ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

THE MAGAZINE OF
THE ORTHOPAEDIC SECTION, APTA

VOL. 17, NO. 2 2005

ORTHOPAEDIC SECTION
PRACTICE EDUCATION RESEARCH
AMERICAN PHYSICAL THERAPY ASSOCIATION

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ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

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- enhancement of clinical practice,
- advancement of education, and
- facilitation of quality research.

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Orthopaedic Physical Therapy Practice (ISSN 1532-0871) is the official magazine of the Orthopaedic Section, APTA, Inc. Nonmember subscriptions are available for $30 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 Practice is indexed by Cumulative Index to Nursing & Allied Health Literature (CINAHL).

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

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Editor's Corner
Technology: Help or Hindrance??

"Important questions need to be adequately answered in our own minds before we 'leap' into using new technology."

I think we have all been there. A new piece of technology, whether it be something we can use clinically or something we might want to use in every day life, comes out and immediately the question becomes…..Will this product make my life better? What will the learning curve be and is it really worth the time?

Can the device be used to solve problems or will it only create problems? Cell phone technology has literally changed a generation and continues to be exploited. However, technology brings with it a double-edged sword. In one instance a cell phone can save a life when we are in need of assistance but it can also be a hazard when used while driving.

Important questions need to be adequately answered in our own minds before we 'leap' into using new technology. This is especially true in the clinic. Clinicians tend to be creatures (sorry about that) of habit. We find a comfort zone and we tend to be very loyal to the endeavor whether it is our methods on evaluating a patient or when we administer treatment.

Every year the exhibit hall at Annual Conference is filled with so called 'hot' items that promise 'utopia' and can solve many of our dilemmas and obstacles in providing care. Some promise to give us an edge in making the patient better quicker while others promise to save us time or money. I am sure most of us can identify with some of the previous 'new' pieces of technology that have 'run their course' and now just sit in the corner of the clinic collecting dust and taking up space. With profit margins becoming increasingly lean, the purchase of any piece of new equipment or technology becomes an important factor to consider. Can a piece of technology really help us become a better clinician and assist us in providing the best patient care? How much of what is fed to us by vendors and advertisements is more smoke and mirrors than actual progress? Also can the technology be abused by the user through the propagation of false claims and unrealistic expectations that lack scientific merit? Harris outlined 6 specific criteria for evaluating the scientific merit of a new (or existing) therapy approach.[1] Even though Dr Harris' focus was on evaluating treatment, the same logic can be applied to the use of technology. Therapists need to develop a logical evidence based decision making process when investigating technology. Just like anything else technology still relies on proper use and the utility still rests with the user who ultimately determines…When to use, how to use, and how to interpret the results.

Our current issue focuses on the use of technology in the clinical setting. Each author has attempted to find answers to various questions by using technology to help in finding answers. Can ultrasound be an effective diagnostic tool in diagnosing musculoskeletal injuries? Is it a cost-effective alternative to current technology such as MRI? Can electromyographical analysis shed light on helping clinicians determine the effects of various modes of exercise on muscle activation? Finally, can motion analysis help us in improving a runners gait to reduce injury and improve efficiency?

My thanks and appreciation go out to authors Teddy Worrell and Ron Olson and also Irene Davis-McClay for contributing to this edition of *OP*. The Editors at *OP* intend to run more 'theme issues' in the future. If you have any ideas on topics you would like to see presented, feel free to contact me or Managing Editor, Sharon Klinski. We would be happy to hear from you!

REFERENCE

1. Harris SR. How should treatments be critiqued for scientific merit? *Phys Ther.* 1996;76:175-181.

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President's Message

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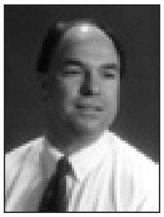

Getting your DPT, a Means of Contributing to your Profession

I hope that by the time this issue of *OP* is in your hands, I will have my DPT degree. I will be ready for a nice glass of pinot or a Boston beer to celebrate while at APTA's Annual Conference and Exposition. A number of people have asked why I went back for my DPT. It's the same reason I gave when I went back for my Masters, to improve myself as a physical therapist. Back in 1978, I surely did not enter physical therapy for the money; when I graduated, my starting salary was little over $11,000 a year, not what you call good money even back then. Money was never a motivating factor—not now nor back then. I was taught that the important things in life are gained through hard work. Satisfaction from trying your best, wisdom learned from enduring the hardships that often accompanies life, honesty, trust, loyalty, caring, and finally making a contribution. Having great ambition in life is fine and well, however, having success in life, without also contributing, is living a life without meaning. What do I mean by contribution? Contribution can be defined in many ways. It also depends on what you are referring it to—here it's about contributing to your profession. The late Dr. Steven Rose was a great role model and teacher at Washington University in St. Louis; his idea of contribution was very basic. Contribution was doing something that made our profession better. Steve, of course, besides being a physical therapist was a true scientist, so contribution to him usually meant providing some evidence for physical therapist practice. As a full professor, Steve would often go to manual therapy continuing education courses with youngsters like me to learn what therapists were learning. Steve, whose boundless enthusiasm and curiosity, would often ask what is the evidence or rationale for the specific interventions that were being taught. Remembrances like that keep me constantly asking what is the evidence or proof for doing the things we do. Also, it did not matter if you were writing about clinical practice in a case report or providing evidence for physical therapy diagnosis or treatment, what mattered to Steve was that you were contributing to physical therapy by providing evidence. Dr. Rose also realized that contribution could be defined in many different ways. Contribution didn't have to be in just research; it could have been in legislative efforts, or in physical therapy education or practice. Contribution is giving back to your profession, doing something that helps not just a person but what is good for the whole.

"Contribution is giving back to your profession, doing something that helps not just a person but what is good for the whole."

What does getting a DPT have to do with contribution? By getting a DPT, I am contributing my part to the profession by accepting and supporting physical therapy as an evidence-based profession. Evidence-based practice is here to stay; in fact it should always have been with us. Clearly ahead of their time in 1987, Mueller and Rose wrote that physical therapists should understand and apply logical explanations for the evaluations and treatments we administer (Mueller MJ, Rose SJ. Physical therapy director as professional value setter. *Phys Ther*. 1987; 67:1389-1398). It sounds like they were advocating evidence-based practice back then. They also suggest that physical therapists should take an inquisitive and innovative approach with each patient. Mueller and Rose also suggest that therapists should not only be up-to-date on the literature but contribute to the body of knowledge of literature in physical therapy. They argue that "clinical research is no different than good clinical practice." *The growth of physical therapy depends on good research, which in turn depends on good clinical practice.* As Muller and Rose emphasize we must be engaged in constant evolution of our skills. What better way is there to improve our clinical skills and improve our clinical practice than getting a DPT?

Getting a DPT is a commitment to professional growth. The investment of time, money, and the hard work often insures that we will take pride in our profession and stay involved. I also believe by getting a DPT we will also create more ownership in our profession. When we really work hard for something, we don't easily like to give up what we have attained. Thus, we must make the DPT something to grasp for, but also something that can be within our reach. Too hard and we will not get therapists to try, too easy and we won't accept the value that goes with the title. Will the DPT really change practice? Only time will tell. By us accepting the challenge of getting a DPT, we will insure that our profession will grow in the right direction. I believe our increased acceptance of the ownership of our profession will stimulate new growth, new ideas, new research, and with it new growth in practice. Eventually with growth in practice, our esteem and value will be elevated, not just by the physicians that send us patients but by the patients themselves. Physicians did not get their direct access from some higher source, they were granted access by the public. This same public is whom we must court to receive our access. The best way to court them is to show them through best practice how we can diagnose, prognose, and treat those movement disorders/conditions/problems that we commonly see. If we are successful at this, we should have no problem attaining a rightful place as primary care health professionals; if we are not successful, we must judge if we deserve a place at all.

Our profession is made up of many parts and the many parts or individuals make up the whole. The strength of our profession depends on each individual part being as strong as possible. The more of us that get our DPT degree the more we will provide further impetus for others to get their DPT—not because we have to get our DPT, but because we want to get our DPT. This sort of fever could be infectious. Wouldn't that be grand?

Finally, the knowledge gained from the course work in a DPT program is not just intended for one self—but should also be used for others. The 'others' in this case are all of those students or patients that we teach or treat. I believe physical therapy has no place for a 'just me' thinking therapist. The knowledge gained, not the titular DPT degree, is the true reward after all of the years of hard work. Knowledge can and often does unlock new doors; it can make the difference between poverty and prosperity and between happiness and ennui. For many, getting a DPT is a personal thing. Having a DPT degree means I care about the physical therapy profession and the direction it is going, it means I made a positive choice to use and enrich my talent. It also means as a person I agree with the vision and direction that APTA has provided, and finally it means that I will continue to do my best at making a lasting and seminal contribution to this profession. I am happy to see our profession continue its growth. For all of those who decide not to get their DPT, please don't take this message as disrespectful to you. I respect your decision. I don't believe that the DPT will be a shibboleth dividing us in two but will be one that really unites us as a profession.

I would like to end this Presidents Message with a special Thank You to Joe Black, PhD who is retiring after many years as Senior Vice President at APTA. Joe has been the fuel behind the push for the DPT; his perspicacity and persistence in helping us understand the recondite reasons of why we need to move on to the doctorate level will pay untold dividends for all future physical therapists. Joe, I hope your retirement is one of happiness and joy. Thank you again.

Gait Retraining in Runners

Irene S. Davis, PT, PhD, FACSM

Running is a popular fitness activity with over 15 million Americans engaging in the sport. Due to its aerobic nature, it has tremendous cardiovascular benefits. However, it is a sport that also involves repetitive loading. For example, a typical runner will strike the ground approximately 1000 times per mile with each foot. Therefore, even minor malalignments and/or abnormal movement patterns can accumulate into an overuse injury. In fact, it has been reported that 50% to 87% of runners will sustain an injury over a one-year period. With 15 million runners in the United States, the number of running related injuries is in the millions. This is associated with substantial medical costs. In addition, cessation of running as a fitness activity can impact one's overall fitness level. The Healthy People 2010 initiative has linked one's fitness level with longevity and productivity.

The etiology of running injuries is multifactorial and each runner has their own threshold for injury. This threshold is dependent on their structure, their mechanics, and their dosage. These factors are interactive and determine how close one functions to their injury threshold. For example, one runner may have poor structural alignment resulting in abnormal mechanics, but only run 10 miles per week. They may continue to run uninjured until they decide to increase their dosage and train for a half-marathon. This increased dosage, in concert with their poor structure and mechanics, may now place them at or above their injury threshold. On the other hand, another runner may have excellent alignment and mechanics, but run ultramarathons, placing him or her at their injury threshold. Therefore, these factors can interact in numerous ways.

While some aspects of structure, such as flexibility, can be altered, basic anatomy is considered relatively unchangeable. Of the 3 factors described, dosage is clearly the most modifiable. However, runners become accustomed to certain running dosage, typically measured by miles run per week. They are reluctant to significantly reduce this mileage as they

“The etiology of running injuries is multifactorial and each runner has their own threshold for injury.”

feel they lose the conditioning effects of the exercise. This leaves mechanics which are also modifiable. It is generally believed that mechanics play a significant role in the development of running related injuries. Therefore, altering these mechanics should help to reduce injury risk. In addition, if one has already sustained an injury thought to be related to their mechanics, the risk for reinjury is high unless these mechanics are altered.

The idea of altering one's movement patterns is not new. Therapists are trained to alter abnormal patterns in their patients to reduce injury risk. They do this in their daily practice. For example, they often train their patients to change the manner in which they lift objects in order to reduce spinal loads. However, gait is often thought of as an automatic skill that some believe is driven by central pattern generators. Therefore, the notion that these automatic actions can be changed through conscious thought is often questioned. However, if we believe that movement patterns can be changed, then there is some hope that gait patterns also can be changed to help reduce injury risk.

There is emerging evidence in the literature that kinematic adaptations are indeed possible through neuromuscular reeducation. A recent study by Hewett et al[1] reported lower extremity mechanics during landing from a jump could be significantly altered through a plyometric training program. The program was designed to teach athletes to land softer and with better lower extremity alignment. Reductions in ground reaction forces and knee moments were noted. In a follow-up study, these same authors reported a significant reduction in serious knee injuries among female athletes who had undergone this training program.[2]

Gait may be more difficult to alter given its repetitive and automatic nature. However, there have been numerous reports in the literature documenting the success of using some type of real time feedback training to alter walking gait. The majority of these report on patients with neurologic involvement, such as adults who have sustained a stroke or children with cerebral palsy. The earliest forms of feedback were limb load monitors placed within the shoe of a patient.[3-5] The aim of this type of feedback was to produce an equal load distribution between lower extremities during gait. Electromyography is one of the most widely used forms of feedback reported in the literature. Reports of improvements in gait symmetry in terms of spatio-temporal parameters and joint motion patterns have been reported.[6-10] Feedback on joint angles has been provided through the use of electrogoniometers for patients with genu recurvatum.[11-13] An overwhelming majority of these studies have reported successful results.

Reports of real-time feedback training are beginning to emerge in the orthopaedic literature. White et al[14] first demonstrated that providing real time visual feedback from an instrumented treadmill could be used to train healthy individuals to exhibit asymmetrical limping strategies. Using the same protocol, they then provided real time feedback, 3 times a week for 8 weeks, to patients who had undergone a hip replacement.[15] They reported a significant improvement in symmetry of reaction forces at weight acceptance. In a related study, Dingwell[16] used an instrumented treadmill to improve the gait of a group of unilateral, trans-tibial amputees. Prior to the training, asymmetries in the measured parameters were 4.6 times greater in the amputee group compared to the control group. These asymmetries were significantly reduced following the training.

However, studies involving feedback during running are sparse. Messier et al[17] provided verbal and visual feedback to a group of female novice runners over a 5 week, 3 sessions per week, running program. Prior to each training session, runners were shown a videotape of their running and were instructed on the features of their gait that they were to try to modify. These were subject-specific mechanics and included characteristics such as excessive vertical oscillation, over-striding, excessive trunk lean, and excessive arm rotation. This group of runners significantly altered the desired kinematic gait variables compared to a control group who received no feedback prior to their training sessions. While this study did not involve the use of real-time feedback, it demonstrates that runners are able to alter their mechanics with training.

