the migraines decreased together with the headache. Eftedal et al recorded decreased duration of future migraines (hours patients stated they had migraines) after HBOT administered for 3 consecutive days during the week after HBOT. Studies reported by Yildiz et al comparing treatment with HBOT to treatment with normobaric oxygen therapy (NBOT), which is 100% oxygen delivered at 1.0-1.1 ATA, showed increased lessening of pain and other symptoms in the HBOT group. Meyers and Meyers found 9 out of 10 subjects experienced lessening of pain and symptoms with HBOT compared to 1 out of 10 with NBOT. That study also found the 9 participants who did not experience lessening of symptoms and pain with NBOT did experience it when switched to HBOT. This may be due to the fact that HBOT treatment increases vasoconstriction and the amount of arterial oxygen to a greater extent than treatment with NBOT.[5]

Cluster headaches

The NBOT is currently an accepted treatment for cluster headaches because it reduces cerebral blood flow. However, HBOT may be a more effective treatment for cluster headaches due to its increased vasoconstriction and ability to increase arterial oxygen. Studies reported by Yildiz et al revealed that HBOT gives immediate relief (reduction of symptoms and pain) in individuals who have not responded to other known treatments. Yildiz et al documented another study performed by Weiss et al whereby one patient resistant to other treatments had a reduction of his current episode and no reoccurrence of cluster headache pain for 7 months after receiving 2 sessions of HBOT. Also, Di Sabato et al found 3 patients reported no reoccurrence in cluster headache pain for 6 months after HBO treatment. However, all of these studies varied in duration and ATA intensity, making the optimal treatment protocol for cluster headaches unknown.[5]

CLINICAL APPLICATION

While considering the above research findings, it follows to ask the question, how will this impact the clinical reasoning process? Clinical reasoning is described by Edwards as "taking action in clinical practice."[12] In today's health care environment, as suggested by Scalzitti, the clinician has the responsibility of directing the management of the patient at achieving optimal outcomes by synthesizing the evidence, clinical expertise, and patient values.[13] The patient/client management model as described by the *Guide to Physical Therapist Practice* gives the clinician a way to organize the management of the patient through the elements of examination, evaluation, diagnosis, prognosis, intervention, and outcomes.[14] In addition, today's clinician must effectively organize the information obtained from this process in terms of the most important person in this process--the patient. Recently, the World Health Organization's International Classification of Functioning, Disability, and Health (WHO-ICF) was adopted by the American Physical Therapy Association.[15] The WHO-ICF model can be specifically applied to musculoskeletal conditions, in order to further prioritize the body functions (impairments) that can directly impact the patient's activity (functional limitations). In addition, this model acknowledges the potential influence of the patient's personal and environmental factors that may impact the patient's progress and outcomes.[16,17] The Orthopaedic Section of the APTA has also further incorporated the WHO-ICF model in clinical practice guidelines, specifically for heel pain and neck pain.[18,19]

Current evidence on HBOT has shown preliminary reports of reduced pain and edema in specific health conditions, such as ankle sprain and complex regional pain syndrome.[10,11] Aiken et al reports the current management of ankle sprains continues to result in an estimated 70% recurrence rate and an average return to sport between 12 and 43 days.[20] A clinician may specifically apply the WHO-ICF Model to the management of ankle sprains and potentially enhance clinical reasoning as described in Figure 1.

Preliminary evidence suggests that HBOT may reduce the primary impairments (body structure/functions) of pain and swelling in the ankle joint.[10] Pain and edema can impact ankle dorsiflexion mobility, which has a direct functional implication when considering the gait requirements in terminal stance. A clinician may choose to focus treatment interventions on addressing these specific impairments because of the strong relationship and overall impact on the activity/functional limitation of walking. In turn, if walking can be restored, then the patient's participation in recreational activities with her spouse can be resumed. The model also recognizes any potential personal and environmental factors that influence the patient's progress and outcomes, such as self-esteem and stress reduction (personal) and conditions of walking on uneven terrain on a nearby walking path (environmental).

Summary and Conclusions

As demonstrated by the studies reviewed, hyperbaric oxygen therapy has been shown to have a range of healing benefits. One benefit repeatedly found in the literature is the fact that an increased partial pressure of oxygen allows more to be dissolved in the blood plasma. This oxygen-rich plasma has been shown to more effectively reach injured tissues than oxygen-bound hemoglobin.[4] This in turn promotes healing and reduces edema. Vasoconstriction also occurs with HBOT, which also reduces edema.[10] This process has been studied with cluster headache, delayed onset muscle soreness, and acute ankle sprains.[5,7,10] Hyperbaric oxygen therapy has also been studied in the treatment of Complex Regional Pain Syndrome. Studies show that increased partial pressure of oxygen in the blood decreases the promotion of fibrous tissue by enhancing the formation of collagen, the growth of fibroblasts, and the phagocytic capabilities of hypoxic leukocytes.[5] Another benefit of increased arterial oxygen is the reduction and prevention of migraines and cluster headaches.[5]

Studies reporting the effect of HBOT on musculoskeletal disorders vary in their administration of HBOT and vary in their results. Additional research is needed on the healing properties of HBOT treatment, particularly regarding musculoskeletal disorders, and needed to create optimal protocols and clinical practice guidelines.

ACKNOWLEDGEMENT

The above authors would like to extend a sincere thank you, and express their appreciation to Roger Nelson, PT, PhD, FAPTA for his professional guidance in regards to the development of this manuscript.

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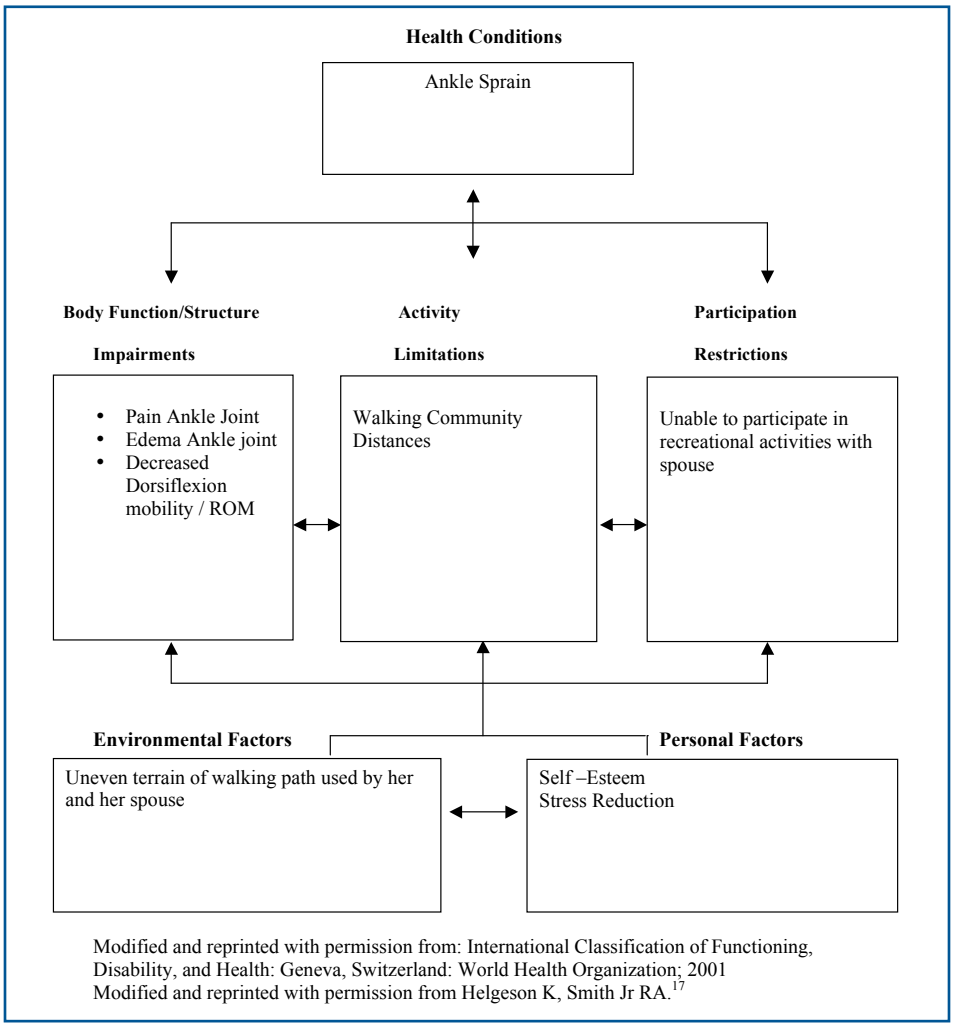

Figure 1. ICF Clinical Application

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Book Reviews

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Cole BJ, Gomoll A. *Biologic Joint Reconstruction: Alternatives to Arthroplasty.* Thorofare, NJ: Slack, Inc.; 2008, 349 pp., illus.

This book, written primarily by physicians, provides the reader with a different perspective of managing patients other than the typical joint arthroplasty. Although arthroplasty is the accepted procedure for more advanced arthritis, there are many other patients who do not qualify for this type of surgical management. The purpose of the book is to detail other procedures used to treat younger patients with degenerative changes who are not appropriate candidates for joint arthroplasty.