Prior to making changes in one's movement patterns, it is important to identify those patterns that are to be related to injury. This can only be done through prospective investigations. We have been engaged in prospective studies to identify biomechanical factors associated with stress fractures, as well as those associated with anterior knee pain. Both of these injuries are among the top 5 most common injuries that runners sustain.[18] In addition, females are at least twice as likely to sustain these injuries compared to their male counterparts. Therefore, our prospective studies were focused on female runners between the ages of 18 and 45 years. In order to eliminate the influence of fitness in our study, all subjects had to be running a minimum of 20 miles per week. Following the instrumented gait analysis, runners are followed monthly for a period of 2 years. Running mileage, as well as any injuries that are sustained are reported. Our preliminary data suggests that female runners who go on to develop a stress fracture exhibit significantly higher peak tibial shock, as well as increased vertical loading rates compared to a group of uninjured age and mileage matched group. Runners who go on to develop anterior knee pain exhibit increased hip adduction and internal rotation. These findings provide the rationale needed to alter these mechanics in runners.

We began our realtime feedback training with the use of a treadmill and a mirror. We have since further developed our realtime feedback to include realtime accelerometry and realtime motion analysis feedback. The following preliminary and case studies will hopefully demonstrate how realtime feedback can be used to retrain abnormal gait patterns in runners.

STUDY 1
Gait Retraining in a Runner with Plantar Fasciitis

A 40-year-old female runner with right plantar fasciitis served as the subject for this study. She had discontinued running as a result of her pain. Prior to her injury, she had been running an average of 15 to 20 miles per week. She had been treated unsuccessfully with foot orthotic devices and was seeking additional advice. A visual analysis of the patient's running revealed the following (Figure 1a): the right hip was in excessive internal rotation and the knee in genu valgum throughout the support phase. In addition, excessive midfoot pronation was observed. Weakness of the right hip abductors and external rotators was noted (4/5 on a manual muscle test), as well as excessive hip internal rotation range of motion (0-70°). The left side exhibited normal hip strength and range of motion.

An instrumented gait analysis was performed to quantify the gait deviations that were noted visually. The frontal and transverse plane motions of the hip and knee are shown in Figure 2 (left panel) and compared to that of a group of healthy runners. Hip adduction and internal rotation and knee abduction and external rotation were found to be greater in the injured runner. It was hypothesized that the plantar fasciitis this runner was experiencing was related to the internally rotated hip and medially deviated position of the knee, placing greater stress on the arch of the foot. The subject agreed to undergo an 8-week training program to address these gait mechanics. Visual feedback was provided as the patient ran on a treadmill in front of a full-length mirror. The patient was instructed verbally to "keep your knees apart" to address the hip adduction. In addition, she was asked to "keep your patella pointed forward" to address the internal rotation of the femur. She ran for 10 minutes and gradually progressed to 32 minutes by the end of the 8-week session. She was seen 3 times a week for the first 3 weeks, 2 times a week for the next 3 weeks, and once a week for the last 2 weeks. The mirror and verbal feedback were progressively removed. She reported soreness in the external rotators and abductors of her right hip during the initial training, which resolved within 2 weeks. She also reported a progressive reduction in the effort required to maintain the aligned posture of her right lower extremity. The subject underwent another instrumented gait analysis to assess any changes that occurred as a result of the training.

Following the gait re-training program, there was a significant reduction in hip internal rotation, hip adduction, and knee abduction and increase in knee internal rotation (as a result of the decreased femoral internal rotation) (Figure 1b & Figure 2 right panel) . The runner returned for a 6 month follow-up gait analysis. She was running 30 minutes, 3 to 4 times per week without pain. The analysis revealed that hip external rotation and abduction were maintained, but knee frontal plane patterns showed a shift towards pretraining levels (Figure 2 right panel).

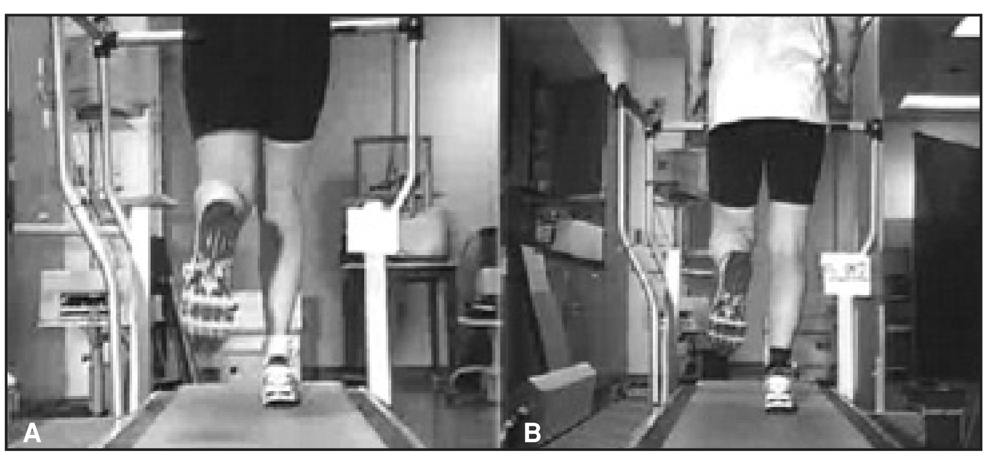

Figure 1. (a) Pretraining gait. Note the genu valgum and hip adduction position. (b) Post-training gait. Note the reduced genu valgum and hip adduction.

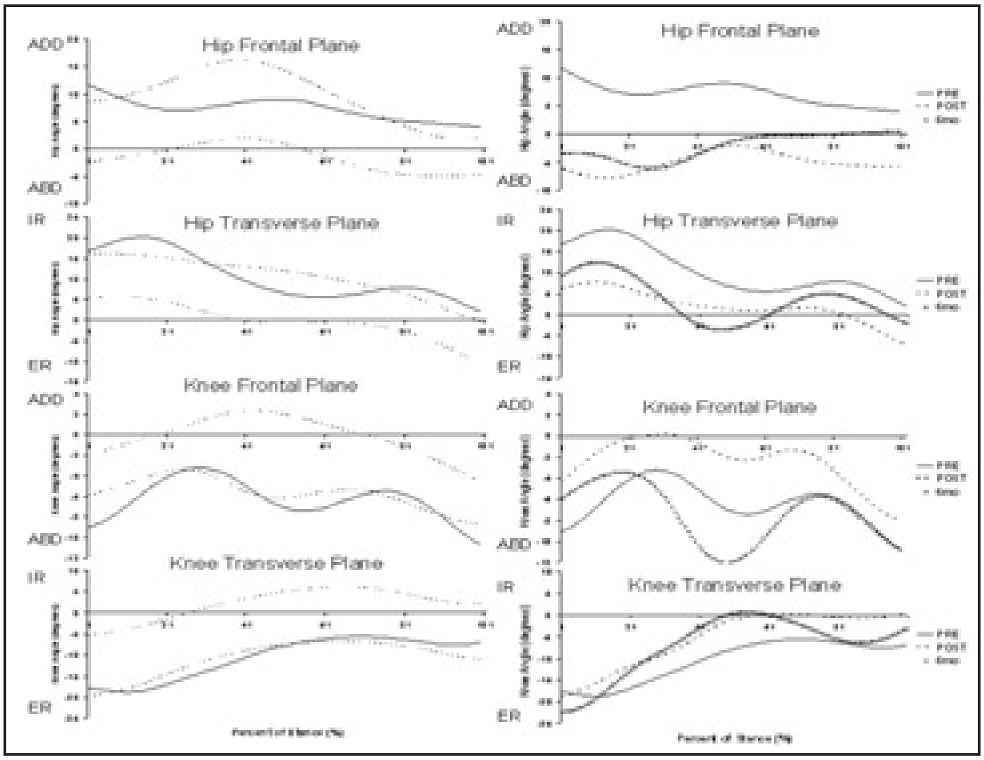

Figure 2. Hip and knee frontal and transverse plane pretraining angular position curves compared to the ± 1SD of the normative database (left) and compared to post-training and 6 month follow-up (right).

Results of this study clearly suggest that the patterns of running gait can be modified. These modifications led to a resolution of the patient's symptoms. However, she reported that the symptoms would return when she became fatigued and reverted to her old pattern. This further supports the hypothesis that the abnormal mechanics were causing the symptoms. Finally, this case study demonstrates the ability of the runner to maintain these new patterns over a 6-month period.

STUDY 2
Gait Retraining in a Runner with Patellofemoral Pain

The subject was a 46-year-old female runner who had been running for 15 years and had been averaging 15 miles per week. She had recently been training for a marathon when she developed left anterior knee pain, prompting her to seek physical therapy advice. Upon evaluation, it was noted that this runner exhibited weakness of the hip abductors and external rotators (4/5 on a manual muscle test). Upon performing a lateral stepdown, she exhibited excessive knee valgum, hip adduction, and femoral internal rotation. A visual gait analysis during running revealed increased hip adduction and internal rotation, knee valgus, and rearfoot pronation during stance (Figure 3a). An instrumented gait analysis revealed excessive hip internal rotation. It was hypothesized that this runner's patellofemoral pain was due to an excessively internally rotated femur and would be resolved if her gait mechanics could be altered so that she exhibited greater hip external rotation during stance. Thus, this runner was placed in a gait retraining program consisting of visits twice a week for 10 weeks.

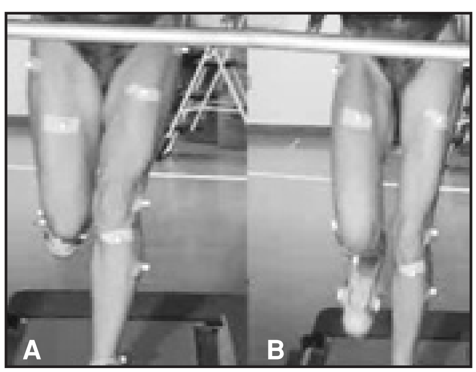

Figure 3. Pre (left) and post (right) training Hip IR. Note the reduction following gait retraining.

A real time motion analysis system was used for this retraining. Retroreflec-tive markers were placed on the left leg. The motion was recorded in real-time with 6 cameras sampling at 120 Hz. The Vicon 370 (Oxford Metrics, UK) 120 Hz 6-camera motion analysis system was used to collect bilateral lower extremity 3D joint kinematic data while the subject ran on a treadmill for 30 minutes (Figure 4). The processed 3D kinematic data collected by the Vicon DataStation were transferred to the Vicon Real-Time Engine which output marker and segment positions and rotations. This information was then on-line transferred to Polygon software where lower extremity segment and marker position data were displayed on a monitor for the subject to observe. Data were only presented during the stance phase of gait by selecting triggers based on heel and toe marker kinematic data. The patient was asked to alter her gait mechanics by shifting the chosen angular curve in the appropriate direction to provide more normal alignment. A real-time display of her hip internal rotation angle was provided as the subject ran on the treadmill at her self-selected pace (Figure 4). The subject was asked to lower her hip internal rotation curve (without altering her foot placement angle).

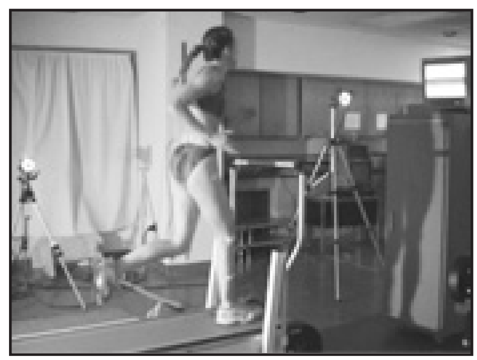

Figure 4. Subject running on the treadmill with retro-reflective markers placed on her pelvis, thighs, shanks, and feet. A video monitor (right) was provided for real-time feedback.

Over the 10-week training period, the runner was able to reduce her amount of hip internal rotation as she ran. This subject also experienced muscle soreness in her hip abductors and external rotators following training. Again, this soreness resolved over the first 2 weeks of gait retraining. By the 5th week of training, the visual feedback was periodically withdrawn. The patellofemoral pain this runner had experienced was resolved and she was able to reduce the amount of hip internal rotation throughout stance (Figure 3b and 5).

This study demonstrates the effective use of the integrated real-time video feed-

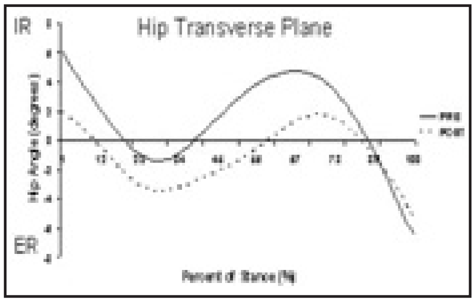

Figure 5. Pre and post-training Hip IR – note the decrease after gait retraining.

back system. The Vicon motion analysis company has just released their first version of their realtime analog feedback system. This will allow us to provide kinetic feedback on variables such as tibial shock, as well as vertical impact peaks measured on the instrumented treadmill.

STUDY 3
Preliminary Study of the Effect of Realtime Feedback During Running on Tibial Shock

The purpose of this preliminary study was to determine whether a runner could reduce their tibial shock while running on a treadmill and receiving a simple real-time feedback display of their shock levels. Four healthy recreational runners (age 25-35 yrs) volunteered to participate in this pilot study. Subjects were all rearfoot strikers without any current lower extremity injuries or conditions that might influence their running mechanics. An accelerometer was attached to their right distal tibia in an anteromedial position. Each subject ran on the treadmill at their own comfortable speed (range 6.0 - 7.0 mph) for 5 minutes. Data were then collected for 5 seconds to establish the subject's baseline values for tibial shock. A monitor, placed in front of the treadmill, then provided a real time visual display of their shock pattern as the subject ran. A horizontal line was placed on the video display at a position that was approximately 50% of each individual's peak shock value. Subjects were instructed to reduce the size of the peaks to below the horizontal target on the screen. They were simply told to try to "run more softly." They were allowed to practice this new pattern with the continuous visual feedback from the tibial shock curve for a period of 5 minutes, after which a second 5-second trial was again collected. The mean peak positive acceleration (tibial shock) was determined over 5 foot strikes for each trial. A one-tailed paired t-test was used to determine whether tibial shock was reduced following the real time feedback. Based on the preliminary nature of this study, an alpha of $P < 0.10$ was used to determine significance.

Following the 5 minutes of feedback, each participant was able to reduce their mean tibial shock. The group mean reduction was 30%, which was significant at the $P = 0.08$ level (Table 1).

This preliminary study demonstrates that runners are able to reduce the loading of their lower extremity by an average of 30% with a very brief training session. Only one of these subjects exhibited a baseline tibial shock value in the high risk range (> 8.89 g's, which was 1.0 standard deviations above the mean of a healthy reference population of runners). There was a considerably lower range of post retraining values for tibial shock compared to the baseline values. This may indicate that there is a floor effect in the potential for those with a normal or low shock value to reduce their shock further. It is notable that the subject with the highest baseline shock produced the greatest reduction. This suggests that we may see large reductions in our proposed study when using a population of high risk runners.