The book is divided into 7 sections. The first, consisting of 4 chapters, covers foundational information. Chapter 1 reviews the basic science, etiology, incidence and natural history of articular cartilage. Chapter 2 covers patient evaluation and comorbidities; specifically it includes malalignment, meniscal deficiency, and instability. High tibial osteotomies for correction of malalignment and meniscus transplantation for meniscal deficiency are discussed, with indications and contraindications for both. Issues of knee instability are also briefly covered. Chapter 3 discusses the imaging modalities used for cartilage defects. Magnetic resonance imaging (MRI) and computed tomography (CT) are covered in detail, addressing the purposes of each, different sequencing used, and pros and cons of each diagnostic tool. The chapter effectively demonstrates how normal variations of the imaging studies can represent pathology to an untrained eye. For someone with limited knowledge in use of the diagnostic tests, the chapter thoroughly clarifies why each is typically used. Chapter 4 covers the topic of allograft processing and safety, specifically, allograft infection rate statistics, instrumentation, tissue bank regulation, and tissue procurement and processing.

Section 2 outlines nonoperative treatments. Chapter 5 covers nutraceuticals, which are food products or ingredients that have an effect on osteoarthritis. Products discussed are glucosamine and chondroitin, lipids, minerals (boron, selenium, zinc, copper), vitamins A, C, E, and willow bank, a botanical extract. Research, as well as the pros and cons for each supplement, are discussed. Chapter 6 covers the typical pharmacological treatments for osteoarthritis, including oral nonsteroidal anti-inflammatory medications, and those are that are injected intra-articularly, such as glucocorticoids. Risk factors for each and recent research are addressed. Chapter 7 covers the rehabilitation of articular cartilage lesions of the knee, and is the only chapter not written by a physician. Instead its contributors are physical therapists. The chapter covers the 9 principles of articular cartilage rehabilitation and the phases of rehab, from acute to return to sport. Although the chapter is not specific to any certain procedure, it covers the basic principles to progress the patient appropriately through treatment.

Sections 3 through 7 cover the operative treatment of the knee, hip, shoulder, elbow, and foot/ankle, respectively. Each chapter covers a specific surgical procedure and follows a structured format for detailing the surgery. Each chapter details a history and physical examination, imaging associated with the condition, indications and contraindications for the procedure, the surgical technique, rehabilitation protocol, potential complications from the surgery, and research results of the surgery. Details of the surgical technique include the instrumentation used, patient positioning, surgical anatomy, the approach used, and technical steps to completing the surgery. Sixteen procedures for the knee are described. These include arthroscopic debridement, microfracture technique, osteochondral autograft transplantation, mosaicplasty, osteochondral autograph transfer, osteochondral allografts, second-generation autologous chondrocyte implantation, and meniscus transplantation to name a few.

Section 4 covers surgical procedures of the hip, including arthroscopy, osteotomy, and arthroscopic femoral head partial resurfacing.

Chapter 5 describes surgical procedures of the shoulder, including debridement and capsular release, biologic glenohumeral resurfacing, and limited shoulder prosthetic resurfacing. Chapter 6 covers surgical procedures of the elbow, including arthroscopy, nonprosthetic elbow arthroplasty, and biologic resurfacing. Chapter 7 covers arthroscopy and cartilage repair of the ankle.

Overall, the book is very well organized and easy to follow. Charts and graphs summarize main points for each chapter, and all are very well referenced. Throughout the book there are excellent color pictures of the surgical procedures, instruments, and diagnostic images. A minor limitation is that untrained clinicians may have difficulty seeing lesions in the images, as many pictures do not have arrows pointing to the problematic site. However, the surgical pictures allow the reader to truly appreciate what occurs in the operating room. It is a great way for therapists to learn more about the surgical procedures, as well as educate patients about the procedure they are about to go through or have gone through. Some chapters also have a nice addition from the contributing author about their own personal results from the procedures they have performed. This book would be a great addition to a therapist at any level who treats joint arthroplasty patients postoperatively, or is looking to gain new information on surgical management of the extremity joints.

Michelle Finnegan, DPT, OCS, MTC, FAAOMPT

Barral JP, Croibier A. *Manual Therapy for the Peripheral Nerves.* New York, NY: Churchill Livingston/Elsevier; 2007, 270 pp., illus (translated from French).

This text describes a rationale for the evaluation and treatment of peripheral nerve lesions from an osteopathic prospec-

tive. The authors are French osteopathic physicians who are well known for their work in visceral manipulation. The purposes of this text are to provide an appreciation of the relationship of the nervous system to structures and organ systems, and how the clinician can influence them locally and globally with a manual therapy approach. Many of the concepts presented are heavily influenced by anatomy, embryology, morphology, and the pathophysiology of nerves and supportive connective tissues.

The text is comprised of 10 sections covering anatomy and physiology of the peripheral nervous system, mechanical-functional interferences of the peripheral nerves, functional pathology of peripheral nerves, treatment of the peripheral nerves-methods of treatment, the cervical plexus and its branches, the brachial plexus and its branches, the lumbar plexus and its branches, the sacral plexus and its branches, nerves of the foot, joint, and skin innervations. Additionally, the text includes a glossary, bibliography, and index.

The first section primarily deals with normal anatomy, embryology, and morphology of the nervous system, supportive connective tissues, vessel supply, innervation patterns, and cellular function of peripheral nerve cells. The second section describes mechanical and functional interferences of peripheral nerves, types of compression, nerve damage classifications, and physiologic consequences.

The third section covers nutrition and metabolism of the peripheral nerves, mechanical and electromagnetic characteristics of nerve tissue, neurophysiology, and the "neuro-psycho-emotional" connection. The authors describe the concept of a dualistic nervous system: the classic nervous system based on neurons communicating in form of electric impulses from one point to another and the "perineural system," a system of communicating with direct current through the connective tissues of nerves, primarily the perineurium. The authors do not provide specific evidence or references to support the latter system. Additionally, the authors report that they have performed SPECT examinations with patients treated with this approach and have demonstrated links with treatment and the limbic system and other body regions. These findings are anecdotal and without references or original scans for comparison.

The fourth section describes the treatment of peripheral nerves and methods of treatment. The authors go step-by-step through palpation techniques for peripheral nerves and how to distinguish between the nerves and other structures. The techniques presented are different from more common clinical neurodynamics popularized by such authors as Shacklock, Butler, and Elvey. The techniques presented rely more on palpation of the involved nerve and testing the "feel," mobility, irritability, and texture of the peripheral nerve as well as the extraneural relationships through relevant structures. Additionally, the chapter describes effects of these techniques on systems throughout the whole organisms. Contraindications, precautions, and exclusion criteria are outlined for these techniques.

Sections 5 through 8 are similar in their arrangement, addressing cervical, brachial, lumbar and sacral plexi, and their respective nerve branches. Each section describes anatomical and topographical relationships and treatment of each of the branches of the plexi, connections with internal organ systems, and some common syndromes.

Sections 9 and 10 are anatomical descriptions of the joint and skin innervations of the foot. Although these sections include pertinent information they would be better incorporated into the rest of the text.

The book is well illustrated with detailed full color illustrations and black and white photos of the authors performing many of the techniques. Throughout the text, there are colored text boxes providing manual therapy implications and insights related to the section topic. The book contains a short bibliography with few references more current than 1997. Those therapists looking for a text with more well-known nervous system gliding or mobilization may be more satisfied with those written by Michael Shacklock or David Butler. This book does provide many thought provoking ideas, observations, and proposed relationships, but does lack sufficient evidence to support many of the authors' observations. The evidence provided is primarily from their own clinical experiences. The text has scattered case studies and would benefit from more structured case studies at the end of each section. Some concepts may have been difficult to fully elucidate with the translation from French to English.

Overall, I found the text thought provoking and informative. I would recommend this to intermediate and advanced physical therapists that have foundational backgrounds in manual therapy and more advanced palpation skills. Applying these manual therapy techniques should be enhanced by continuing education course work provided by instructors experienced in this type of work. With the lack of supportive evidence, the clinician should critically question and assess the concepts and techniques presented.

Timothy J. McMahon, MPT, OCS, COMT

Weiland AJ, Rohde RS. *Acute Management of Hand Injuries.* Thorofare, NJ: Slack, Inc.; 2009, 196 pp., illus.

This book was written to provide a reference for those practitioners who may not have extensive training in the area of hand or wrist injuries. It was meant to aid a health care practitioner in the initial management of acute hand and wrist conditions. This book is not intended to replace the consultation or treatment by the experienced upper extremity professionals.

The book is organized into 7 sections. The first section presents the basics of assessing acute hand injury patients through examination and evaluation. The evaluation includes suggestions for the subjective interview of the patient and his or her onset of injury as well as the examination of the hand with objective findings of sensation, range of motion, strength, perfusion, palpation, and inspection.

Sections 2 through 7 outline injuries to the hand and wrist. Each chapter discusses the mechanism of injury, evaluation, acute treatment, definitive treatment with referral to a hand specialist, and potential prob-

lems as well as special considerations. The second section discusses bone and joint injuries in 12 chapters. Specific topics of discussion include general concepts of injury, mallet fractures, finger tip injuries, phalanx fractures, dislocations and volar plate injuries, gamekeeper's thumb, metacarpal fractures, scaphoid fractures, carpal fractures, perilunate dislocations, distal radius fractures, and compartment syndrome. The third section reviews tendon injuries. The 4 chapters in the third section review lacerations of the extensor and flexor tendons and avulsions of the flexor and extensor tendons.

The fourth section discusses nerve injuries as outlined in 4 chapters: digital nerve injuries, median nerve injuries, ulnar nerve injuries, and radial nerve injuries. Section 5 reviews hand and wrist infections, and includes a color atlas of photographs. Also included is the review of paronychial infections, infectious tenosynovitis, septic arthritis, web/palmar space infections, cellulitis, Herpetic Whitlow, and bite wounds. Other traumatic digit injuries are included in section 6 (amputation, ring avulsion injury, and injection injuries) and section 7 (gunshot wounds, frostbite, and burns). Lastly, appendices at the end of the book describe commonly used splints, digital anesthetic block, quick references for tetanus and rabies, removal of tight rings, common hand infections and bite wounds, treatment of chemical burns, orthopaedic abbreviations, hand examination diagram, and motor/sensory nerve quick reference.

This book is well organized and presents basic information of hand and wrist injuries. It is useful for the acute care of an injury but often, physical therapists are not the first to evaluate such an injury. It is an excellent review and is a good reference to understand the initial stages of injury and management.

Sylvia Mehl, MS, PT, OCS

Remember Orthopaedic Practice is online (member login required). Check out current and archived issues today at www.orthopt.org/publications!

UPCOMING MEETINGS

2009
National Student Conclave
October 17-19, 2009
Miami, FL

2010
Combined Sections Meeting
February 17-20, 2010
San Diego, CA

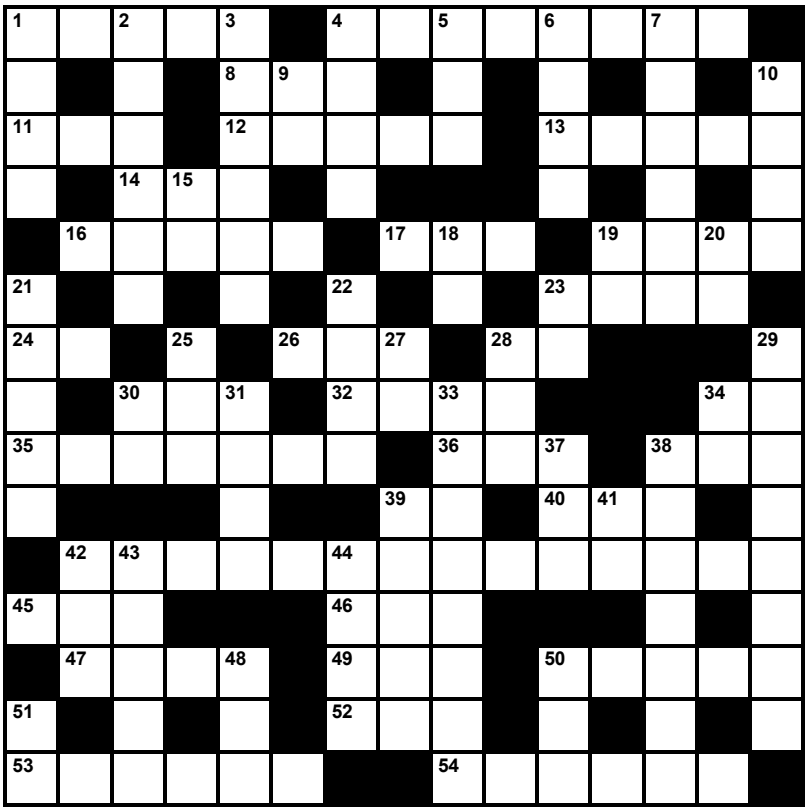
Annual Conference: PT 2010
June 16-19, 2010
Boston, MA

2011
Combined Sections Meeting
February 9-13, 2011
New Orleans, LA

Annual Conference: PT 2011
June 16-19, 2011
Washington, DC

Shoulder Bits and Pieces

Crossword by Myles Mellor
www.themecrosswords.com



Across

1 C1 vertebra
4 Bone openings
8 Trouble
11 Practice suffix
12 See 18 down
13 _____sis: "swayback"
14 Rule out
16 Spinal ___: tube formed by vertebrae, where the spinal fluid and membranes are
17 Estimated arrival time, abbr.
19 Neck connection
23 Medical trial
24 Email address intro
26 Under prefix
28 First lumbar vertebra
30 Test site

Down

1 C2
2 A type of vertebra
3 Relating to the fused bones forming the pelvis
4 At the front
5 Regret
6 The lumbar curve is more pronounced in the female than the ____
7 Brain-spinal cord connections
9 French, of the
10 Thick whitish collection of nerve tissue
15 Used before a vowel
18 It begins at the middle of the second and ends at the middle of the twelfth thoracic vertebra (goes with 12 across)
19 Guy
20 __ the base of the spine

Answers to the crossword puzzle can be found at www.orthopt.org

2009 AAOMPT ANNUAL CONFERENCE

PHYSICAL THERAPISTS: The 1st Choice for Musculoskeletal Care

OCTOBER 14 – 18

Hyatt Regency Crystal City, Washington DC

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The 2009 AAOMPT Annual Conference in Washington DC is your opportunity to be in the "seat of power" surrounded by the heart of legislation, national monuments and memorials. We invite you to learn, share and participate in your own AAOMPT experience, including personal visits to Capitol Hill Legislators. Don't miss this opportunity to participate in this important conference with your peers and gain information and resources to advance your skill level and increase proficiency in OMPT.

Make your plans to attend today! For complete program information and on-line registration go to www.aaompt.org

THE 2009 AAOMPT ANNUAL MEETING WILL OFFER:

Pre-Conference Sessions

Wednesday, October 14

The Selective Functional Movement Assessment: An Integrated Model to Address Regional Interdependence
Kyle Kiesel, PT, PhD, ATC, CSCS
Phil Pilsky PT, DSc, OCS, ATC, CSCS

Wednesday, October 14 and Thursday, October 15

Lumbopelvic Motor Control: Advanced Clinical Assessment and Treatment of Motor Control Dysfunction in Low Back Pelvic Pain
Paul Hodges Bphty (Hons) PhD MedDr

Ultrasound Imaging: Assessing Muscular Behavior to Augment Lumbar Stabilization Training
Deydre S. Teyhen, PT, PhD

CAPITOL HILL DAY
Thursday October, 15

AAOMPT is pleased to offer the opportunity for you to become active in the Advocacy roll of AAOMPT. On Thursday, beginning with a session to review current issues and prepare participants for their personal visits to congressmen, AAOMPT will lead State Delegations to Capitol Hill. Let your voice be heard.

Keynote Presentations – Friday, October 16

Training the Brain in Back Pain: Requirements of Spinal Control, Changes in the System with Pain, and Changing the Brain in Pain
Paul Hodges Bphty(Hons) PhD MedDr

Lumbopelvic Motor Control: Moving Evidence into Action
Deydre S. Teyhen, PT, PhD

Educational Sessions – Saturday, October 17

Lumbar Stabilization Training: Initial Phases and Patient Response
Deydre Teyhen, PT, PhD

Consideration of Breathing and Continence in Back Pain
Paul Hodges, Bphty(Hons) PhD MedDr

Musculoskeletal Clinical Reasoning: Thin Slicing Our Way to Clinical Expertise
Timothy Flynn, PT, PhD
Britt Smith, PT, DPT

APTA Statehouse Strategies – Promoting & Defending Vision 2020 at the State Level
Justin Elliott, Director, State Government Affairs, APTA

Speaking to the Media: The Inside Scoop
Stephania Bell, PT, OCS, CSCS

Spinal Stabilization Training for the Lumbar and Lower Quarter Patient
Alec Kay, PT, DMT, FAAOMPT, OCS, ATC
Jim Rivard, PT, MOMT, FAAOMPT, OCS

Physical Therapist 2.0 Considerations for an Evolving Marketplace
Eric Robertson, PT, DPT, OCS

Chronic Ankle Instability (CAI): Recognition Across the Clinical Spectrum
James Beazell, PT, DPT, OCS, FAAOMPT
Jay Hertel, PhD, ATC, FASCM, FNATA
Eric Magrum, PT, OCS, FAAOMPT

Quantitative Sensory Testing: Basic Assessment Skills for the Identification of Impaired Pain Processing
Carol Courtney, PT, PhD, ATC, FAAOMPT
Carina Lowry, PT, DPT, OCS, FAAOMPT
Michael O'Hern, PT, MHS, OCS, FAAOMPT
Alicia Emerson Kavchak, PT, MS, OCS, FAAOMPT

Direct Access Care of Musculoskeletal Pathology Provided by Pyisical Therapists: A Wartime Model
Dan Rhon, D.Sc., OCS, FAAOMPT
Skip Gill, D.Sc., OCSCert., MDT, FAAOMPT

Roles and Barriers for Direct Access to Physical Therapy in the Development of a Culture of Patient-Centered Efficiency in the United States Health Care System
Todd Davenport, PT, DPT, OCS
Kornelia Kulig, PT, PhD, PT, FAAOMPT
Cheryl Resnik, PT, DPT, MSHCM

How Central Sensitization Becomes a Facilitated Segment
Richard Kring, DMT, DPT, PT, FAAOMPT

Selected Manual Therapy Interventions and Functional Exercises for the Shoulder – Student Session
Bob Boyles, PT, DSc, OCS, FAAOMPT
Danny McMillian, PT, DSc, OCS, CSCS

Research Day – Sunday, October 18

Research day will present a series of selected abstracts of research inquiry from case-report and case-series up to clinical trials. Abstracts will also be presented in poster presentations on Friday evening. For complete program information and on-line registration go to www.aaompt.org

The conference will also offer you many opportunities to visit with exhibitors who will be showcasing the latest information, research, products and resources available to you to achieve success in OMPT.