STUDY 4
Preliminary Study of the Short-Term Retention of Gait Changes Developed during Realtime Feedback to Reduce Tibial Shock

The purpose of this preliminary study was to assess the effect of realtime feedback of tibial shock on both tibial shock and ground reaction forces. Therefore, the study was conducted at the University of Massachusetts where an instrumented treadmill is available. Three healthy recreational runners (age 23-28 yrs) volunteered to participate in this pilot.

An accelerometer was attached to their right distal tibia in an anteromedial position. Subjects ran on a force-measuring instrumented treadmill to monitor concurrent changes in ground reaction force. Each subject ran on the treadmill at their own comfortable speed (range 5.4 – 5.9 mph) for 5 minutes. Data were then collected for 5 seconds to establish the subject's baseline values for tibial shock and ground reaction force. A monitor, placed in front of the treadmill, then provided a real time visual display of their shock pattern as the subject ran. A horizontal line was placed on the video display at a position that was approximately 50% of each individual's peak shock value. Subjects were instructed to reduce the size of the peaks to below the horizontal target on the screen. They were simply told to try to "run more softly." They were allowed to practice this new pattern with the continuous visual feedback from the tibial shock curve for a period of 10 minutes, after which a second 5-second trial was collected. This period of training was followed by a second 10-minute period during which no feedback was provided. The subjects were instructed to continue running in the new way that they had been practicing. No further verbal feedback was given. At the end of this period, a further 5 second trial was collected. The subject then cooled down for 5 minutes. The mean peak positive acceleration (tibial shock) was determined over 5 foot strikes for each trial. The variables considered were peak tibial shock, average vertical loading rate and impact peak. All of these have been associated with tibial stress fracture retrospectively in our previous studies.

Following the 10 minutes of feedback, each participant was able to make a sizeable reduction in their mean tibial shock (Table 2). Average loading rate and impact peak were also reduced.

Following the 10-minute period without feedback, the participants were able to maintain their reduction in tibial shock. Average loading rate and impact peak also remained reduced, compared to baseline values (Table 3).

Table 1. Baseline and Post-training Peak Tibial Shock Values (* $P = 0.08$)

Subject	Normal (g)	Post Training (g)	Reduction (%)
1	4.51 ± 0.89	3.92 ± 0.67	13.22
2	3.71 ± 0.73	3.44 ± 0.43	7.19
3	4.77 ± 0.26	2.64 ± 1.67	44.54
4	9.41 ± 0.48	4.05 ± 1.27	57.00
Mean	**5.60 ± 2.58**	**3.51 ± 0.63***	**30.49**

Table 2. Baseline and Post-training Peak Tibial Shock Values

Variable	Baseline	Post-training	Reduction (%)
Tibial shcok (g)	7.29 ± 1.25	3.83 ± 0.37	47.51
Ave load rate (BW/s)	28.39 ± 3.72	20.05 ± 1.14	29.37
Impact peak (BW)	1.50 ± 0.12	1.11 ± 0.16	25.71

Table 3. Baseline and Maintenance Period Peak Tibial Shock Values

Variable	Baseline	Maintenance	Reduction (%)
Tibial shcok (g)	7.29 ± 1.25	3.77 ± 0.17	49.33
Ave load rate (BW/s)	28.39 ± 3.72	21.35 ± 4.39	24.82
Impact peak (BW)	1.50 ± 0.12	1.13 ± 0.25	24.52

This preliminary study demonstrates that runners are able to reduce the loading of their lower extremity by an average of more than 25% with a very brief training session, with a particularly large decrease in tibial shock, the variable used to provide feedback. All of these subjects had baseline values of tibial shock within the normal range and were still able to make large reductions following a brief training period. This effect was maintained in the short-term when feedback was removed, indicating the potential for runners to learn a modified running gait.

STUDY 5
Gait Retraining Case Study of Patient with High Tibial Shock

This subject was a 20-year-old female collegiate runner with a history of multiple overuse injuries of her left lower extremity. Evaluation of her gait mechanics (session 1) revealed high loading variables (especially tibial shock) with the left being greater. This subject lived 2 hours from the university and could not undergo a prolonged course of retraining. However, she was provided verbal instruction in softening her landing while running on a treadmill. She was given the opportunity to practice this technique for approximately 20 minutes during treadmill running. She returned in one year and asked to be reassessed. At that visit, we tested her while running overground again (session 2a), provided her with 30 minutes of realtime feedback on her tibial shock during treadmill running and then tested her again (session 2b).

Table 4 and Figure 6 demonstrate the reduction in the magnitude of the loading variables from her baseline to her 1 yr follow-up. In addition, her loading was further reduced with additional feedback training that day. There was a reduction in all variables with the exception of the impact force, all other variables decreased. This subject now reports being able to run competitively and remain injury-free.

FUTURE DIRECTIONS

While these preliminary and case studies have demonstrated that gait patterns can be changed, there is much work to be done in this area. Research is needed to determine the optimal gait retraining protocols. This includes determining the feedback variables that provide the most effective results. In addition, work needs to be done in optimizing the feedback training schedules. Finally, we need more follow-up studies to determine the permanence of these gait related changes and their influence on future injury incidence. These are the investigations that we are currently engaged in. It is hoped that by further understanding the etiology of running-related injuries, we can better direct interventions towards minimizing them. In this way, we can help runners remain healthy throughout their lifetime.

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Table 4. Comparison of Loading Variables Across Sessions

Variable	Tibial shock (g)	Fz Impact (bw)	Inst. Load Rate (bw/s)	Av Load Rate (bw/s)
Session 1	11.13	1.8	140.2	128.4
Session 2a	9.5	2.0	93.6	63.2
Session 2b	8.43	1.9	85.9	52.8

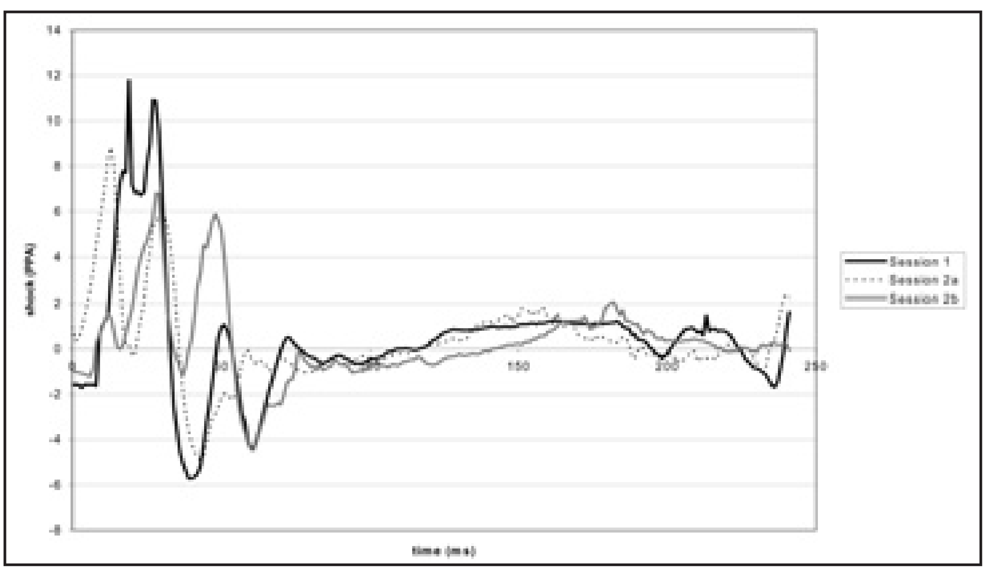

Figure 6. Progressive reduction in peak tibial shock from baseline (session 1) to 1 year follow-up (session 2a) to post-training at the 1 year follow-up.

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Applications of Diagnostic Musculoskeletal Ultrasound in Musculoskeletal Practice

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INTRODUCTION

Musculoskeletal ultrasound (MSUS) has been used by rheumatologists in Europe for several years.[1-4] In the United States orthopaedic surgeons[5,6] have reported the diagnostic accuracy of MSUS in patients with rotator cuff pathology. Several musculoskeletal radiologist training programs such as Thomas Jefferson University and the University of Michigan Health System provide subspecialty training in MSUS for medical doctors. We have been unable to locate literature reporting the use and accuracy of MSUS by physical therapists. The purposes of this article are: (1) to describe the basic principles of MSUS, (2) to provide examples of normal and abnormal MSUS scans obtained in our research lab, (3) to provide on-line resources for MSUS training and reference text books, (4) to provide recommendations and precautions for physical therapists using MSUS.

Diagnostic and therapeutic ultrasounds are similar in that both produce frequencies greater than 20,000 hertz. Continuous or pulsed therapeutic ultrasound either 1 MHz or 3 MHz produce thermal and nonthermal energy into the tissue to facilitate treatment goals such as increasing tissue extensibility. Diagnostic ultrasound produces pulsed waves at 7.5 to 20 MHz that are reflected back to the sound head and processed in the computer to produce pulsed echo images.[7] We are using a Phillips EnVisor HD Ultrasound system in our lab. This sophisticated system changes the scanning frequencies based on the quality of the images at specific tissue depths. The reflectivity is determined by the following 2 factors: acoustic impedance of the 2 materials and the angle of incidence of the sound head. More dense tissues such as bone and collagen reflect more waves than less dense tissues such as water or fat.[7] The grey scale images are displayed on the computer screen. The quality of the image has greatly improved with high frequency linear transducers (sound head) and with better axial and horizontal resolution than magnetic resonance imaging (MRI).[8] The ultrasound transducers must be held at a 90º angle to the scanning target tissue so that the maximal number of waves will be processed into an accurate image. Artifacts may occur when the transducer is not held perpendicular to the scanning object or the scanning object is oval.[7] Anisotropy is the property of a substance to display different scanning properties (images) based on the angle of the scanning beam.[7,9] Therefore, a review of the anatomy and the orientation of the scanned structure are mandatory. For example, before beginning our current study concerning ankle injuries, I returned to the fresh tissue lab to dissect and measure the orientation angles of the ankle ligaments relative to a bony landmark.

Tendons are well suited for MSUS study because of the parallel fascicles of collagen and the ground substance which provide different reflectivity, attenuation, and back scatter.[7] Parallel collagen fibers appear as echogenic (white) and ground substance appears hypoechoic (Figure1). The Achilles tendon has a dense epitendon that surrounds the tendon and appears as a reflective thin line.[10]

Figure 1. Right noninvolved (RNI) Achilles tendon approximately 5 cm superior to calcaneal insertion. Note the hyperechoic line (bright line) demonstrating the posterior calcaneus at the insertion of the Achilles tendon. Also note the anisotropic appearance of the Achilles tendon. The epitendon appears as a hyperechoic line superiorly to the tendon. As the tendon inserts into the calcaneous it becomes wider.

Dynamic scanning allows the clinician to view the target tissue during active ROM and clinical stress testing. This is especially insightful at the ankle joint. For example, I have observed the anterior talofibular ligament being drawn into the ankle joint by the negative pressure created by the tear that had extended into the capsule.

CASE PRESENTATIONS

We will now provide several examples of how we are using MSUS at Duke Student Health. The first patient is a 30-year-old law student who presented to student health with a 2-year history of pain in his left Achilles tendon. He rated his pain 2-3/10 and described it as dull. Ankle ROM was 90-130 on the left and 80-135 on the right. A palpable mass was identified 5 cm proximal to the insertion on the calcaneus in the Achilles tendon. On the day of the MSUS, he played racquetball for over 1 hour and he rated his pain as 7/10 and described the pain as sharp. At that time he had a noted antalgic gait. Figure 2 represents a transverse scan (perpendicular to the long axis of the tendon) at the palpable mass on the involved side and at the same location on the noninvolved tendon (a mark was made 5 cm proximal to the insertion). Figure 3 represents a longitudinal scan (parallel to the tendon) quan-

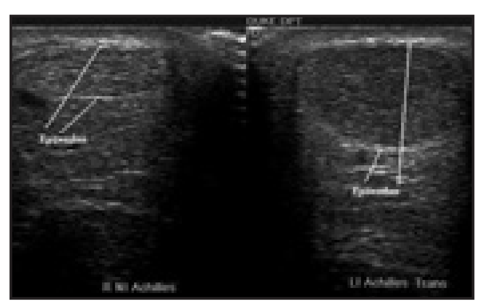

Figure 2. Transverse scan of the Achilles tendon demonstrating normal tendon architecture (RNI= right noninvolved). Note the epitendon surrounding the tendon as a white thin circle and the tendon has an anisotropic appearance. The involved tendon (LI= left involved) is approximately twice a large as the noninvolved tendon. In addition, note the loss of reflectivity due to the scarring within the tendon.

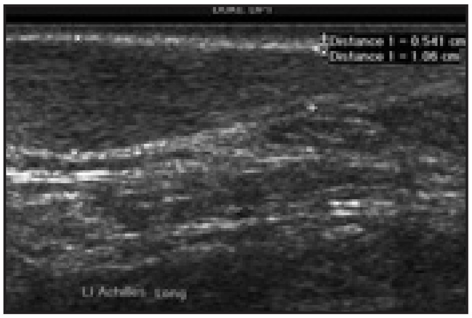

Figure 3. Longitudinal scan of the same patient as in Figure 2 involved tendon demonstrating almost a 100% increase in size.

tifying the magnitude of the tendonosis. No evidence of a tear or partial tear was identified. I reviewed the scan with the patient and discussed with him literature concerning Achilles tendonosis and possible of tendon tear or rupture. He was informed of the risks of playing racquetball, ie, deceleration forces (eccentric contraction). The referring physician was provided the digital image to review.

A 20-year-old male presented to student health with a history of being kicked in the calf while playing soccer. He had significant swelling and pain in his calf. A doppler ultrasound was performed to rule out deep venous thrombosis, which was reported as 'normal.' Three months after the injury, he continued to have 1 to 2 cm of swelling in his calf after playing basketball for one hour. He was continuing to ace wrap his lower leg during basketball. He returned to student health and requested an MRI to determine why his calf continued to swell with activity. The MRI reported "edema of the muscle belly of the medical gastrocnemius." Approximately 3 months later, he continued to report slight pain in the lateral gastrocnemius and continued swelling after activity. In consultation with the attending MD, I performed a scan of both calves. Figure 4 demonstrates a hypoechoic region in the lateral gastrocnemius that appears to represent scar tissue within the lateral head of the gastrocnemius. We could not explain the discrepancy between the MRI and MSUS findings. We scanned the area of point tenderness. We hypothesized that the scar tissue was interfering with the venous drainage of his right lower leg.