SPECIAL INTEREST GROUP

OHSIG Moves Forward

Since CSM 2009 in Las Vegas, the Occupational Health Special Interest Group has experienced a bit of turmoil. We are pleased to announce however that we have re-grouped. We have the support of the Orthopaedic Section leadership, and can now move forward with OHSIG business at hand!

In light of these recent events, we would like to update our OHSIG members on where we are, what we are working on, and how you can participate.

Due to unforeseen circumstances, nominations for President and other positions did not get on the Orthopaedic Section fall 2008 electronic ballot. Subsequently, it was felt that the voting could take place at the next CSM during the SIG General Business Meeting. Unfortunately, as fate would have it, the current OHSIG President, Margot Miller, could not attend due to health issues and Steve Allison, OHSIG VP could not attend the 2009 CSM SIG meeting due to work.

At the SIG meeting, the remaining board members were able to facilitate discussions attempting to complete OHSIG business at the General Business Meeting. Votes were taken for President and for the Membership, Education, and Nominating Committee Chair positions

As a result of recent SIG policy changes instituted in 2007, the Orthopaedic Section BOD deemed the election invalid. Bill O'Grady, the OHSIG Liaison to the Orthopaedic Section BOD, has been appointed OHSIG Interim President. Joe Kleinkort and Steve Allison resigned their OHSIG BOD positions due to business and personal reasons. Dee Daley has been appointed OHSIG VP/Ed Chair. Advisors were named including Rick Wickstrom, Gwen Simons, and Margot Miller.

Until the next election, voting members of the OHSIG governing board will be Bill O'Grady, Dee Daley, and one member of the Orthopaedic Section BOD. After the next election and according to the updated policies, the 3 voting members will be the SIG President and Vice President and the Orthopedic BOD liaison to OHSIG. Additionally, the new policies eliminate the OHSIG Treasurer and Secretary positions. Nonvoting members of OHSIG include the advisors: Rick Wickstrom, Gwen Simons, and Margot Miller; and Committee Chair persons: John Lowe, Nominating Committee; Drew Bossen, Practice and Reimbursement; Kathy Rockefeller, Research; and Rick Wickstrom, Membership.

The first OHSIG BOD call under Bill O'Grady's lead was held April 23, 2009. Participants included Bill O'Grady, Dee Daley, Rick Wickstrom, Gwen Simons, Margot Miller, Drew Bossen, Kathy Rockefeller, John Lowe, and Terri DeFlorian, Executive Director Orthopaedic Section, taking Minutes.

The current status of the OHSIG since CSM 2009 was presented. The new Governing Board, Advisors, and Committee Chairs were announced and the election process was discussed. The Nominating Committee has been instructed to solicit nominations for President and one Nominating Committee Member for the fall 2009 election. The OHSIG President will assume duties at CSM 2010. Dee Daley will assume VP/Ed Chair duties until the fall election 2010, with the new VP/Ed Chair assuming duties at CSM 2011.

A motion was made to approve the letter written to several researchers related to concerns the researchers had regarding the FCE Revised Guidelines. They had objected to our description of the guidelines as "evidence-based." We responded that their conclusion that the guideline was developed using an "expert based/consensus based methodology rather than an evidence-based methodology" was correct. We thanked them for the feedback and agreed that we would change the wording to reflect this. The letter has gone out and we have received a very cordial response from the researchers.

The next motion was made to nominate Gwen Simons and Jeremy Skoog to the Nominating Committee. Gwen will serve on the committee for the fall 2009 election only. Jeremy Skoog would serve a 3-year term on the Nominating Committee. John Lowe would serve as Nominating Committee Chair through the fall election 2010. Motion approved.

The final motion was made for those appointed as Committee Chairs at CSM to become committee members. This included Lorena Pettit, Education; Janet Peterson, Membership.

It was agreed that Dee Daley would represent OHSIG at the Orthopaedic Section Strategic Planning meeting in LaCrosse Oct 8-10, 2009.

We have much work to do on behalf of OHSIG members and we are ready to move forward! Dee Daley and Margot Miller will take the lead for Occupational Health specialization/certification. Rick Wickstrom and Janet Peterson will be tasked to do the revisions on the Ergonomics Guidelines. Gwen Simmons will do the revisions on the Legal Guidelines and John Lowe and Dee Daley will spearhead the Work Rehab revisions. Plans are underway for a 2009 Summer Working Session for OHSIG Board members. Over the next year, we look forward to opportunities for member involvement in reviewing updates of various Occupational Health Guidelines. We will keep you informed of our progress and look forward to a productive year!

Submitted on behalf of OHSIG by Margot Miller, Dee Daley, and Bill O'Grady

Foot&ankle

SPECIAL INTEREST GROUP

The Navicular Whip Thrust Technique

Stephen Paulseth, PT, DPT, SCS, ATC
Paulseth and Associates Physical Therapy

Jason B. Han, PT, DPT, CSCS
University of Pittsburgh Medical Center/Center for Sports Medicine

RobRoy L. Martin, PT, PhD, CSCS
Duquesne University Department of Physical Therapy

The navicular plays a critical role in medial longitudinal arch support and normal foot function. It normally undergoes the greatest displacement of any of the tarsal bones and serves as the insertion site of muscles that are essential for proper foot function. The subtalar and midtarsal joints allow the foot to function as both a shock-absorber and rigid lever during the gait cycle. To assist in this function the navicular should glide plantarmedially on the talus with pronation and dorsolaterally with supination.[1] Abnormal positioning or movement of the navicular may result in pain and/or decreased function. Also, the tibialis posterior muscle attaches directly on the navicular, contributing to dynamic arch support and controlling pronation. When the foot is being loaded early in the stance phase, the tibialis posterior muscle contracts eccentrically to control subtalar and transverse tarsal joint pronation. This muscle then contracts concentrically, as the foot moves toward supination and plantarflexion, from mid-stance to push-off.[2-4] Therefore like the navicular, dysfunction of the tibialis posterior, can be associated with abnormal biomechanics that potentially contributes to foot and ankle related pathology.

Given the importance of the navicular in normal foot mechanics it seems feasible that re-establishing its proper alignment and function could be potentially helpful for patients with musculoskeletal foot and ankle related pathology.[5] A mobilization technique we have found to be effective is the navicular whip. This technique is similar in application to the described cuboid whip.[6] The navicular whip is performed with the patient in a prone position. The clinician's fingers are interlocked on the dorsum of the patients involved foot, while the thumbs are positioned on the plantar aspect of the navicular. The knee is flexed to approximately 70º with the ankle in neutral dorsiflexion. The knee is then passively extended while the ankle is plantarflexed. At the end range of ankle plantar flexion, the thumbs provide a dorsal grade V thrust to the navicular (Figure 1). We have successfully implemented the navicular thrust for individuals with musculoskeletal foot and ankle pathologies that were associated with tibialis posterior weakness.

Figure 1. Navicular whip mobilization technique.

Indications for the navicular whip include tibialis posterior weakness in individuals with the diagnosis of:

- Plantar Fasciitis
- Grade I or II Posterior Tibialis Dysfunction
- Tarsal Tunnel Syndrome

Contraindications:

- Painful or limited ankle plantarflexion range of motion
- Pregnancy and immediately postpartum
- Acute inflammatory conditions (ie, rheumatoid arthritis)
- Osteoporosis
- Children
- Diabetic neuropathy with loss of protective sensation
- Bone malignancies or infections
- Fracture in the leg, ankle, and/or foot
- Pathological ligament laxity in the ankle or foot

As an objective measure in the clinic, we manual muscle test the tibialis posterior before and after the application of the navicular whip thrust technique. When the technique is successfully implemented, we have found a significant increase in force output immediately after delivery of the mobilization with manual muscle testing. We hypothesize that correction of the positional fault of the navicular may alter the length-tension relationship of the tibialis posterior resulting in improved muscle function.

In an attempt to maintain the positional correction achieved with the navicular whip, we apply supporting taping. The taping techniques applied alone or in combination with one another include a navicular tab, low-dye arch support, and high-dye navicular lift. The high-dye navicular lift is a technique we find particularly effective. With this technique, the patient positioned supine with foot resting off the treatment table. Beginning on the lateral aspect of the calcaneus the tape is applied plantarmedially beneath the midfoot; specifically under the navicular. The tape is then pulled and elevated

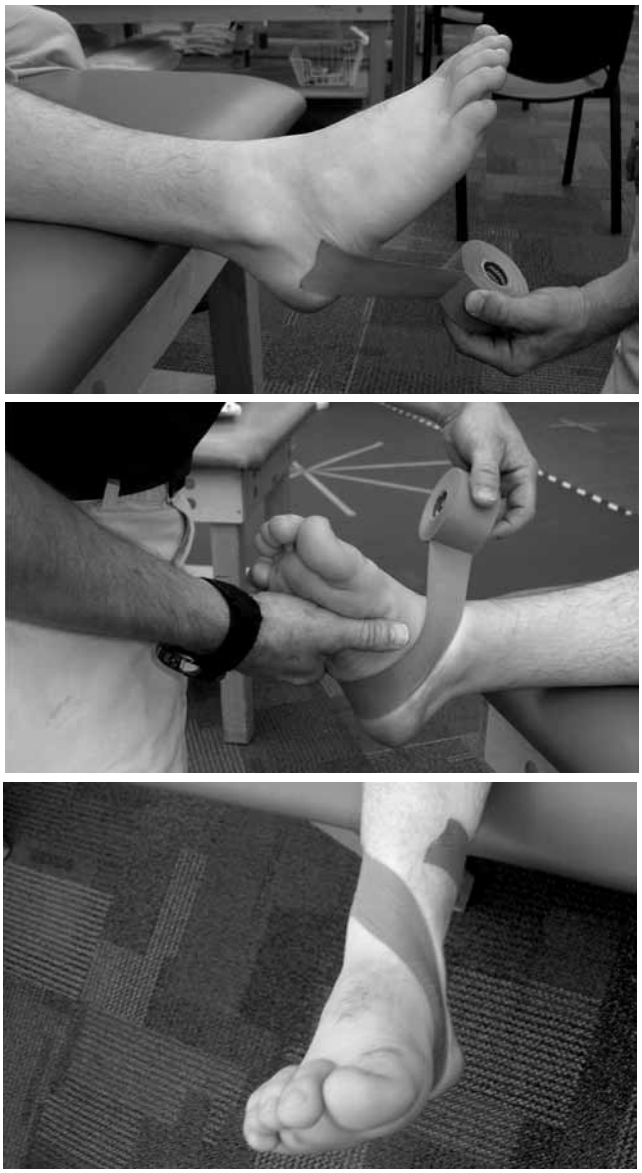

Figure 2. The high-dye navicular lift taping technique.

dorsally, winding laterally across the ankle and continuing to the posteriormedial calf (Figure 2). An emphasis is placed on inverting the calcaneus and lifting the navicular. The taping technique in addition to theoretically maintaining the correct position of the navicular, may also serve as a test to assess if the use of a more permanent foot orthotic device is indicated. A similar use of tape, as a means to evaluate for potential orthotics prescription, has been described.[7,8]

When looking at the available evidence related to manual therapy, much of the literature has focused on the ankle complex with minimal research on techniques distal to the talocrural joint. A review of taping techniques found foot and leg posture could be altered with taping techniques. Specifically, an increase in navicular height, reduction of tibial internal rotation, reduction calcaneal eversion, and increase medial plantar pressure were noted.[9] Muscle activation was also affected with taping as a reduction in peak tibialis posterior and tibialis anterior activity were noted.[9] When specifically researching individuals with plantar fasciitis, a review of literature found minimal evidence to support the use of manual therapy while low-dye taping provided short-term (7 to 10 days) pain relief.[10]

Clinically, we have found decreased pain and increased function following the navicular whip thrust technique and supportive taping strategies. The indications for these interventions include individuals with musculoskeletal foot and ankle related pathology and associated tibialis posterior weakness. Further research is needed to validate the effectiveness of these interventions.

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PerformingArts

SPECIAL INTEREST GROUP

President's Letter

I have learned over the years that there is a difference between taking a vacation and taking a trip. The prior is restful and the latter, while fun, can leave you needing a vacation too! I hope you have the opportunity this summer for reflection and rejuvenation of your mind and soul!

In 2008, the Orthopaedic Section revised the Special Interest Group (SIG) and Education Interest Group policies. SIGs are now required to have only two officers (President and Vice President); the offices of Treasurer and Secretary no longer exist. You will notice this change starting with the fall elections. The budget system was streamlined to provide more efficiency as well as consistency between the SIGs. The new policies also served to clarify procedural items. Thank you to Tom McPoil for his diligence on this document and thank you to the entire Orthopaedic Section Board for updating the policies to help guide the SIGs.

Monthly citation blasts continue thanks to Shaw Bronner, our Research Chairperson; she ***could use your assistance*** by writing up an annotated bibliography. Please contact her at shaw.bronner@liu.edu. If you DO NOT receive this free benefit as a PASIG member, please contact Tara Frederickson (tfred@orthopt.org) to be added to the list.

Keep in mind that the PASIG offers a Student Research Scholarship of $400 to defray the cost of presenting your performing arts research at CSM. More details are found on our website: http://www.orthopt.org/sig_pa.php.

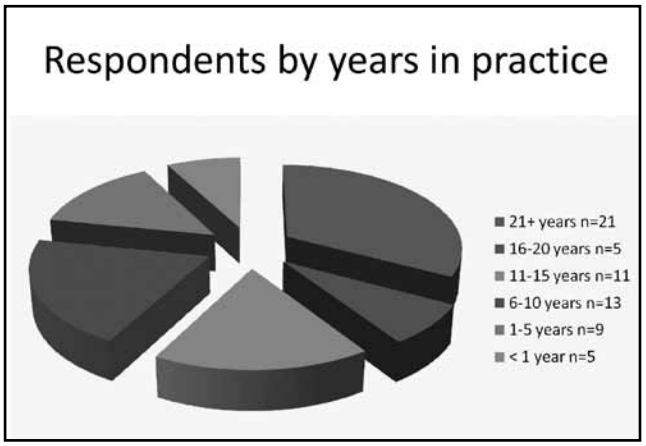
This fall, the PASIG will be electing a new Vice President and two nominating committee members. Sheyi Ojofeitimi (sheyi.ojofeitimi@liu.edu), Nominating Committee Chair, will be coordinating this effort, so ***please consider volunteering***.

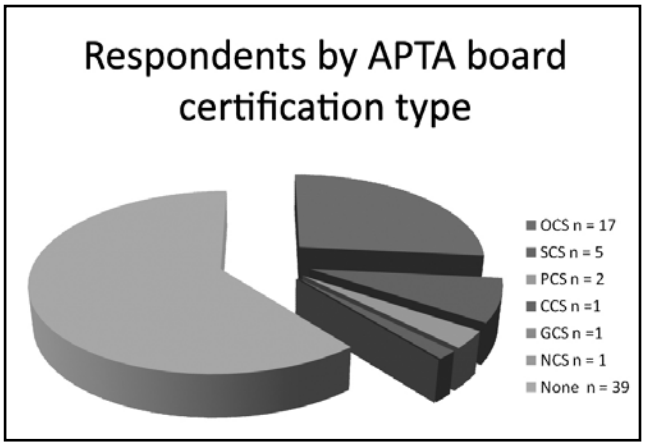
In this issue, I am including a summary of the PASIG survey that was distributed December 2008 – March 2009. The results have provided valuable information that we plan to use for developing a better Web site and meeting your needs. Many thanks to those who took the time to complete the survey; we appreciate learning more about our membership and your feedback has been helpful.