Figure 4. Longitudinal scan of injured calf demonstrating hypoechoic region (arrow) within the lateral head of the right involved (RIV) lateral gastrocnemius compared to left noninvolved (LNI) lateral gastrocnemius.

A 30-year-old female presented with right shoulder pain for 6 months. She reported an insidious onset with increased pain with kayaking and weight lifting. Examination revealed positive hyperabduction[11] and load and shift test bilaterally and a positive impingement test on the right for pain. The MSUS was performed with the arm in internal rotation with the transducer placed longitudinally. Figure 5 demonstrates a large anechoic image because the ultrasound wave is being absorbed by the fluid. In addition, Figure 6 demonstrates that the right supraspinatus is edematous compared to the left. Given this information, the patient was able to observe the anatomical changes and conceptually understand her shoulder problem. Moreover, she realized the seriousness of her problem. She immediately agreed to stop kayaking and weight lifting and began a pain-free rotator cuff endurance strengthening program.[12] She was scanned 2 1/2 weeks later and there was a marked reduction of the size of the bursa as demonstrated in Figure 7. She did not take any NSAIDS during the 2 1/2 week interval.

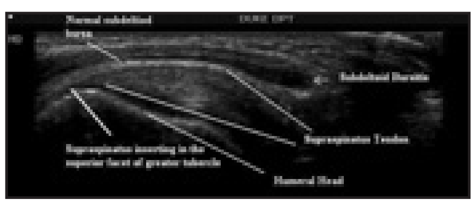

Figure 5. Longitudinal scan of the subacromial space with the arm internally rotated demonstrating a large anechoic region demonstrating acute subacromial bursitis.

Figure 6. Right involved supraspinatus tendon compared to left noninvolved tendon. Arrow demonstrates enlarged bursa.

Figure 7. Follow-up scan performed 2 1/2 weeks after activity modification and HEP.

This 27-year-old female student presented with a history of plantar fascia pain at the medial calcaneal tubercle. A palpable mass was identified at that location. She had a high arch and forefoot adductus. Her scan revealed a large area of hypoechoic representing a plantar fascianosis (Figure 8). She was treated with orthotics, new shoes, and a stretching program for dorsiflexion. In addition, she is considering other medical treatments.

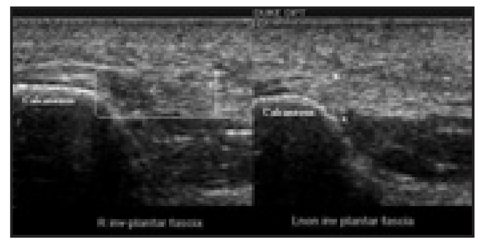

Figure 8. The scan on the right is the noninvolved planter fascia (L NI). Note the hyperechcoic nature of the fascia which is consistent as it inserts into the calcaneous between the "Xs." In contrast, the involved fascia (R IV) demonstrates a hypoechoic large mass in which is demonstrated with the rectangular box. Also, note the arrow which demonstrates the scarring with the fascia.

DIAGNOSTIC ULTRASOUND LEARNING RECOURSES

The following web sites provide excellent learning opportunities for physical therapists wishing to use MSUS in their practices:

1. http://www.doctor33.it/eular/ultrasound/index.htm
2. http://www.med.umich.edu/rad/muscskel/mskus/
3. http://www.caiysideresearch.demon.co.uk/Musculoskeletal.html

There are several texts available. The quality of the images varies greatly and I have found one text that has been truly helpful.[7] Because of the development of faster scanning frequencies, linear transducers, and enhanced computing power, one should carefully research the products available.

PRECAUTIONS

The MSUS is the most operator-dependent diagnostic imaging modality.[2,13] Therefore, accuracy of your scanning techniques must be established compared to MRI and surgical findings.

Because of the litigious nature of our society, caution should be used in making a diagnosis with this modality. The MSUS is used to confirm a clinical diagnosis based on the patient's history and physical examination. I caution the patient and physician that any finding by the MSUS must be confirmed by MRI. We are collecting data now on my accuracy using MSUS in patients with ankle injuries that have had MRI and/or surgery. Data comparing the accuracy of MRI to surgical findings at the ankle is inconclusive at the present time.[14-17] Technical improvements in MRI and the increase in number of musculoskeletal radiologists promises to improve the accuracy of MRI in musculoskeletal injuries. The high cost of MRI, however, is a limiting factor for many patients. If the accuracy of MSUS can be established for a specific person at a specific joint, tremendous cost savings will be possible.[18] In addition, state laws vary regarding who may perform an ultrasound. We are using the MSUS for research purposing only.

CONCLUSIONS

Musculoskeletal ultrasound has been used in Europe for many years and it is increasingly being used in the United States. The MSUS is very dependent on the skills of the sonographer and must be validated with MRI or surgical findings. It has been very helpful in diagnosing and managing students with musculoskeletal injuries at Duke University Student Health Division. We will be presenting accuracy data for our MSUS in 2006.

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The Use of Surface Electromyography to Determine Muscle Activation during Isotonic and Elastic Resistance Exercises for Shoulder Rehabilitation

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Various exercises are used in physical therapy to strengthen and rehabilitate the shoulder following injury or surgery.[1-9] Proper shoulder rehabilitation and strengthening is essential for the non-athlete and athlete following trauma or dysfunction of the shoulder. To date, many resistance exercise programs and techniques are available but few have been scientifically validated. Two common methods of training involve isotonic exercise using a constant load and exercise involving elastic tubing. The resistance provided by isotonic exercise is gravity dependent and the resistance pattern changes with changes in body position of the patient (ie, standing, prone, supine). Elastic tubing provides increased resistance as the length of the band is stretched throughout the exercise range. Unlike isotonic exercise elastic tubing is not dependent on gravity for providing resistance. With elastic tubing, resistance is dependent on the thickness of the tubing and the rate and magnitude of stretch of the material.[10-12] Resistance levels in tubing are categorically denoted by different colors (ie, lighter colors signify less resistance). A literature review by the authors prior to publication of this study found that only 3 peer reviewed studies have actually quantified the resistance provided by elastic tubing during exercise.[10-12] Most rehabilitation programs use a combination of each method but little research is available to evaluate the effectiveness of each with regard to exercise progression and stimulation of select muscles.

Optimal gains in strength require that exercise not only overload the muscle but also be progressive as patient strength increases. Currently, most progression methods have been classified in rehabilitation by establishing passive, active-assisted, and active progressions that relate more to the influence of gravity than offering insight into the most productive method of resistance to be used.

> "The authors hypothesize that the method of resistance (tubing vs. isotonic) will elicit different muscle activation profiles."

No previous studies directly related to quantifying and comparing elastic exercise (variable resistance: variable torque) and isotonic exercise (constant resistance: variable torque) with regard to muscle activity could be found. Earlier studies analyzing shoulder isotonic strengthening exercises for the shoulder have been contradictory and have not clearly established similar specific results regarding muscle activation patterns.[3,10] The authors hypothesize that the method of resistance (tubing vs. isotonic) will elicit different muscle activation profiles. Since the resistance provided by elastic tubing is not dependent on gravity, there may be greater muscle effort associated with select exercises across a greater range of movement. Despite the popularity of using tubing for rehabilitation of the shoulder few studies have investigated the performance characteristics of this material. This study was an attempt to fill a void in the rehabilitation literature regarding the muscle activation profiles when training with elastic tubing. The results of the study may assist in allowing categorization of the most stimulating exercises for the muscles of the shoulder girdle. Furthermore, the data may help delineate the unique advantages of using either type of exercise modality (isotonic versus elastic).

The objectives of this study are to: (1) determine differences in muscle activity (EMG) in the shoulder while using isotonic loads and resistance provided by elastic tubing, (2) establish a prioritization of exercises and techniques (isotonic vs. tubing) based on muscle activation (EMG) levels, (3) differentiate among muscle groups of the shoulder girdle to classify exercises and draw conclusions on how to effectively prescribe each form of resistance for the greatest improvement in strength and function of the shoulder.

METHODS

Subjects

Seven males and 5 females aged 20-44 years participated in the study (ave age= 29.7 years and height and weight of 69.4 inches 156.8 pounds (range ht = 64-75, wt 127-195). To be included in the study none of the subjects had a previous shoulder, elbow, or wrist pathology of their dominant upper extremity that has resulted in a permanent restriction of range of motion or decreased muscle strength in performing any activities for daily living. Subjects were recruited from the clinic where testing was performed. All subjects were required to read and sign a university-approved consent form prior to participating.

Instrumentation

A commercially available fixed cable 16 channel surface measuring electromyographic (EMG) system and accompanying software was used for data collection and analysis.* Disposable bipolar surface pediatric ECG/EMG Ag/AgCl wet-gel electrodes were used to record electrical activity of 8 different muscles of the shoulder girdle. All data points collected using full wave rectification and integration. Data for each muscle was percent normalized to the fixed value obtained from specific maximum EMG activity of an isometric muscle test designed to elicit a maximum response. The specific test positions are shown in Appendix A. The diameter of the pediatric electrode was 10mm. Input impedence was greater than 10 MΩ, and the common mode rejection ratio was 130 dB at 0 Hertz, 100 dB at 0-60 Hertz, and a minimum of 85 dB at 10-500 Hertz. Signal processing included full wave integration and rectification and was referenced to the fixed value maximum value from the isometric testing for each muscle. Data smoothing was performed over an interval of 50 data points using the root mean square method (RMS).

Three colors of Thera-Band† elastic tubing, (red, green, blue) were used to provide elastic resistance during performance of 4 different exercise positions. These 3 colors were chosen based on their routine use in the performance of various shoulder exercises. Isotonic resistance was provided using standard dumbbells at weights of 2, 5, and 8 pounds. These loads were selected to arbitrarily note resistances which would be categorically labeled as light, medium, and heavier loads.

PROCEDURES

Subjects were required to participate in one test session lasting approximately 90 minutes. Prior to testing all subjects were required to read and sign the consent form and also given an opportunity to ask questions to the investigators. Prior to placement of electrodes the skin area was cleaned using an alcohol prep pad to increase electrical conductivity and decrease skin resistance. Electrodes were then placed on selected 8 different

Figure 1. Surface EMG placement on a subject.

shoulder muscles of the dominant upper extremity. These muscles included the upper trapezius/supraspinatus, anterior and posterior aspects of the deltoid, infraspinatus, middle trapezius, pectoralis major (clavicular portion), latissimus dorsi, and biceps brachii. Placement of electrodes for each muscle was according to the locations recommended by Cram and Kasman.[13] Figure 1 shows a subject in preparation for data collection. The specific locations and landmarks can be found in appendix A.

Following skin preparation and electrode placement each subject was required to perform 8 different isometric tests to generate a maximum EMG signal. The positions used for each muscle can be found in Appendix B. Subjects were asked to perform a one maximum isometric contraction against an immoveable surface (ie, wall) for 5 seconds. Data collection occurred throughout the entire time period. A rest period of 1 minute was allotted between each isometric test. Following the isometric protocol, subjects were randomly assigned to perform either the free weight or elastic tubing exercises using the required resistances. Prior to data collection, subjects were instructed and demonstrated proper performance of each exercise. Warm-up repetitions preceded each exercise and subjects were instructed and supervised on how to correctly perform each movement. Data sampling was conducted over a 10-second period. Subjects were instructed to allow 2 seconds for performing the concentric phase. This allowed approximately 5 repetitions to be performed during data collection. A rest period between 1 to 3 minutes followed each trial. The free weight exercises were performed using 2, 5, and 8 pounds of resistance. Exercises during the free weight trials included: (1) sidelying external rotation, (2) scaption full can exercise, (3) prone shoulder retraction with dominant arm only, and (4) prone shoulder extension with dominant arm only. Tubing exercises with red, green, and blue Thera-Band consisted of: (1) standing shoulder external rotation with the arm placed in 90º elbow flexion and the tubing horizontally in line the level of the elbow, (2) scaption exercise emulating a D2 PNF pattern with the tubing anchored at the level of the subject's foot, (3) standing shoulder retraction also using both arms, and (4) standing shoulder extension using both hands to promote symmetry of movement. Figures 2 and 3 show a subject performing scaption with a weight and using tubing, respectively. If any exercise caused pain or discomfort, the subject was allowed to terminate the exercise. A total of 24 test trials (3 weights x 4 exercises and 3 tubing resistances x 4 exercises) were collected.

DATA ANALYSIS

All trials of EMG data and motion data were processed, reduced, and averaged for each trial and condition using full-wave rectification and integration. Data

Figure 2. Subject performing scaption exercise with dumbbell.

Figure 3. Subject performing D2 PNF exercise with elastic tubing.

smoothing was conducted using the root mean square method. All values were expressed as a percentage of the maximum EMG signal elicited during the respective isometric tests for each muscle. Paired T-tests were used to analyze the data for each muscle group across the two different loading conditions (free weight vs tubing) and the 3 resistance settings (red, green, blue or 2, 5, 8 pounds).

RESULTS

The results of this study are presented in graphs showing plots of resistance (1=lightest load, 2= medium load, 3= greatest load) against percent of EMG signal in relation to the tested maximum isometric response for each muscle group and exercise.

External Rotation Exercise

Greatest EMG activity according to percent maximum isometric activity was found in the infraspinatus muscle during external rotation exercise for both isotonic and tubing exercises. Percent EMG values ranged between 36% and 79% of EMG isometric maximum for isotonic exercise and 65% to 87% for tubing exercise (Figure 4). Tubing exercise at the red and green color levels showed significantly greater EMG activity when compared to isotonic exercise using 2 and 5

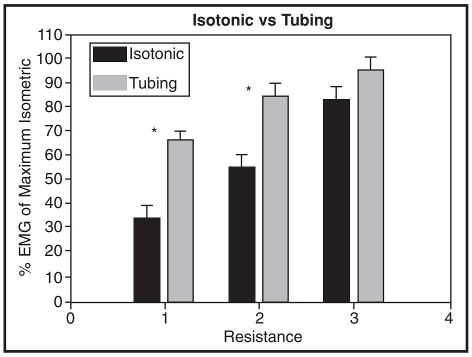

Figure 4. Infraspinatus activity for external rotation exercise.

pound loads respectively. Tubing exercise also showed significantly greater EMG activity in the upper trapezius/supraspinatus muscle groups when comparing green tubing to a 5 pound load (24% vs 10%). Posterior deltoid EMG activity was significantly greater using an 8 pound load than when subjects performed the exercise using blue tubing (67% versus 40%) (Figure 5). This was also the case when comparing anterior deltoid activity at the highest loads (45% isotonic vs 23% tubing). Tubing exercise showed significantly greater EMG activity for the rhomboid/mid-trapezius muscle group, pectoralis major, and biceps brachii at only the lowest loads (red tubing vs 2 pounds). The EMG values were generally less than 10% for the biceps brachii and pectoralis major muscles but were 38% and 21% with of EMG isometric maximum for tubing and isotonic exercise respectively when comparing muscle activity in the rhomboid and mid-trapezius muscle groups. No significant differences were found in the latissimus dorsi group across loads and exercise with values generally ranging less than 30% of EMG isometric maximum.