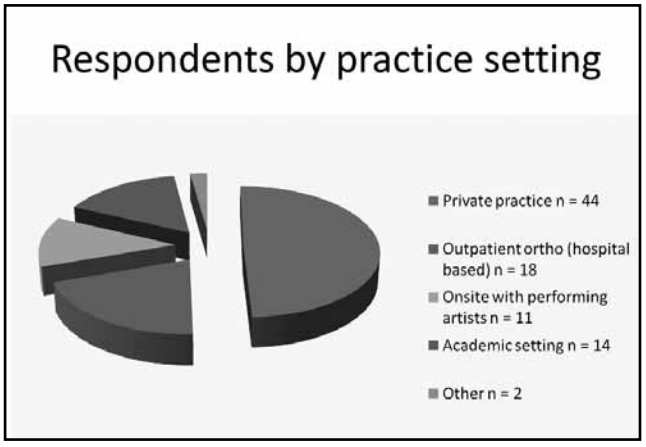
Yours in the arts,
Leigh A. Roberts, PT, DPT, OCS

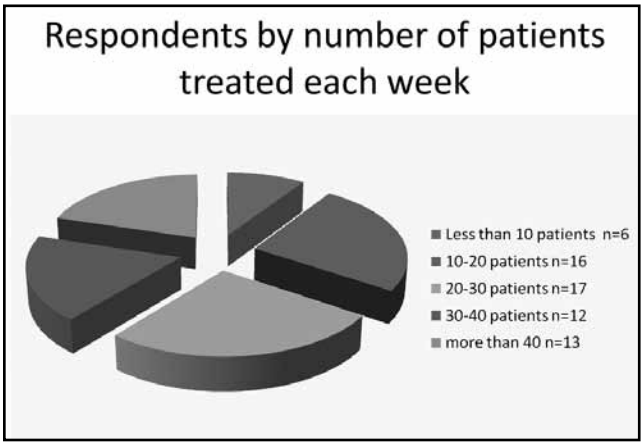
PASIG Membership Survey 2008
N=64 as of 4/9/09
Return rate 8.9%

General information about members



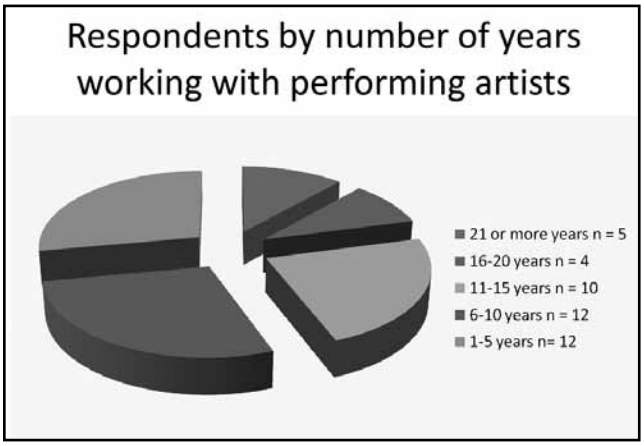


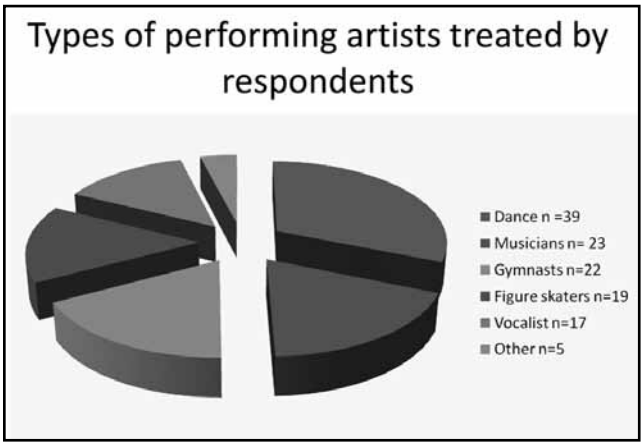




Respondents by acquisition of clinical skills

How skill was acquired	Number of responses
Workshops, seminars, study groups	14 responses
Internship	9 responses
Formal PT residency/fellowship	7 responses
Continuing education	7 responses
On the job experience; self study; conference; in-service peer interaction	0 responses





Performing arts related questions

Other information that we obtained from our respondents

GENERAL INFORMATION REGARDING THE RESPONDENTS

Ninety-two percent of respondents reported an interest in CEU courses offered by PASIG with 68% of them preferring a home study course.

CLINIC/PRACTICE INFORMATION

Thirty percent of the respondents provide performing arts student affiliations.

Thirty eight percent of respondents are interested in a performing arts fellowship program.

PERFORMING ARTS RELATED INFORMATION

Thirty percent of respondents have submitted abstracts to an APTA conference.

Seventeen percent of respondents have published performing arts related papers.

Forty four percent would like assistance in writing research.

PASIG SPECIFIC INFORMATION

Sixty six percent of respondents felt the Web site was useful as 3.7/5.

Eighty six percent of respondents felt the monthly citation blasts were useful as 4.2/5.

PainManagement

SPECIAL INTEREST GROUP

Brain Atrophy Associated with Chronic Pain

John Garzione, PT, DPT, DAAPM

Recently, a patient who complained to her referring physician, that she was not able to be seen in my clinic for 3 weeks due to a patient backlog, was told by her physician "it is not that important, it is only physical therapy." When she was finally seen in my office, she reported that she had chronic unremitting back pain for the past 3 years despite injections, opiates, and physical therapy at 2 other clinics. I then realized that many physicians do not recognize the long-term effects of chronic pain not only physically and emotionally, but cognitively as well. In 2004, Apkarian et al[1] showed that people with chronic back pain had as much as 11% of brain atrophy as compared to normal controls. This amounted to a normal aging process of 10 to 20 years. Other investigators have also reported (2-7) a loss of brain tissue in chronic pain patients who have had various diagnoses. A number of other studies have implicated that people who have chronic pain also had alterations of neurochemistry and central nervous processing of input signals including odors, heat, taste, touch, and emotions.[8-11] Interestingly, was that the pain patients studied did not have confounding factors such as diabetes, stroke, hypertension, posttraumatic stress disorder, or major depressive disorders. Chronic pain patients do not process external stimuli in a normal way which may be because of altered dopamine and opioid availability or a reduction of receptors for these substances in the forebrain.[12-14] For me, these studies put in perspective the work that we do with our patients goes beyond helping with the physical aspects of their lives. Not only did this 26-year-old patient complain of chronic back pain, she complained that she was forgetting more than she used to. Was this related to brain atrophy and/or altered brain neurochemistry? I think so. After an aggressive core strengthening program of 2 hours per visit, 3 visits per week for 8 weeks, nutritional suggestions, and pain control modalities, her back pain decreased and her reported memory deficits also seemed to decrease.

I am not sure if we are able to prevent loss or restore brain tissue in chronic pain patients, but these research findings suggest that with proper treatment and pain reduction we can help decrease altered mental function in addition to improving physical function. It is important; it is physical therapy.

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Iontophoresis for the Treatment of Pain Associated with Chronic Calcified Patellar Tendonitis

Alison Dillemuth, PT and John Garzione, PT, DPT

INTRODUCTION

Patellar tendonitis is a well-described clinical entity caused by repeated stress from contraction of the quadriceps muscle. This can cause inflammation of the tendon, leading to either

tendon degeneration, calcification, or ossification at the tibial tubercle. This condition is normally self limiting, but occasionally can create persistent anterior knee pain. The standard of care for this discomfort in adults is ice, anti-inflammatory medications, and relative rest. Surgical debridement of the intratendinous tissue has been described for recalcitrant cases.[1]

The use of iontophoresis to decrease pain and inflammation is not a new procedure to physical therapists. The choice of which drug to use in iontophoresis, however, presents a challenge. The 3 major classifications of nonsteroidal anti-inflammatory agents which can be used with iontophoresis are: Salicylates (Salicylic Acid), Proponic Acids (Ketoprofen), and Indo Acetic Acids (Acetic Acid).[2] Typically, if a patient does not have a favorable response to one NSAID classification, a change to another classification will cause a desired response. Acetic Acid has been postulated as a medication that aides resorption of calcifications such as myositis ossificans, heel spurs, systemic sclerosis-related calcinosis, and calcific tendonitis. Four articles/case studies showed a reduction in calcifications, as seen on x-ray, using a combination of acetic acid iontophoresis, electrical stimulation, and/or pulsed ultrasound[3-6] while another study showed no appreciable change in the size of the calcification with the treated group as compared to an untreated control group.[7] A common thread in the majority of the articles describing the use of iontophoresis with Acetic Acid was pain relief. There have been no articles published, known to the authors, that have studied iontophoresis for pain relief and/or reduction of an ossification associated with chronic calcified patellar tendonitis in an adult.

CASE STUDY

Patient was a 49-year-old female who was referred to Physical Therapy with a diagnosis of chronic left patellar tendonitis with ossification at the tibial tubercle. She was alert, well-oriented, and took no medications. Her range of motion, strength, and sensation of the left lower extremity were within normal limits throughout. She described her pain at the distal patellar tendon as 9/10 on the Visual Analogue Scale (VAS) with deep palpation or kneeling. The Visual Analog Scale (VAS) is a 10 centimeter line, the length of which is taken to represent a continuum of a painful experience. It is a single instrument that enables the subject to express the extent of his pain in such a way that it can be given a numerical value. There is a very high correlation between successive measurements of pain severity on a VAS, confirming the reproducibility of this method. This tool is widely used in clinical trials to establish the value of a given treatment.[8] The patient worked as a per diem Physical Therapist, exercised on a ski simulator 30 minutes 3 to 5 days a week and participated in Yoga class 1 hour a week. She continued this exercise regime throughout the course of physical therapy. Treatment consisted of iontophoresis with 4% Acetic Acid for 78 mA*min. TIW to the tibial tubercle with the indifferent (positive electrode) placed at the superior lateral ipsilateral thigh. This dosage was selected per Ciccone's[9] report that the average dosage which produced successful outcomes was 78 mA* of iontophoresis with Dexamethasone and Lidocaine. Even though Dexamethasone was not used in this case study, we felt that 78 mA*min was an appropriate starting current dose. After 15 treatments, a one month follow-up X-ray did not reveal a change in size or consistency of the bony deposit at the tibial tubercle, but her pain was decreasing. The protocol was continued to investigate whether the calcification could be dissolved with further treatment. A second follow-up X-ray was taken at 3 months (45 treatments) with no noted change in the bony deposit. She had reached a functional plateau with consistent 2/10 pain to palpation, and the ion was changed to 10% Ketoprofen at 78 mA*min. Ketoprofen is a nonsteroidal anti-inflammatory drug in the Proponic Acid classification. This drug was shown by Panus[10] to be successfully iontophoresed into the first centimeter of muscle through pig skin. After 5 treatments, her pain level ranged from 1 to 2/10 with kneeling and deep palpation. Two treatments later, her pain was 0/10 with kneeling on tile and remained at that level at 10 months follow-up.