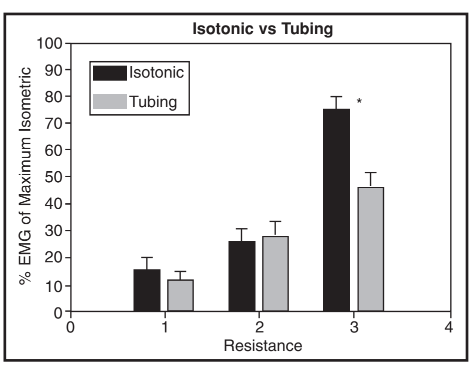

Figure 5. Posterior deltoid activity for external rotation exercise.

Full Can Exercise

Activity in the infraspinatus was significantly greater for all loads when tubing was used. These differences ranged from 17% at the low load to 20 and 12% at the middle and high loads respectively (Figure 6). Trapezius/supraspinatus activity showed the same pattern across loads with greater differences in muscle activity for tubing of 24%, 33%, and 31% for the light, medium, and heavy loads respectively (Figure 7). In addition posterior deltoid activity showed similar dominance with 22%, 60%, and 60% greater muscle activity with each heavier load respectively. Anterior deltoid EMG activity was very high for both tubing and isotonic exercises with tubing showing a greater activity but no comparisons were statistically significant. Electromyographic values ranged from 129% to 214% of EMG maximum isometric values. Rhomboid/mid-trapezius activity was also not significantly different for each condition with values ranging from 44% to 68% of EMG maximum isometric values.

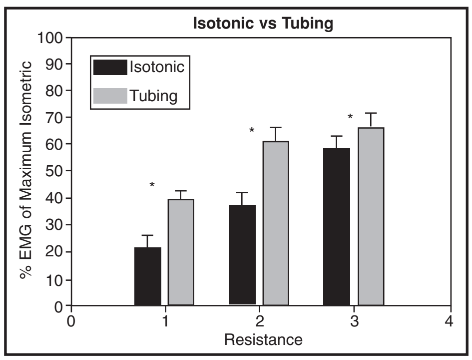

Figure 6. Infraspinatus activity for full can exercise.

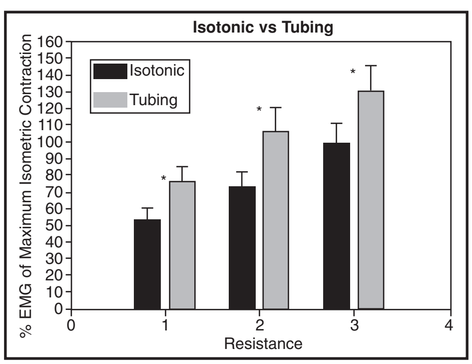

Figure 7. Upper trapezius/supraspinatus activity for full can exercise.

Pectoralis major activity was greater with isotonic loads but only significantly greater (20% difference) at the heaviest load (blue tubing versus 8 pounds). Biceps activity was within a range of 26% to 58% across treatments but not statistically significant. Biceps brachii activity was also very similar to values obtained for the pectoralis muscle group. Latissimus dorsi muscle activity favored tubing exercise with less than 35% EMG maximum isometric activity across loads and conditions but a significantly greater EMG activity was found for tubing at only the highest load (32% versus 25%).

Retraction Exercise

Isotonic loads generated greater EMG activity (12%-15%) in the infraspinatus muscle progressively across all 3 loads when compared to tubing exercise (Figure 8). Upper trapezius/supraspinatus activity was almost identical between isotonic and tubing exercises across all 3 loads. Values ranged from 22% to 40% of EMG maximum isometric values. Posterior deltoid values were significantly greater for isotonic exercise across all 3 loads when compared to tubing (Figure 9). Differences ranged from 24% at the low load to 41% at the highest load. The absolute EMG activity was greater than 100% of EMG maximum for isotonic exercise at 5 (113%) and 8 (129%) pound loads. The EMG values for tubing ranged from 65% to 88% of EMG maximum isometric values. Anterior deltoid values were statistically insignificant for tubing and isotonic exercise and were low (less than 40%) for all 3 loads. Rhomboid/midtrapezius values were greatest for isotonic loads and in the

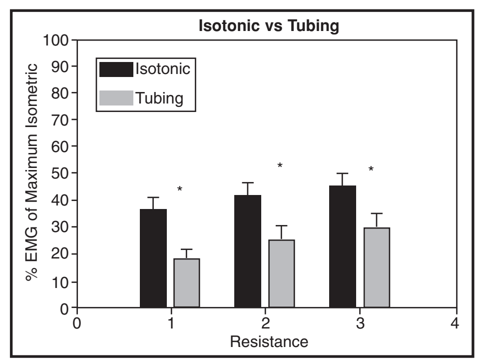

Figure 8. Infraspinatus activity for retraction exercise.

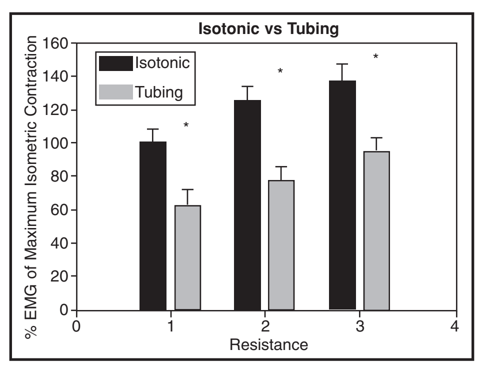

Figure 9. Posterior deltoid activity for retraction exercise.

range of 50% to 65% of maximum EMG values. Tubing generated approximately 30% to 50% of maximum isometric muscle activity across the 3 loads. Pectoralis major and bicep brachii activity for tubing and isotonic loads were not statistically significant and generally lower than 20% of the maximum isometric EMG values. The EMG activity in the latissimus dorsi was consistently greater for isotonic exercise at all 3 loads. These differences were significant (28%-33%) and generally 60% to 70% of the EMG maximum isometric value.

Extension Exercise

The EMG activity in the infraspinatus muscle was significantly greater (8% difference in EMG activity) only at the highest load and favored the isotonic condition. Most of the differences between tubing and isotonic exercise were statistically insignificant for the upper trapezius/supraspinatus, posterior deltoid, bicep brachii, and rhomboid/mid trapezius muscle groups. However greatest overall EMG activity was found for the posterior deltoid as the load (tubing or isotonic) was progressively increased. Muscle activity approached 110% to 112% at the highest load for isotonic and tubing exercise respectively (Figure 10). Activity in the latissimus dorsi muscle was greater for isotonic exercise with differences ranging between 8% and 17%. However, statistical significance was only found at the highest load (17%) (Figure 11). Anterior deltoid EMG activity was generally greater when subjects performed extension exercises with tubing. However, overall EMG values were less than 40% of maximum isometric EMG values.

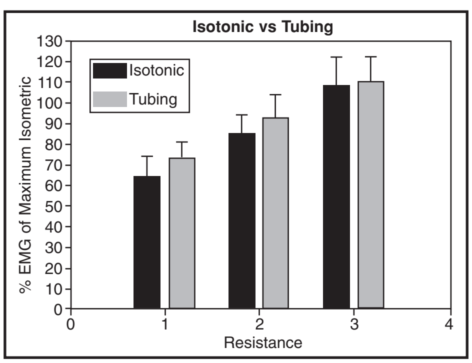

Figure 10. Posterior deltoid activity for extension exercise.

DISCUSSION

This study represents an attempt to identify the unique resistance properties

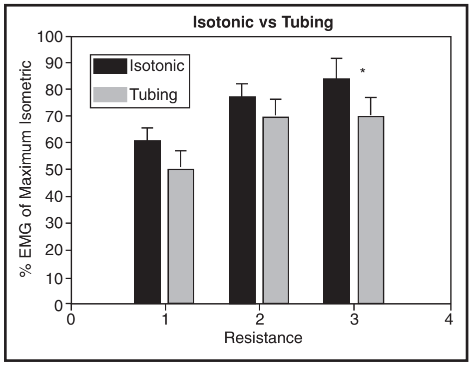

Figure 11. Latissimus dorsi activity for extension exercise.

of isotonic and variable resistance elastic exercise by analyzing muscle activity during commonly performed shoulder girdle and rotator cuff exercises. The results highlight the effects of load as well as movement pattern and body position in stimulating muscle activity. A general analysis of the data shows that tubing exercise exhibited advantages over isotonic exercise when pivoting or diagonal movements were performed. This was case with the full can exercise and also the external rotation movement. Even though there were some modifications in position with each exercise when isotonic loads were used tubing may allow better positioning to invoke an isolated muscle response since the resistance is not gravity dependent. Unfortunately, we did not analyze the muscle EMG response to determine overall EMG activity throughout the exercise range. We were primarily interested in looking at peak amplitudes of EMG signal to denote increased effort. We may have found different results had we analyzed the time integral of EMG response and hence the time course of muscle effort or work throughout the effort during a repetition.

The increased effort of the anterior or posterior deltoid muscle in the full can exercise and also the retraction and extension exercises are noteworthy. This muscle seems particularly suited for the movements performed based on the pennation angle of the deltoid muscle and also the pattern of movement. The activity of the deltoid and infraspinatus muscles also predominated over the signal intensity of the supraspinatus and upper trapezius muscles. Hintermeister et al also found that the infraspinatus was the muscle primarily active with the external rotation movement while using indwelling EMG.[14] Furthermore, Worrell et al also found low activity levels in the supraspinatus while using the empty can position in standing.[15] They recommended that the supraspinatus may be more effectively activated in the prone position while performing shoulder flexion. Reinhold and colleagues compared 7 different cuff strengthening exercises and found that sidelying external rotation using an isotonic load elicited greatest activity for the infraspinatus and teres minor and that the greatest activity of supraspinatus and middle and posterior deltoid muscles was present during prone horizontal abduction at 100º with full humeral external rotation.[8] However, it is important to note that comparison of EMG data across studies can be misleading since methodologies and data collection procedures vary widely. Another interesting finding from our data points to the consistent patterns of activity we noticed across the loading conditions. As loads were increased, EMG signals also showed increases in muscle effort. This certainly provides evidence for the fact that both modes of exercise, isotonic and elastic training, can be progressive in nature. This is in agreement with the results presented by McCann et al.[16]

Isotonic loads seemed to be most productive with greater EMG activity when prone retraction and extension exercises were performed. Ultimately it may be realistic to use isotonic loading for these exercises and use tubing resistance for more consistent resistance in some of the more gravity dependent positions in standing. We tried to select exercises that were commonly performed by patients who have shoulder pathology. Based on our results and limits of our study we feel that in order to stimulate the infraspinatus and posterior deltoid muscles one should use tubing in external rotation and full can exercises when choosing among the exercises analyzed in this study. Isotonic loading may be more suitable for retraction and extension exercises in prone to best stimulate the latissimus dorsi, posterior deltoid, and rhomboid and midtrapezius muscles.

We recognize several limitations in our study design. The primary issue may be load equivalencies. Since no data exists comparing isotonic loads to tubing elongation loads, we had to estimate load responses between the two types of resistance. However based on clinical experience and also extrapolation of the previous literature we felt the loads of 2, 5, and 8 pounds were similar to the red, green, and blue tubing colors. In addition, using peak EMG amplitude values to assess the worthiness of muscle response may be misleading. Total muscle effort as measured by integrated EMG across the repetitions of effort may be more important. Future studies should investigate this issue. We also limited our data collection efforts to only concentric contractions or half the effort of movement. However, we felt the extrapolation of eccentric muscle contraction to EMG signal response would be invalid. Furthermore, our selection of segment positions during the maximum effort isometric tests may have led to efforts which were not truly representative of the best positions to place the muscles in question in their most mechanically advantageous positions. This may explain why we had values greater than 100% of maximum on some measures. Finally, our sample size may have limited finding significance along with large variations in scores we found across treatments. However, it must be noted that our study suffers the limitations in measurement and artifact that accompany surface EMG responses.[17]

CONCLUSIONS

Type of load and body position significantly influences specificity of muscle effort during rehabilitative exercise. The results show that a selection of a variety of exercises and a combination of tubing and isotonic exercise will have the greatest effect on increasing therapeutic response in the shoulder girdle muscles. Clinicians may favor the selection of tubing exercises for diagonal or standing movements while prone positions may best be done with isotonic loads to stimulate the appropriate muscles. Future studies should investigate other exercises as well as look at the total contraction states of muscle contraction during exercise. In dwelling EMG is also needed to validate the results of this study.

ACKNOWLEDGMENTS

This study was made possible by funding and equipment donations by the Hygenic Corporation. The authors also acknowledge Mr. Steve Hoffman, MS, PT, ATC, SCS for allowing testing to be conducted at North Hill Orthopedic and Sports Physical Therapy.

Equipment Suppliers

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APPENDIX A

Electrode Placements for Each Muscle Group.
** Inter-electrode distance was 2 cm for each muscle.

Muscle	Placement
Upper trapezius/supraspinatus	Directly above the spine of the scapula, over the suprascapular fossa.
Anterior deltoid	Anterior aspect of arm, approximately 4 cm below the clavicle, running parallel to the muscle fibers.
Posterior deltoid	Two centimeters below lateral border of the spine of scapula and directed on an oblique angle toward the arm, running parallel to the muscle fibers.
Infraspinatus	Placed parallel to and approximately 4 cm below the spine of the scapula, near the lateral aspect over the infraspinatus fossa of the scapula.
Middle trapezius	Medial to the spine of scapula next to the root of the scapula
Pectoralis major (clavicular portion)	On chest wall at an oblique angle toward the clavicle and 2 cm below just medial to the axillary fold.
Lattissimus dorsi	Approximately 4 cm below inferior tip of the scapula, half the distance between the spine and the lateral edge of the torso. Electrodes oriented in a slightly oblique angle of 25˚.
Biceps brachii	Parallel to the muscle fibers along the lateral aspect of the arm and near the center of mass of the muscle belly.

APPENDIX B

Test Positions for Isometric Contractions and Maximum EMG Activity for each Muscle Group.
**All tests were done with the patient standing.

Trapezius	Shrug with arms at side and fully extended in with wrist in neutral against immoveable resistance
Anterior Deltoid	90˚ elbow flexion and shoulder in neutral position against side of body. Force applied anteriorly against closed hand and against wall.
Posterior Deltoid	90˚ elbow flexion and shoulder in neutral position against side of body. Subject oriented with back against wall and posterior aspect of elbow applying force into wall with shoulder and elbow remaining in same plane during effort.
Mid-Trapezius/Rhomboid	Subject grasps ends of towel with each hand and elbows bent 90˚. Patient attempts to externally rotate shoulders
Latissimus Dorsi	Subject performs shoulder depression against extended arm and closed fist into solid surface of plinth table while attempting to depress the shoulder girdle.
Infraspinatus	Subject standing with lateral aspect of upper arm against wall with elbow flexed 90˚ and shoulder in neutral. Towel placed under axilla and subject applies maximum external rotation effort into wall.
Pectoralis Major	Subject performs horizontal adduction against immoveable pole with shoulder at 90˚ flexion.
Biceps Brachii	Elbow flexed to 90˚ with shoulder in neutral and forearm supinated to 90˚. Subject attempts to bend elbow against maximum resistance provided manually by tester.

Practice Affairs

Bob Rowe, PT, DMT, MHS, FAAOMPT; Practice Chair

For just over a year I have served as the Orthopaedic Section Practice Committee Chair, and during that time my perspective regarding the world of physical therapy has changed immensely. Currently we are in a challenging period of time. There are many opportunities at our fingertips and yet many barriers lie in our path. As you know the recently released MedPac Study did not provide us with the favorable report to Congress we were hoping for relative to Medicare Direct Access. Secondary to this outcome, we must work even harder to convince each member of Congress to understand our side of the issue since there is no doubt that we can provide safe, effective, and efficient physical therapy services to Medicare beneficiaries without the referral of a colleague within health care. Each of us must make the effort to contact our Senate and House members of Congress to educate them regarding our perspective of this issue. The American Physical Therapy Association works diligently on our behalf, but they need our assistance since a letter and/or phone call from a constituent is worth 100 letters from an APTA staffer. If you need assistance with how to contact your member of Congress, contact Mike Matlack in Government Affairs within APTA. He will be more than happy to assist you.

Another important issue currently facing us is the exponential growth of POPTS practices. There are many points that can be made relative to this issue, but I would like to focus on one that is directly linked to our future place within the health care culture. The APTA has developed Vision 2020 to give the physical therapy profession as well as each physical therapist a goal to strive for in terms of professional growth and development. If we are to be autonomous practitioners of choice for musculoskeletal conditions, then we are impeding the path by accepting positions as 'employees' of a colleague within health care. It is very difficult to maintain a collegial relationship based on mutual respect within the culture of 'employer/employee' environments. Employees may be valued, but they are seldom if ever viewed as peers. Autonomous practice components are within our individual practice and our employment/practice relationships. In consideration of that, it is important for all physical therapists, regardless of their setting, to shift their perspective at all levels to being an autonomous practitioner within both their practice and practice environments. This requires separating from POPTS employment relationships and necessitates a strong consideration for engaging in other more unconventional 'nonemployee' employment contracts in other settings such as hospitals, private practices, and clinics within academic institutions. Perhaps more importantly each physical therapist should make every effort to move themselves and the profession towards all elements of APTA Vision 2020.

Book Reviews

Coordinated by Michael J. Wooden, PT, MS, OCS

Beredjiklian P, Bozentka D. *Review of Hand Surgery*. Philadelphia, Pa: Saunders, Inc.; 2004, 273 pp, illus.

This text, with contributions by several authors, provides a comprehensive review of disorders of the hand and surgical corrections of the upper extremity. The text is organized into 13 chapters. The first chapter reviews the anatomy of the hand thoroughly and includes the osteology, arthrology, tendons, ligaments, and nerves of the hand and upper extremity. The second chapter discusses the injuries and disorders of the tendons and muscles as well as the principles of the repairs and the prognoses. The next 3 chapters review skin and soft tissue defects, vascular disorders of the hand and upper extremity, and nerve injuries and related disorders, including compression neuropathies, crush syndromes, and reflex sympathetic dystrophy.

In the middle of the text, fractures of the hand, wrist, and forearm as well as dislocations and instability of the hand and wrist are discussed, including the mechanism of injury and their medical management. Microvascular hand surgery is reviewed in chapter 8 that includes a discussion of amputation and replantation. The next chapter reviews osteoarthritis, rheumatoid arthritis, and other related conditions. The discussion includes classification and treatment for each diagnosis. Tumors, infection, and pediatric hand surgery are reviewed in chapters 10 through 12. The text finishes with a chapter on rehabilitation. Kinesiology is reviewed extensively and the use of orthotics and prosthetics for treatment.

This textbook outlines in great detail the anatomy, kinesiology, clinical assessment, diagnostic testing, and basic treatment for disorders of the hand and wrist. This text does not go into detail regarding the treatment techniques of the physical therapist beyond splinting and superficial management. It does not provide a guideline for specific treatment protocols postoperatively or management of the various conditions described. However, this is an excellent reference for those therapists providing treatment for disorders of the hand and wrist that need a resource to review the medical approach. It is very well organized, thoroughly indexed, and easy to use.

Sylvia Mehl, PT, OCS

Davis C. *Complementary Therapies in Rehabilitation*. Thorofare, NJ: Slack Incorporated; 2004, 385 pp.

With the increase in alternative therapies in physical and occupational therapy practice, this book comes at an opportune time. The title aptly describes the intent and contents of the book.

In the introduction, the editor touches on some key areas today in our health system, stating that we have switched to an economic-based system that has become focused on treatment units, productivity, and profit. As a result, we have lost the real reason we went into rehabilitation. The editor believes that in our western medical mode we lack intuition, creativity, and free-thinking in our treatment planning, that our treatments must be from the heart, treating the whole person, not just the symptoms. In her opinion, these negative qualities contribute to the present crisis in our health care system.

The first two chapters attempt to lay the foundation for alternative therapies. In the ensuing sections and chapters, 20 complementary therapies are nicely presented by various experts in their respective fields. Some of the more recognizable therapies covered are myofascial release, massage, craniosacral therapy, yoga, Tai Chi, Feldenkrais, and Pilates. Less familiar therapies include Complete Decongestive Therapy, Qi Gong, magnets, and lasers.

The editor and the contributors have done an excellent job with their descriptions. Within each chapter the basics are explained along with a brief history of the therapy and evidence for successful use. Also included in each chapter is how and to whom the application of the therapy is given. Finally, there is some information on current research, along with many references. However, the lack of clinical research on these therapies is obvious, and encouraging clinicians to connect with 'universal energy' seems a bit of a reach. The clinician has the responsibility to treat what he or she has found through objective examination and assessment, and to rely on evidence.

Read with an open mind, this would be a useful book for the clinician interested in learning about alternative therapies.

Dan Bankson, MSPT, CFMT

Product News

Product information is supplied by manufacturers. Products described should not be construed as having the endorsement of the Orthopaedic Section, APTA, Inc.

Biodex Introduces New Gait Trainer 2

The new Biodex Gait Trainer 2 helps clinicians bring acute gait patients up to speed by promoting correct stride length. Audio and visual biofeedback prompts proper gait patterns of step length, step speed and step length variability (step symmetry) so that, through repetition, patients relearn to walk. Printed color exercise summary reports track patient progress and document outcome. Ideal for use with stroke, spinal cord, head injury, amputee, orthopedic, neurologic, vestibular and older patient populations, the Gait Trainer 2 features an easy-to-use, high resolution color touch-screen display. Clinicians need only select the patient's age and height to automatically calculate the exact speed needed to achieve the desired step cycle. With a zero-starting speed, 0.1 mph speed increments, chest strap telemetry or contact heart rate monitoring, and an open platform with a low six-inch profile, the Gait Trainer 2 can also be used as a standard treadmill for various exercise and rehabilitation applications.

The Gait Trainer 2 has a forward speed range of 0 to 10 mph with reverse speeds of 0 to 3 mph and a choice of 0- to 15-percent or -3- to 12-percent grade. It can support up to 400 pounds and store data for up to 500 patients. Options include Standard and Geriatric/Pediatric Handrails.

For more information on the Biodex Balance System, contact Biodex Medical Systems, Inc. at 1-800-224-6339 (In NY and Int'l, call 631-924-9000), e-mail sales@biodex.com or visit us on the web at www.biodex.com.

TACTILUS® INSOLE SYSTEM HARDWARE
(COURTESY OF SENSOR PRODUCTS LLC 2005)

Sensor Systems Can Improve Quality of Life for Millions

Dynamic Plantar Pressure Measurement Technology Helps Evaluate and Diagnose a Diverse Range of Plantar Problems

Through recent advances in its Tactilus® plantar pressure measurement technology, Sensor Products LLC is now positioned to assist podiatrists, orthopedists, chiropractors and other medical professionals in making the best diagnoses and recommendations for their patients. Essentially, the emergence of technologies like the Tactilus® foot platform and insole systems is critical to the well-being of millions of people.

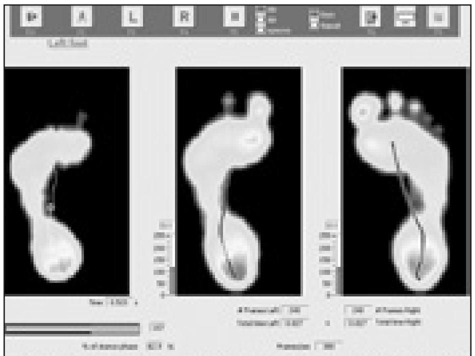
TACTILUS® FOOT PLATFORM
(COURTESY SENSOR PRODUCTS LLC 2005)

For instance, diabetes is the fifth major cause of disease-related deaths in the United States. Out of the estimated 18.2 million Americans affected, 4.5 million will suffer from plantar problems like degenerative foot disorder and complications due to neuropathy such as bunions, hammertoes, Charcot feet and more. Experts on the disease stress comprehensive foot care for amputation prevention and overall comfort for diabetes sufferers. Orthotic devices and appropriate footwear play a large role in the quality of life for these patients.

However, diabetics aren't the only demographic subjected to pain caused by plantar pressure abnormalities. In fact, about 100 million Americans experience biomechanical plantar problems caused by obesity or arthritis-induced heel pain, heel spurs, hammertoes or neuromas. By utilizing Tactilus® foot platform and insole electronic pressure measurement sensors, professionals can easily detect, diagnose and monitor patients with these and other plantar abnormalities.

"These new analysis systems are the most advanced in the world and can be dedicated to innumerable applications," said Carlos Ruiz, Tactilus® product manager. "The link between technological advancement and human quality of life is ultimately exhibited because of the diverse global populations the Tactilus® systems can potentially benefit."

Employing user-friendly software, the foot platform and insole sensor systems generate in-depth statistical information and dynamic 2-D and 3-D profile images for such medical and ergonomic body mapping needs as: diabetic and neuropathic patient screening, orthotic and prosthetic efficacy profiling, pronation/supination impact evaluation during bipedal locomotion activities, pre- and post-surgical comparative analysis, ulceration detection, degenerative foot disorder monitoring, ray hypermobility diagnosis, and early scoliosis detection. With unprecedented speed and accuracy, the systems comprehensively profile plantar pressure distribution and magnitude.



TACTILUS® SOFTWARE: 2-D VIEW OF PRESSURE VS. TIME
(COURTESY OF SENSOR PRODUCTS LLC 2005)

The Tactilus® foot platform analysis system enables professionals to perform dynamic pressure profiling in order to evaluate shoe-to-ground interaction related to the diabetic foot, pronation, foot arch and weight-bearing capabilities and assess impact effects in bipedal locomotion activities of both feet, either exclusively, or in relation to each other. The platform detects body motion (foot-knee-hip) to effectively profile any abnormalities. In addition, densely packed sensors in the Tactilus® platform analysis system offer the user high resolution images and a modular architecture.

The Tactilus® insole systems are advantageous in their basic design by assessing foot-to-shoe interaction. The foot insole is comprised a thin and highly durable substrate material and ranges in size from unisex US 1.5 to 10.5 (EUR 33 to 44). The insole sensor collects precise data for determining pedal pressure points and assessing athletic plantar implants in activities ranging from standing and walking to running, jumping, skiing and skating. Working at speeds up to 500 Hz, this system's velocity is unmatched by any other technology.

Both the Tactilus® foot platform and insole analysis systems possess robust sensors which can endure thousands of uses with consistent repeatability, and are highly resistant to electromagnetic noise, temperature, and humidity fluctuations. The full-scale Windows-based software provides isobar and region-of-interest viewing, graphical displays of data in bar charts, line scans and histograms, statistical analysis of average/minimum/maximum pressures, total force over any selected area, analysis view of all nine major foot zones, pressure vs. time and more.

Demonstrations of Tactilus® analysis systems can be requested by contacting Sensor Products at 1.973.884.1755, tactilus@sensorprod.com or at www. sensor prod.com/tactilus.

Active Standing Achievable with New EasyStand Evolv

Altimate Medical's new EasyStand Evolv stander has a modular base that allows options such as the "Active Standing" Glider to be added to the basic unit at any time. In addition to its modularity, the new Glider features a tray that can be used while gliding and adjustable foot plates for precise knee height positioning.

The EasyStand Evolv with Glider offers safe, dynamic leg movement and therapeutic motion while standing to individuals who are unable to stand upright or walk on their own. Individually adjustable resistance cylinders can be adjusted by the users and provides them with twelve different settings from mild to vigorous.

Reaching an upright standing position in the EasyStand Evolv with Glider is simple. The new flip-up knees give the user additional space for transferring. When moving from sitting to standing the EasyStand Evolv's lifting design mimics the body's natural pivot points, minimizing shear.

Altimate Medical manufactures standing technology that focuses on health and independence for kids and adults with disabilities. For more information on the new EasyStand Evolv contact Altimate Medical at 800-342-8968 or visit our website at www.easystand.com/ evolv.

WebWatch: http://www.freemedicaljournals.com/

The Free Medical Journals Site was created to promote the free availability of full text medical journals on the Internet. Visitors to the site do not have to register and the links to medial journals appear in alphabetical order or by specialty with indication of when full text becomes free (for example, *The New England Journal of Medicine* allows free access to original articles after 6 months).

The site also has links to free books on medicine and offers an email service that will automatically email you when new free journals are added to the database.