CONCLUSIONS

Although no firm conclusions can be made from one case study, this illustrates that iontophoresis is a viable treatment for chronic patellar tendonitis with calcification even without a reduction of the calcification. This study additionally supports that when one anti-inflammatory ion has reached its maximum benefit, another ion from a different classification can be implemented to cause a desired response for continued patient improvement.

ACKNOWLEDGMENTS

The authors would like to thank Greg Vance for his suggestions and compounding the iontophoresis solutions as well as Donna Lucarini from Empi, Inc who provided the electrodes, and the loan of the Dupel unit. We would also like to especially thank Dr. Samer Tawakkol who performed the X-rays and provided invaluable support for this case study.

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Alison Dillemuth, PT was a PRN Physical Therapist working at West Houston Medical Center when this article was written. She now lives with her husband and 2 children in Shanghai, China.

SPECIAL INTEREST GROUP

Summer/Fall 2009 Practice Analysis Update

Amie Hesbach, MSPT, CCRP, CCRT, ARSIG, President

I was reminded recently that I continue to refer to the ARSIG Practice Analysis. So some ask, "What the heck is a Practice Analysis?" and "Why is the ARSIG doing one?"

Further information about Practice Analyses, especially with regards to developing Postgraduate Clinical Residency and Fellowship Programs, is found on the APTA Web site. An excellent answer to our first question, "What is a practice analysis?," is found here. "A practice analysis is a systematic plan of study of the professional practice behaviors and knowledge that comprise a specialty area of practice. The purpose of the practice analysis is to collect data that reliably and accurately describes what knowledge and skills are necessary to practice in a given area of specialization."

Steps in the Practice Analysis "process" that have been completed by the ARSIG include:

1. Indentify a practice analysis coordinator.
2. Develop the pilot survey.
3. Field test the pilot survey.
4. Analyze pilot data.
5. Revise the survey, if necessary.
6. Submit the revised survey to the Committee.
7. Conduct the practice analysis survey.

Our "next steps" are:

8. Analyze the practice analysis survey results.
9. Interpret practice analysis survey results.
10. Submit the full technical report to the Committee.

The process, we're finding, is slow but deliberate, and, overall, very exciting. We hope that the results of our Practice Analysis will be published in the near future and cited in future animal rehabilitation/physical therapy educational and legislative plans. We are indebted to our National Advisory Group as well as those who tested our pilot survey. We'll certainly keep you up to date on our progress.

NEVADA REGULATORY UPDATE

Thanks to Robyn Roth, PT, MPA, APT (http://www.sugarlandranch.org)

https://www.nvvetboard.us/GLSuiteWeb/HomeFrame.aspx

NRS 638.008 "Practice of veterinary medicine" defined. "Practice of veterinary medicine" means:

1. To diagnose, treat, correct, change, relieve, or prevent animal disease, deformity, defect, injury, or other physical or mental conditions, including, but not limited to:
   (a) The prescription or the administration of any drug, medicine, biologic, apparatus, application, anesthetic or other therapeutic or diagnostic substance or technique;
   (b) The collection of embryos;
   (c) Testing for pregnancy or for correcting sterility or infertility;
   (d) Acupuncture;
   (e) Dentistry;
   (f) Chiropractic procedures;
   (g) Surgery, including cosmetic surgery; or
   (h) Rendering advice or recommendation with regard to any of these.
2. To represent, directly or indirectly, publicly or privately, an ability and willingness to do any act described in subsection 1.
3. To use any title, words, abbreviation or letters in a manner or under circumstances which induce the belief that the person using them is qualified to do any act described in subsection 1, except if the person is a veterinarian.

(Added to NRS by 1989, 536; A 1995, 1676)

https://www.nvvetboard.us/GLSuiteWeb/HomeFrame.aspx

Nevada Administrative Code (NAC 638)

ANIMAL PHYSICAL THERAPY

638.750 "Animal physical therapy" defined.
638.760 Requirements to practice; application for certificate of registration; fee.
638.770 Expiration and renewal of certificate; fee.
638.780 Standards of practice for physical therapist holding certificate; maintenance of records.
638.790 Disciplinary action.

ANIMAL PHYSICAL THERAPY

NAC 638.750 "Animal physical therapy" defined. (NRS 638.070) As used in NAC 638.750 to 638.790, inclusive, "animal physical therapy" means the rehabilitation of injuries in a nonhuman animal through the use of the following techniques, but does not include animal chiropractic:

1. Stretching;
2. Massage therapy;
3. Rehabilitative exercise;
4. Hydrotherapy;
5. Application of heat or cold; and
6. Stimulation by the use of:
   (a) Low-level lasers;
   (b) Electrical sources;
   (c) Magnetic fields; or
   (d) Noninvasive therapeutic ultrasound.

(Added to NAC by Bd. of Veterinary Med. Exam'rs by R009-04, eff. 4-26-2004; A by R091-06, 11-13-2006)

NAC 638.760 Requirements to practice; application for certificate of registration; fee. (NRS 638.070)

1. A person shall not practice animal physical therapy in this State unless he is:

(a) A veterinarian;
(b) A licensed veterinary technician who complies with the provisions of NAC 638.053; or
(c) A physical therapist who has obtained a certificate of registration pursuant to this section and complies with the provisions of NAC 638.780.

2. A physical therapist who desires to secure a certificate of registration to practice animal physical therapy in this State must make written application to the Board.
3. The application must be on a form provided by the Board, include any information required by the Board and be accompanied by satisfactory proof that the applicant:
(a) Is of good moral character;
(b) Has been an active licensed physical therapist in this State for at least 3 years;
(c) Is in good standing with the State Board of Physical Therapy Examiners;
(d) Has successfully completed at least 100 hours of instruction or course work, or a combination of both, in the area of animal physical therapy, which must include, without limitation, assessment and planning of treatment, behavior, biomechanics, common orthopedic and neurological conditions, comparative anatomy, neurology, and therapeutic modalities and exercises; and
(e) Has completed at least 125 hours of supervised clinical experience in animal physical therapy with a licensed veterinarian.
4. The application must be signed by the applicant, notarized and accompanied by a fee of $50.
5. Except as otherwise provided in NAC 638.790, upon receipt of the application and information required by subsection 3 and payment of the fee, the Board will issue to the physical therapist a certificate of registration.

(Added to NAC by Bd. of Veterinary Med. Exam'rs by R009-04, eff. 4-26-2004; A by R075-06, 11-13-2006)

NAC 638.770 Expiration and renewal of certificate; fee. (NRS 638.070)

1. Each certificate of registration issued pursuant to NAC 638.760 or renewed pursuant to this section expires on January 1 of each year.
2. Each application for renewal of a certificate of registration must be:
(a) Submitted in the form established by the Board;
(b) Signed by the physical therapist and accompanied by a renewal fee of $25;
(c) Accompanied by proof that the physical therapist completed, during the 12-month period immediately preceding the beginning of the new registration year, at least 5 hours of continuing education in animal physical therapy approved by the Board; and
(d) Accompanied by proof that his license as a physical therapist in this State is active and that he is in good standing with the State Board of Physical Therapy Examiners.
3. A physical therapist who fails to renew his certificate of registration before it expires forfeits his certificate of registration.
4. Except as otherwise provided in NAC 638.790, upon receipt of the application for renewal and the information required by subsection 2 and payment of the renewal fee, the Board will renew the certificate of registration of the physical therapist.