A nice feature is a service called AMEDEO. You can customize your online profile with an email service that sends an email every week that displays bibliographical details and links to available abstracts from your preferred areas of interest.

Over 1400 free journals are listed and the site highlights the names of Journals which are indexed in Medline. The breadth of medical journals is broad. Topics range from sports medicine to cell research. Journals are listed from other languages such as Spanish, German, and French.

Another advantage with the site is the company's assurance to not sell your information for solicitation. This includes not allowing access to pharmaceutical companies that sponsor some AMEDEO topics.

Upcoming Election

Watch for the upcoming Orthopaedic Section's election! Offices open for the 2006 election are 1 Director, and 1 Nominating Committee Member. The voting period is from November 1, 2005 – November 30, 2005.

Watch for more details to come!

Occupational Health Physical Therapists Special Interest Group

Orthopaedic Section, APTA, Inc.

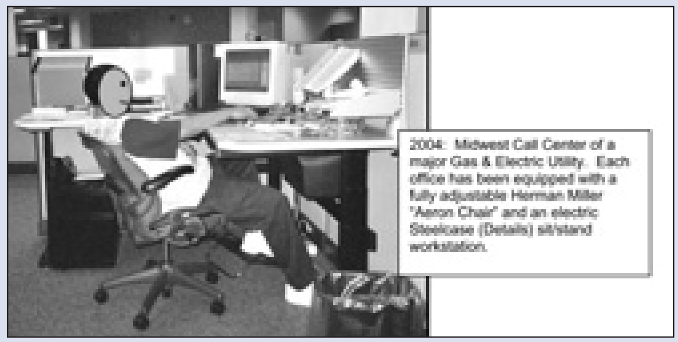
Summer 2005 | Volume 17, Number 2

A Smarter Way to Sit

Drew Bossen, PT, MBA
Atlas Ergonomics, LLC

Sitting…it sounds simple enough. Yet, despite years of training, training, and more training the saga goes on. The saga 'stars' the seated workers; be it a Call Center or a manufacturer performing bench-work, we continue to observe in semi-flexed, rounded postures. As physical therapists we know all too well, how these faulty postures take their toll over time. So what is the solution?

Consider the following, in January of 1976 Herman Miller Inc. introduced the first fully integrated ergonomic chair, 'The Ergon Chair.' Its initial deployment took place across the Corporate Offices of Texas Instruments in Dallas, Texas. Three months into the project Herman Miller's development team visited the Dallas facility to assess the outcome of their deployment. To the dismay of the development team they found countless employees continuing to sit in semi-flexed, rounded postures. The chair, in and of itself, had not changed the affective behavior of the worker. Interviews of users demonstrated a clear 'disconnect' between this highly adjustable chair and the ability to use it.[1]



2004: Midwest Call Center of a major Gas & Electric Utility. Each office has been equipped with a fully adjustable Herman Miller "Aeron Chair" and an electric Steelcase (Details) sit/stand workstation.

In response to these findings the development team created, what some consider to be, the first office ergonomic training program known to Corporate America.

Board of Directors and Committee Chairs

Now fast forward 30 years to today…what has changed? The same issues remain within office and manufacturing facilities across the country. The format of our solution has changed somewhat with the advent of technology. We may use the web or a computer-based training format but the solution remains one-dimensional: training, training, and more training. In the final analysis we have yet to solve the equation for the end-user.

As the physicist, Albert Einstein, noted… "The definition of insanity is doing the same thing over and over, expecting a different result." Hence, the 'disconnect' experienced at Texas Instruments in 1976 continues today.

2004: Midwest Call Center of a major Gas & Electric Utility. Each office has been equipped with a fully adjustable Herman Miller 'Aeron Chair' and an electric Steelcase (Details) sit/stand workstation.

It is Time to Consider an Alternative Approach…

I think it is safe to say that training as we traditionally packaged it is not the answer. Regardless of the user group: engineers, PhDs, or entry-level Call Center trainees, the issues are the same. We need to quit blaming the individual workers for the failure to sit in an upright neutral posture and consider an alternative solution.

Perhaps we could learn from exploring the successes of other professions. Perhaps if we viewed this problem from an 'Engineering' or a 'Lean Manufacturing' perspective, an alternative solution would come forth. For at its essence, 'Lean Manufacturing' is an improvement method which uses data to identify and eliminate process problems.

Dr W Edward Deming, an American statistician who led the quality movement in Japan (and later in America), spent much of his time trying to convince people that most quality problems are "in the process, not in the person." For most of his 60+ year career, he promoted the 85/15 rule, based on his experience that 85% of problems were built into the way work was done (and hence under the control of management). Only 15% of the problems, he said were really the fault of individual employees.[2]

In Deming's view of the world, the failure of the individual to maintain an upright neutral posture would be considered a quality issue. As with any manufacturing process, the goal is to have the highest level of quality, or said in another way, the elimination of defects is the goal.

Consider a change in your perspective. Consider how you might respond differently if upon entering a large Call Center you observed 60% of the population seated in faulty sitting postures. If in that consideration, you viewed these faulty sitting postures and their sequela as the ultimate 'defect' of the 'Process of Sitting' perhaps then we could begin to build viable model to solve for the ongoing 'disconnect' between highly adjustable ergonomic chair and the ability to maintain an upright neutral seated posture.

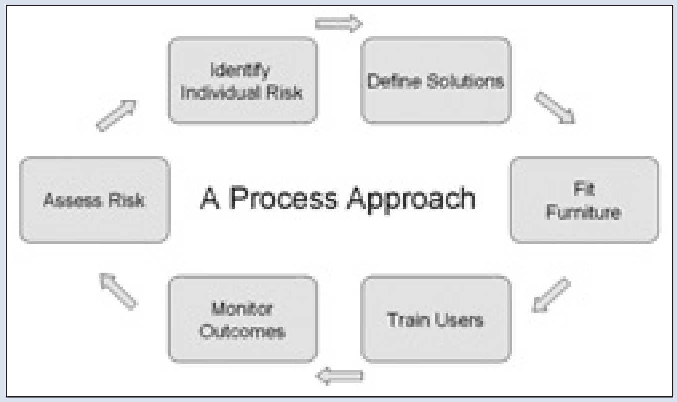
Making Improvements that Last…

When implemented, Lean Manufacturing techniques can be powerful. One such technique is a problem-solving method known as DMAIC (pronounced duh-MAY-ick). DMAIC stands for Define-Measure-Analyze-Improve-Control. DMAIC is described as a "structured, data-based problem-solving process." That means:

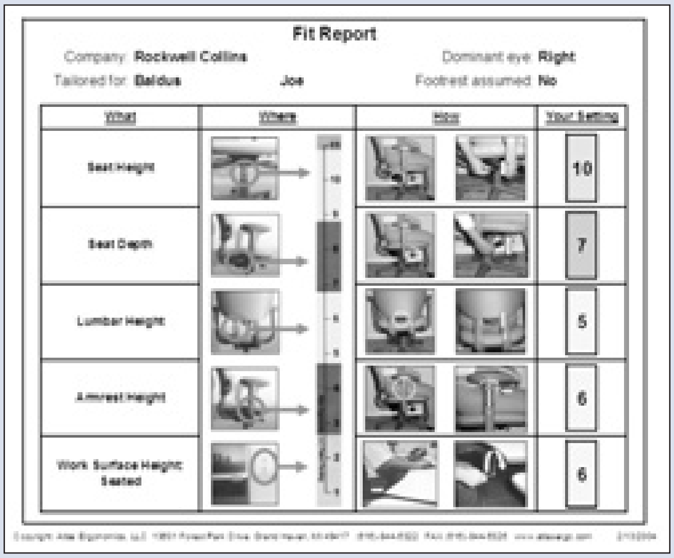
- Doing specific activities in a specific sequence (that's the 'structured' and 'process' part).
- Gathering data in nearly every phase to help you make decisions (the 'data-based' part).
- Making sure that the implemented solutions truly eliminate the cause of the problem you are trying to fix.[2]

A Process Approach…

Our 'Process Approach' was born out of this methodology; a simple yet comprehensive approach to the challenges of the seated worker. The focus is not on the training of the individual, the focus is on the 'Process of Sitting.' Our patent pending process blends the use of technology with trained health care providers to effectively solve the known challenges of the seated worker.



- Step 1. Assess Risk: Workers are asked to complete an on-line risk assessment of their work environment, including a survey of their work-related discomfort.
- Step 2. Measurement of Risk: The Risk Assessment Tool scores the responses of the workers based on 3 criteria:
  - Ergonomic risk factors,
  - Level of discomfort, and
  - Prior medical history.
- Step 3. Define Solutions: Based on the data, trained health care providers define solutions for the individual users.
- Step 4. Fit Furniture: The chair and workstation are labeled with a patent pending ground reference labeling system. This creates a consistent reference point for all of the major adjustment features of chair and workstation. Each user is then 'fitted' relative to the reference system. The final deliverable is the Fit Report©. The Fit Report© creates a sustainable blueprint for upright neutral posture.
- Step 5. Training: Yes we do train, but not in the traditional sense. We focus our training on the use of the Fit Report©. It is the tool which addresses the 'Process of Sitting.'



- Step 6. Monitor Outcomes: At month 1-3-6-9-12 following implementation, we again survey the end-users relative to their level of work-related discomfort. Individuals with continued high levels of work-related discomfort are again paired with trained health care providers to assess the situation. The trained providers in turn make further recommendations for change as needed. The Process continues…

Outcomes…

We have experienced extraordinary outcomes when utilizing this 'process approach' to sitting. The metrics are routinely monitored and measured across environments to assess the viability and influence of the program.

- Experience of Workplace Discomfort
  - Reduced [Range: 45% to 65%]
- Total Discomfort
  - Reduced [Range: 50% to 80%]
- Maximum Discomfort
  - Reduced [Range: 50% to 70%]
- Productivity Loss
  - Reduced [Range 55% to 80%]

In Conclusion…

This is truly a story of 'Process Improvement.' Once you begin to understand the needs of your customers (ie, in this case seated workers), you can then take the next step of figuring out a better way to deliver what they want. Few workers are opposed to sitting in an upright neutral posture. They just don't understand know how to get there. The answer lies in providing the worker with a process to serve their needs. By providing them a viable, sustainable tool, we have worked toward the elimination of the 'defect,' the faulty sitting posture. As the sitting postures improved, the level of associated work-related discomfort, correspondingly decrease. Hence, quality, as a measure of the individual worker and the aggregate organization has improved.

The Process doesn't stop there. We are in the process correlating work-related discomfort to the attributes of these highly adjustable ergonomic chairs and workstations. Across large populations we will be able to determine which of these attributes truly deliver on risk reduction for the end-user. Over time we will be able to track this risk reduction against the associated cost of work-related injuries. In addition, the data will be useful in identifying gaps between the needs of users and the current product offerings by manufacturers. In the end, the data will influence the marketplace to deliver a higher level of quality to the end-user. The Process continues…

SOURCES

1. Sherman R. Development Team of the Herman Miller "Ergon Chair," 1976; Currently Executive Vice President for Product Development-Atlas Ergonomics, LLC.
2. George M, Rowlands D, Kastle B. *What is Lean Six Sigma?* New York, NY: McGraw-Hill; 2004.

PASIG

Performing Arts Special Interest Group • Orthopaedic Section, APTA

PRESIDENT'S LETTER

Summer Salutations!

Under construction! It seems that the spring and summer months are consumed with home improvement and clean-up projects. The PASIG has spent most of the spring working in the same manner. The Executive Board and Committee Chairs have been busy creating, coordinating, and dedicating efforts to enhance the continued development of the membership.

The Orthopaedic Section website has also been under construction and will offer a new look and links for all members to make the most of this technology. There has been a renewed effort from the Membership Committee to update our PASIG membership and make this information available in the new "find a PT" section. Everyone should be able to gain information about where we are all practicing, what type of performing artists we treat, and the availability of mentorships and affiliation programs. I encourage each one of you to fill out the form electronically or manually (see below) and help us maintain an up-to-date site for all of us to use.

The PASIG committees continue to construct their strategic plans for: (1) enhancing research efforts and information with the proposed listserve project, (2) interstate licensing information and development of a universal dance medicine screening tool, (3) evolution of the student research scholarship program, and (4) educational programming for CSM, off site continuing education, and the possibility of a PASIG home study course.

New committee chairs have now been appointed for the following committees:

1) Practice Committee – Joel Dixon
2) Membership/Website – Julie O'Connell
3) Student Research – Leigh Roberts

These individuals as well as the other committee members and chairs—Shaw Bronner, Research and Tara Jo Manal, Education—are spending a great deal of time creating and maintaining services to enhanced education, research, and practice for all PASIG members.

The PASIG needs your talents, expertise, and spirit to continue to move forward in all of these areas to enhance our practice. Please do not hesitate to contact one of the committee chairs to volunteer your time or I can be reached directly at sclint@lsuhsc.edu for any questions, concerns, or comments.

Caring for the arts brings out the best in all of us!

Susan C. Clinton, PT, MHS
PASIG President

PASIG STUDENT SCHOLARSHIP INFORMATION

ATTENTION ALL STUDENTS - WOULD YOU LIKE $400 FOR YOUR RESEARCH? All student members of PASIG are invited to submit a poster or platform presentation for CSM 2006. The topic must be related to performing arts and physical therapy to be considered for the scholarship. Find more information on CSM 2006 at http://www.apta.org/Meetings/CSM.

HOW TO APPLY:

1. Must be a member of PASIG. If you are not a member of PASIG go to www.orthopt.org to learn how to join.
2. Submit an abstract to the APTA for presentation at CSM 2006 - deadline is July 15, 2005. For details on how to write your abstract, see http://apta-csm2006. abstractcentral.com/.
3. Once your abstract is accepted, contact the PASIG for scholarship application. You must show proof of your abstract acceptance to CSM 2006 and plan to attend CSM 2006. The scholarship award is up to $400.00 and is intended to be used to defray costs of attending CSM 2006; receipts should be provided as proof of expenses. Deadline for applying for PASIG scholarship is November 1, 2005.
4. Contact Leigh Roberts at Lroberts@bodydynamicsinc.com or 703-527-9557 for more information.

PRACTICE ANALYSIS UPDATE

This document has been accepted for publication this year.

Gamboa J, Hagins M, Manal T. An Analysis to Define the Clinical Practice of Physical Therapy for Performing Artists. *Journal of Dance Medicine and Science*. Vol.9, Issue 2.

Congratulations and thank you to all who participated in making this important document a reality!