(Added to NAC by Bd. of Veterinary Med. Exam'rs by R009-04, eff. 4-26-2004)

NAC 638.780 Standards of practice for physical therapist holding certificate; maintenance of records. (NRS 638.070)

1. A physical therapist who has been issued a certificate of registration pursuant to NAC 638.760 may practice animal physical therapy only:
(a) Under the direction of a veterinarian licensed in this State who has established a valid veterinarian-client-patient relationship concerning the animal receiving the animal physical therapy before the animal physical therapy is performed; and
(b) If the physical therapist assumes individual liability for the quality of the animal physical therapy performed.
2. The veterinarian under whose direction the physical therapist performs the animal physical therapy:
(a) Is not required to supervise the physical therapist during the animal physical therapy.
(b) Is not liable for the acts or omissions of the physical therapist who performs the animal physical therapy.
3. Each physical therapist who has been issued a certificate of registration shall:
(a) Maintain in this State for at least 4 years a separate written medical record of each animal receiving animal physical therapy from the physical therapist.
(b) Within 48 hours after the initial visit with the animal, mail or transmit by facsimile machine a complete copy of the medical record to the veterinarian under whose direction the physical therapist performs the animal physical therapy.
(c) Within 48 hours after each subsequent visit with the animal, mail or transmit by facsimile machine a progress report to the veterinarian under whose direction the physical therapist performs the animal physical therapy.
4. The veterinarian shall include the copy of the medical record received pursuant to subsection 3 in the medical record required pursuant to NAC 638.0475. The written medical record must include, without limitation:
(a) The name, address and telephone number of the owner of the animal;
(b) The name or identifying number, or both, of the animal;
(c) The age, sex and breed of the animal;
(d) The dates of care, custody or treatment of the animal;
(e) The results of a basic rehabilitation examination related to physical therapy;
(f) The diagnosis and treatment plan related to physical therapy recommended by the physical therapist for the animal; and
(g) The progress and disposition of the case.

(Added to NAC by Bd. of Veterinary Med. Exam'rs by R009-04, eff. 4-26-2004)

NAC 638.790 Disciplinary action. (NRS 638.070)

1. A violation of a provision of chapter 638 or 640 of NRS or a regulation adopted by the State Board of Physical Therapy Examiners or the Nevada State Board of Veterinary Medical Examiners is a ground for disciplinary action.

2. If the Nevada State Board of Veterinary Medical Examiners determines that an applicant for a certificate of registration pursuant to NAC 638.760 or a physical therapist who has been issued a certificate of registration pursuant to NAC 638.760 has committed any act which is a ground for disciplinary action, the Board may:
   (a) Refuse to issue a certificate of registration;
   (b) Refuse to renew a certificate of registration;
   (c) Revoke a certificate of registration;
   (d) Suspend a certificate of registration for a definite period or until further order of the Board;
   (e) Impose a fine in an amount not to exceed $10,000 for each act that constitutes a ground for disciplinary action;
   (f) Place a physical therapist who has been issued a certificate of registration on probation subject to any reasonable conditions imposed by the Board, including, without limitation, requiring courses in continuing education or a periodic or continuous review of his animal physical therapy practice;
   (g) Administer a public reprimand;
   (h) Require the physical therapist who has been issued a certificate of registration to take a competency examination or a mental or physical examination; and
   (i) Require the physical therapist who has been issued a certificate of registration to pay all costs, including, without limitation, attorney's fees, incurred by the Board in taking disciplinary action against him.

(Added to NAC by Bd. of Veterinary Med. Exam'rs by R009-04, eff. 4-26-2004)

USE OF CLINICAL REASONING PATHWAY FOR A CANINE PATIENT

Lisa Bedenbaugh, PT, CCRP

The following case presented to our clinic with a diagnosis of hip dysplasia. The patient was a 9-month-old male, neutered English Bulldog with a 5 to 6 week history of intermittent lameness. The owner took her dog to her regular veterinarian, who performed radiographs of both hips/stifles and shoulders/elbows, and gave a diagnosis of hip dysplasia. They recommended starting dog on a glucosamine supplement, reducing his weight, and taking him on regular walks to maintain strength. The owner sought out our rehabilitation services, as she wanted to see if there were any other non-surgical options to keep symptoms minimized, due to his young age.

A subjective history of the complaint was taken from the owner. She states that the dog began about 5 to 6 weeks ago with intermittent limping and decreased interest in going for his daily walk, or just sitting and refusing to go farther than a certain distance. She also noticed he would have trouble on occasion with stairs. She denied any known trauma or injury to the dog.

At time of evaluation, radiographs were examined with the assistance of a fourth-year veterinary student. The left femoral head was slightly more than 50% exposed outside the acetabulum, but otherwise, the radiographs were unremarkable. Passive range of motion was found to be normal in all joints, although the dog did display some discomfort with end-range shoulder extension on the right. Ortolani sign was negative bilaterally; no patellar luxations palpable. Neurological exam was unremarkable, but the dog did display slight atrophy along the caudal aspect of the right shoulder. Gait pattern was found to be quite asymmetrical in the front limbs, with increased external rotation noted in bilateral shoulders, especially on the right. The dog would extend his shoulder well to advance limb, but would not fully flex the shoulder or elbow through the stance phase. Initially, the dog presented similar to an elbow dysplasia case, but further palpation and range of motion testing revealed no motion limitations or pain with manual testing of either limb. Gait pattern appear normal in bilateral hind limbs, with good hip extension through stance phase, and no increased lumbar lateral flexion with swing phase.

Dog was placed in the underwater treadmill, and manual assistance was given to rotate shoulder into a more neutral position. Once manual stabilization was given, the dog showed a much more normalized gait pattern, so it was reasoned that the problem was due to muscle weakness/imbalance versus a joint or biomechanical problem.

A problem list was drawn up and included: increased shoulder external rotation in standing and walking; decreased shoulder and elbow flexion while walking; mild atrophy over caudal portion of right shoulder, mild tenderness to palpation and trigger points palpable in caudal portion of deltoid and proximal triceps.

Miller's Guide to Canine Anatomy was referenced, to determine which muscles are used for the actions of shoulder flexion and internal rotation, since these were the motions lacking during gait with this animal. Deltoideus is the primary shoulder flexor, and teres major medially rotates the shoulder. Both muscles are innervated by the axillary nerve. An injury to this nerve would cause weakness to both muscles as well as explaining the localized area of atrophy noticed along the caudal portion of the shoulder. The owner was further questioned regarding any type of injury the dog may have sustained to that shoulder, and she reported that she had once picked the dog up by the front limbs, in the axillary area and that he had limped for a day or so after the incident, but seemed to improve over the next 2 days. The owner did state that after that incident was when she started to notice the dog limping more, but that he had occasionally shown some lameness prior to that incident.

The owner was educated in a home exercise program including dynamic weight shifting over front limbs, to develop dynamic stability for the shoulder, massage to caudal shoulder musculature, instruction in passive shoulder extension range of motion exercises, and it was also suggested that she use a front "Walkabout" sling, due to his difficulty completing his daily walks. This was thought to provide some support, so that he could walk a little farther before becoming fatigued, and thus be able to increase his endurance. A sling was fit for the dog, and when slight assistance was given to support his front end weight, the sling also provided a little abduction and internal rotation due to the fit of the sling around his shoulder. This allowed for a much more normalized gait pattern.

A written copy of our findings was sent to the referring veterinarian. In addition, a recommendation was made to the owner that the dog be seen by a veterinarian at our clinic who practices holistic medicine, for possible acupuncture treatment, in order to assist with stimulation of the axillary nerve pathway. We recommended following up with another rehabilitation appointment in 1 to 2 weeks, in order to review home exercise program with owner and modify as necessary, as well to continue work on dynamic stability and strengthening exercises.

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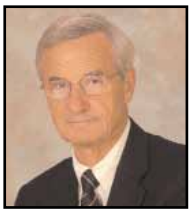

Stanley V. Paris, PT, PhD, FAPTA

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E1 - Extremity Evaluation and Manipulation
30 Hours, 3.0 CEUs (No Prerequisite)
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Washington, DC . . . . . Busby . . . . . Aug 6 - 9
Grand Rapids, MI . . . . . Naas . . . . . Aug 13 - 16
St. Petersburg Beach, FL Turner . . . . . Aug 13 - 16
Baton Rouge, LA . . . . . Baldwin . . . . . Aug 27 - 30
Seattle, WA . . . . . Turner . . . . . Sep 17 - 20
Ft. Lauderdale, FL . . . . Naas . . . . . Nov 5 - 8
Chicago, IL . . . . . Busby . . . . . Nov 5 - 8
St. Augustine, FL . . . . . Patla/Baldwin . . Nov 19 - 22

The Older Adult with a Neurological Impairment
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Chicago, IL . . . . . Decker . . . . . Jul 23 - 26
San Diego, CA . . . . . Decker . . . . . Oct 15 - 18

CF 2: Intermediate Cranio-Facial
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Atlanta, GA . . . . . Conrad . . . . . Aug 28 - 30
Baltimore, MD . . . . . Patla . . . . . Oct 9 - 11
Boston, MA . . . . . Patla . . . . . Nov 13 - 15
Columbus, OH . . . . . Conrad . . . . . Nov 20 - 22

Applied Musculoskeletal Imaging for Physical Therapists
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Advanced Manipulation Including Thrust of the Spine & Extremities
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Boston, MA . . . . . Nyberg . . . . . Oct 31 - Nov 1
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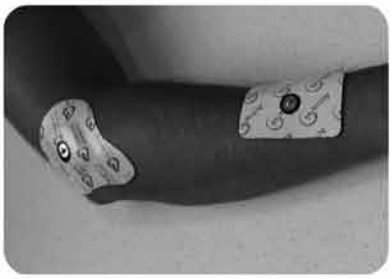

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