Jennifer M. Gamboa, MPT, OCS, Owner/Director, Physical Therapy Services, Body Dynamics, Inc, Arlington, VA. Director, Health and Wellness Program, Universal Ballet Academy, Washington, D.C., Past-president, Performing Arts Special Interest Group, Orthopaedic Section, Inc., American Physical Therapy Association. Correspondence and reprint requests should be sent to: 5130 Wilson Blvd., Suite B-1, Arlington, VA 22203; email: jgamboa@bodydynamicsinc.com; phone 703.527.9557; fax: 703.526.0438

Marshall Hagins, PhD, PT, Associate Professor, Division of Physical Therapy, long Island University, Brooklyn, NY.; Research Associate and Senior Clinical Instructor, Harkness Center for Dance Injuries, Hospital for Joint Diseases, N.Y. N.Y.; Owner, Brooklyn Arts Physical Therapy, Brooklyn, NY.

Tara Jo Manal, MPT, OCS, SCS, Director, Physical Therapy Clinic, University of Delaware, Newark, DE.

CALL FOR AUTHORS

The PASIG is considering the creation of a home study course to be offered through the Orthopaedic Section. Anyone interested in authoring a manuscript, or assisting the authorship should contact Susan Clinton, PT, MHS at sclint@lsuhsc.edu by July 15th, 2005.

The PASIG Education Committee has begun its preparation for educational programming at CSM 2006. If you have suggestions or recommendations for this programming, please contact Tara Jo Manal, MPT, OCS, SCS, our Education Committee Chair, at tarajo@udel.edu. We look forward to hearing from you.

PASIG Nominating Committee: CALL FOR NOMINATIONS

The Nominating Committee would like to encourage all those interested in serving the PASIG beginning either 2006 or 2007 to step forward and join us. In 2006 there will be one position open on the Nominating Committee. 2007 will see positions available as Vice President, Secretary, and another Nominating Committee position will open up. Each position is for a 3-year term. You may self-nominate or nominate another candidate. Upon agreeing to be nominated, you will write a short biography and submit ideas regarding your role as an officer of the PASIG. We have other committees you may find of interest including: Practice, Research, Public Relations and Media, Membership, and Education.

2006 and 2007
Nominating Committee
Duties:

- Is responsible directly to the membership.
- The senior member of the committee becomes the chair and sits as a nonvoting member on the PASIG Board of Directors.

Additional Responsibilities:

- Carries out or supervises the carrying out of the Policies and Procedures for elections via ballot and works with the Orthopaedic Section office on coordinating this project.
- Prepares a slate of candidates for each PASIG election that is submitted to the Executive Board 4 months prior to the CSM Business Meeting.

2007
PASIG Vice President
Duties:

- Assumes all duties of the President if she/he is unable to serve and/or attend scheduled meetings.

Additional Responsibilities:

- Serves as a voting member of the Executive Board.
- Reviews the policies and procedures and updates annually.
- Serves as liaison to Orthopaedic Section Program Coordinator regarding changes to Policies and Procedures.
- Attends the following meetings: PASIG Executive Board Meetings and conference calls, PASIG Annual Business Meeting at CSM.
- Forwards copies of official correspondence to the President and to the Section's Program Coordinator.
- Assists the President in providing for the orientation of all new officers and chairs.
- Chairs the PASIG Education Committee to facilitate PASIG programming at CSM.
- Coordinates PASIG programming (for CSM) with the Program Chair of the Orthopaedic Section based on suggestions by the PASIG membership.
- Is the liaison for all PASIG program speakers to the Orthopaedic Section and is responsible for meeting all speaker information deadlines for CSM.
- Other duties as assigned by the President.

2007
PASIG Secretary
Duties:

- Records minutes of the PASIG Annual Business Meeting and Executive Board Meetings.
- Carries out official correspondence on behalf of the PASIG including mailed notification of meetings and elections.
- Sends notices as specifically requested by the PASIG Executive Board.

Additional Responsibilities:

- Serves as a voting member of the Executive Board.
- Records minutes of Executive Board conference calls.
- Distributes minutes to the Executive Board.
- Serves as Editor for the PASIG newsletter and Chair of the Publication Committee.

- Sends all information to be included in *Orthopaedic Physical Therapy Practice* prior to each deadline (newsletter submission) to the Section office.
- Serves as liaison to the Editors of Orthopaedic Section and APTA publications (eg, OPTP).
- Attends the following meetings: PASIG Executive Board Meetings and conference calls, PASIG Annual Business Meeting at CSM.
- Forwards copies of official correspondence to the President and to the Section's Program Coordinator.
- Maintains a file that includes the following items for use in assisting the President in the orientation of the successor to the office of Secretary: minutes from meetings and conference calls, records associated with the newsletter.
- Acts as historian for the PASIG. Maintains a historical account of PASIG activities/meetings, etc.
- Other duties as assigned by the President.

If you are interested in nominating a candidate, please contact one of the following Nominating Committee members:

Gayanne Grossman (Gngrossman@aol.com)
Karen Hamill (dancingkaren@hotmail.com)
Stephania Bell (StephaniaB@comcast.net)

Performing Arts Special Interest Group MEMBERSHIP FORM

To be a PASIG member, you must also be a member of the Orthopaedic Section. You may use this form for new membership, change of address, or updating your information.

Name: ____________________

Are you a: ❑ PT ❑ PTA ❑ Student

Prof. degrees/certifications: ____________________

Company name: ____________________

Address: ____________________

Phone: ____________ Fax: ____________ e-mail: ____________

APTA member number: ____________ Orthopedic Section Member: ❑ yes ❑ no

Years of experience treating performing artists: ______

What percent of your patient population are performing arts patients?
_____Dancers _____Gymnasts _____Skaters
_____Musicians _____Vocalists _____Circus Performers

Please list if you are affiliated with any performing arts schools, companies, or groups below:

____

____

Do you accept Student Affiliations? ❑ Yes ❑ No If yes, would you be willing to be a mentor? ❑ Yes ❑ No

Are you interested in serving as a mentor to other physical therapists or physical therapy students interested in the treatment of performing artists? ❑ Yes ❑ No

Are you interested in serving on any of the PASIG Committees?
❑ Practice ❑ Research
❑ Education ❑ Student Scholarship
❑ Nominating ❑ Membership/website

Can we list your name and contact information on the PASIG website, www.orthopt.org for a membership contact:
❑ Yes ❑ No

Thank you for taking time to complete this questionnaire. We look forward to having you as a member. Please return this form to the Orthopaedic Section or email the information to tfred@orthopt.org.

Julie O'Connell, PT
PASIG Secretary and Membership Chair

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gngrossman@aol.com

For a complete listing of our officers please visit our website.

Pain MANAGEMENT

SPECIAL INTEREST GROUP • ORTHOPAEDIC SECTION, APTA, INC.

PRESIDENT'S MESSAGE

Joe Kleinkort, PT, MA, PhD, CIE, DAAPM

In the last decade there has been a tremendous decline in the ability of people to get the therapy they need. This has been caused by the rise in control held by insurance companies and managed care. With reimbursement on the decline and lack of approval of adequate rehabilitation for various conditions, our health care system continues to create greater chronicity in the aging adult populous. The future insures that with this significant lack of caring for the patient up front that a greater number of people will suffer from an ever growing number of chronic conditions that therapists will ultimately be called upon to manage. As therapists it is our responsibility to prepare for this onslaught of a new and more difficult patient population to address.

There are new and exciting tools that are finally being approved for use in this country after nearly 3 decades of use in other countries around the world. The laser is one of these tools. The laser has properties that set it apart from other photostimulators. I have enjoyed the clinical use of lasers in my practice since 1980 with tremendous results. Since this issue of *Orthopaedic Physical Therapy Practice* is dedicated to new tools in orthopaedic practice, I must say that although this tool has been accepted in the world for over 25 years it has just recently received FDA approval in this country.

There is nothing that can replace the manual skills and knowledge that come with long and exacting study in the area of orthopaedics. Laser, however, is one of those tools that can radically improve a practitioner's outcomes and speed of delivery. Laser use is wide and varied in chronic and acute pain management as well as the industrial setting. The physiological effects are well documented.

With the ever increasing need to shorten times in rehabilitation and improve on outcomes, the laser is one powerful tool that can be used by the clinician to enhance improved outcomes.

As a profession we must embrace new technology with cautious optimism and bring it into our plan of action. After returning from a recent trip to China, I am reminded how truly blessed we are in this country but also how we must meet change with vigor and determination in our professional areas. We must continue to strive for the ideals that brought us to this profession and touch others lives who are in pain in a very positive way. Embrace change therefore and make a difference in other people's lives with the new technology that is there for us to utilize.

Finally, we are still looking for papers to publish in the area of chronic pain. Please forward these to me at indusrehab@aol.com and I will make sure that we include them in upcoming issues. This is your voice and let that voice be heard.

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SPECIAL INTEREST GROUP

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Case Scenario: 3 to 4 month postoperative CCL reconstruction with a continued lameness. The stifle is stable (no significant drawer sign), no meniscal damage, and there is no edema or swelling present in the stifle. Attempts at typical rehabilitation have not produced successful results (ie, neuromuscular electrical stimulation to the quadriceps and hamstrings, underwater treadmill, land treadmill, balance and proprioceptive work, Theraband, etc.) In addition, all the adjacent joints have been cleared for pathology. Some other areas to examine for compensatory problems:

Are there restrictions in hip flexion from the limb being carried in hip and stifle flexion? Is there a flexed posture of the lumbar spine?

The iliopsoas muscle comprises a fusion of the psoas major and the iliacus. The action of the iliopsoas muscle is to draw the hindlimb forward by flexing the coxofemoral joint. When the femur is in a fixed position, the iliopsoas acts to flex and fixate the vertebral column. (It originates on the transverse process of L2 and L3, attaches by means of the ventral aponeurosis of the quadratus lumborum on L3 and L4, and attaches on the ventral and lateral surfaces of L4, L5, L6, and L7. It then attaches to the trochanter minor of the femur.

As the hindlimb is held in stifle flexion to compensate or protect the CCL reconstruction, the hip is also held in flexion. If the dog does not normally weightbear within 2 to 4 weeks, the iliopsoas becomes tightened and the muscle begins to shorten.

Areas to check:

(1) Measure hip extension with a goniometer and compare it to the contralateral side. Keep in mind that pathology at the hip, such as hip dysplasia, may cause restrictions.
(2) Palpate the iliopsoas—is there pain in this area with palpation? Are there soft tissue restrictions?
(3) Is the spine held in a flexed or tucked under posture? Keep in mind that dogs with spinal stenosis will keep their spine in a flexed or tucked under posture.

Treatment:

(1) Soft tissue massage or cross friction massage to the muscle to facilitate in the elongation.
(2) Stretching of the hip flexors both in a weighted and non-weighted position.
(3) Strengthening of the hip extensors.
(4) Active range of motion and therapeutic exercise to encourage hip extension.

Is there a rotation at the iliosacral joint? Is the cranial dorsal iliac spine located more caudal on the affected side?

(The caudal dorsal iliac spine will also be located more caudal on the affected side.)

If the hip and stifle are held in continuous flexion, a caudal rotation of the ilium can occur on the affected side. If this is not corrected, it will cause a functional leg length discrepancy (because the affected side of the ilium is rotated caudally) or cause a compensation of increased stifle and hock extension in a stance.

Treatment:

(1) Manually mobilize the ilium in to a cranial mobilization to correct the rotation.

(2) Use a muscle energy technique to cause a firing of the hip extensors to correct the rotation. Hold the hip in more flexion and tap or per cuss the gluteal area, attempting to get the dog to contract the gluteals and push in to hip extension. Once the dog is pushing in to hip extension, resist the movement for up to 5 to 10 seconds. Optimally, it should be repeated 3 times.

(3) Both treatments mentioned above may be combined.

****Perform performing stretching and mobilizations, the areas to be treated should be warmed up with modalities, exercise, or massage.*

MEET OUR NEW OFFICERS

Sandy Brown, MSPT, CCRP

Sandy has been treating canine patients for over 5 years. Her private practice, Therapet, is located in the Veterinary Specialty and Emergency Center in Overland Park, Kansas and has the areas only underwater treadmill. Her patients range from elder dogs with osteoarthritis to champions who recently competed at Westminster. Although she treats dogs with a multitude of various diagnoses, she also focuses on canine fitness and conditioning (and in her spare time trains for triathlons).

Charles S. Evans, MPT, CCRP

Charlie is a licensed practicing physical therapist who has worked at the Dartmouth Hitchcock Medical Center in Manchester, NH and at Rehab 3 at Marsh Brook in Somersworth, NH. While at these facilities, he practiced in orthopaedic physical therapy utilizing both land-based and aquatic therapies. Charlie is presently working full time as the Director of Rehabilitation at the Dover Veterinary Hospital. He has had a life-long interest in working with animals and has many years of experience as a veterinary assistant. He received his Masters degree in Physical Therapy from Notre Dame College and has produced research papers in the area of veterinary rehabilitation. In December 2003 he received his certification as a Certified Canine Rehabilitation Practitioner from the University of Tennessee veterinary and physical therapy programs. Charlie is a member of the APTA as well as a member of the Animal Special Interest Group within the Orthopaedic Section. He is the NH Liaison to the Animal Special Interest Group and National Liaison Coordinator for the Animal Special Interest Group.

Susan Giegold, PT, LVT, CCRP

Susan currently works with both human and nonhuman patients in Syracuse, NY. She has been providing rehabilitation services for animals for the past 5 years and is the owner of Four Paws Rehabilitation. She works with several veterinarians in the greater Syracuse area. While most of her nonhuman patients are canine, she has a special interest in feline rehabilitation. Additionally, she is working on her DPT at SUNY Upstate Medical University.

Orthopaedic Physical Therapy Practice Instructions to Authors

Christopher Hughes, PT, PhD, OCS, Editor
Sharon L. Klinski, Managing Editor

1. *Orthopaedic Physical Therapy Practice (OPTP)* will publish articles pertaining to clinical practice. Articles describing treatment techniques as well as case studies and reviews of literature are acceptable. Language and format of articles should be consistent with the *Guide to Physical Therapist Practice*.

2. Manuscripts should be reports of personal experiences and written as such. Though suggested reading lists are welcomed, references should otherwise be kept to a minimum with the exception of reviews of literature.

3. Manuscript Preparation Guidelines
(details can be found at www.orthopt.org)

4. Manuscripts are accepted by mail or electronically. Save your monograph to a 3 1/2" IBM-compatible computer disk in Microsoft Word or plain text format. Provide 2 hard copies of the monograph. Protect any original photographs and artwork for shipment. The manuscript should be sent to:

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