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Physical Therapy Practice

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VOL. 22, NO. 1 2010

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Regular features

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To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

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Guest Editorial

Anthony Delitto, PT, PhD, FAPTA

Richard Earl Erhard, DC, PT
March 21, 1942 - October 3, 2009

When asked to prepare a few words that would pay tribute to Richard E. Erhard, or, as he was known to those closest to him, "Dr E," I felt compelled to simply list his accomplishments in our profession, such as a founding member of AAOMPT, first President of IFOMPT, etc. But the countless accolades that I received over the past few weeks were even more enlightening. Words like "a giant in our profession," a great friend, a great human being and a great professional," I realized that to capture Dr E, you need to know more than his listed accomplishments. You had to explore the source of the words people used to describe him and know that their thoughts came straight from the hearts of people from all walks of life, including patients, students, clinicians, and fellow academicians.

I was left to ponder the sources and reasons for his almost universal appeal professionally. One aspect always came to the forefront: Dr. Erhard was primarily based in the clinic and his teaching and research emanated from his patients. When he taught clinicians, it was always with patients in the forefront. His "students" saw firsthand both his decision-making and his hands-on skills. For those of us fortunate enough to have him as a clinical mentor, you knew within seconds that you were witnessing a master at work. Simply put, Dr E was in his element in the clinic. Mentorship is defined in many ways, especially around the "hallowed halls" of academia and defining mentorship is difficult to capture with words. For the countless clinicians who have taken the time to write to me and his family about Dr. Erhard's clinical mentorship, a definition is unnecessary. He was a mentor in every sense of the word and his mentees witnessed firsthand the results of his clinical encounters, namely, patients got better. For those who heard him in more formal class settings or read his work, his clinical reasoning was not only logical, but it made sense on Monday when you were treating your patients and continued to make sense as you watched the results of your encounters.

Dr. Erhard was one of the principles in the development of the Treatment Based Classification or TBC. Suffice to say that many here at the University of Pittsburgh have made a pretty good living off of the TBC! What cannot be forgotten is the fact that the TBC emanated from the clinic. In documenting Dr. Erhard and Richard Bowling's "The Recognition and Management of the Pelvic Component of Low Back and Sciatic Pain," which was published by the Orthopaedic Section, APTA in 1978, clinicians were allowed a window into the minds of two very gifted clinicians. This work represented Dick and Rick's initial attempts to formalize their thoughts of their clinical observations as well as their mechanistic explanation regarding the sacroiliac joint. Unlike others in the Orthopaedic Physical Therapy world who selectively use literature only when it supports their original views and believe that straying from initial observations is tantamount to heresy, history will confirm that Erhard and Bowling's "first approximation" was not sufficient to either author. Observation was further operationalized and subjected to study and peer-reviewed publication, which in turn modified the TBC. Dr. Erhard was a part of the entire evolution of the TBC from start to finish and was absolutely supportive of the evolution, even when evidence was produced that was less supportive of the initial observations contained in this publication. In essence, he was a true clinical scholar.

The TBC continues to be studied and, in turn, continues to evolve. We have seen other musculoskeletal content areas follow a similar path beginning with clinical observation, measurement, study and refinement followed by further study. This process reminds me of a quote from Winston Churchill, one of Dr. Erhard's favorites: "To improve is to change; to be perfect is to change often." After reading "The Recognition and Management of the Pelvic Component of Low Back and Sciatic Pain," remember to place these thoughts in the context of the evolution of the TBC. Understanding how clinical investigation can refine our thoughts and ultimately lead us to better solutions to serve our patients is the least we can do as a profession to honor the memory of Dr. Erhard. Trust me: he would have it no other way.

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President's Corner

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

The fall has come and gone quickly this year as it seems to do each year. For me, this is in part due to the excitement and anticipation of the college football season. As you follow-up your favorite team through the season there are many highs and lows, always looking forward to the next game until the realization that the season is over.

However the lows associated with the loss of any game cannot compare with the loss of Richard E. Erhard, PT, DC who lost his long battle with cancer on October 3rd. For many of us, Dick was a beloved friend and mentor. For those that did not know him personally, you know of his impact on the practice of orthopaedic physical therapy.

Dick Erhard received a Bachelor's of Science degree from Thiel College in 1964 and received a certificate of physical therapy from the D.T. Watson School of Physiatrics in 1964. He received a Doctor of Chiropractic degree from Logan College of Chiropractic in 1983. Throughout his career, Dick was actively involved in innovative clinical practice that included serving as a director of a hospital and outpatient physical therapy department and owner of a physical therapy practice. Most recently, Dick served as director of physical therapy and chiropractic services for the University of Pittsburgh Spine Specialty Center. Dick served as an assistant professor in the University of Pittsburgh Department of Physical Therapy from 1983 to 2005, where he taught orthopaedic manual therapy. Dick has also served as an adjunct faculty for many physical therapy programs across the country. Dick was a long time member of the Orthopaedic Section and he was one of the founding fathers of the American Academy of Orthopaedic Manual Physical Therapy and served as the first president of the International Academy of Orthopaedic Manual Physical Therapy. Dick was an expert diagnostician and was known for his ability to solve complex clinical problems as well as for his clinical teaching abilities to pass these skills on to future generations.

For much of his career, Dick partnered with Richard W. Bowling, PT, MS to advance the practice of orthopaedic physical therapy. Sadly, Rick has suffered from amyotrophic lateral sclerosis since 1999. In their day, Rick and Dick taught orthopaedic physical therapy to countless physical therapists in Southwestern Pennsylvania and throughout the United States, in what was affectionately known as the "Rick and Dick Show." Many physical therapists, including me, looked to Dick and Rick as their mentor. Mentor is a word that is often overused. A mentor is not only an expert, but someone who is willing to challenge present thinking. Above all, a mentor is someone who gives and is willing to pass on his knowledge to others. When a mentor passes on their knowledge, they not only help others grow and develop, but they spread their knowledge and skill, producing a rippling effect. An example of this "rippling effect" is the work that Dick and Rick did to develop a treatment-based classification system for the evaluation and treatment of low back pain, which has served as the basis to enhance evidence-based physical therapy for the management of low back pain. Their mentorship has directly influenced the work of individuals such as Delitto, Fritz, Wainner, Childs, Hicks, and George, who in turn have influenced many other physical therapists. In this manner, Dick and Rick have truly impacted the practice of orthopaedic physical therapy and it was for this reason that the Orthopaedic Section established the Richard W. Bowling - Richard E. Erhard Orthopaedic Clinical Practice Award. Dick and Rick were the initial recipients of this award in 2007. This year, I am pleased to announce that Anthony Delitto, PT, PhD, FAPTA is the recipient of the 2010 Richard W. Bowling – Richard E. Erhard Orthopaedic Clinical Practice Award which is befitting given the close professional and personal relationship that he had with Dick Erhard and Rick Bowling.

The passing of Dick Erhard was bittersweet in that it allowed me to come to know his family better and it brought many friends and colleagues together to celebrate his life. A memorial service was held at Heinz Chapel on the campus of the University of Pittsburgh, which was followed by a reception that was attended by many well known physical therapists including Stanley Paris, Joe Farrell, Mike Rogers, Dennis Hart, Julie Fritz, John Childs, Michael Cibulka, and Gerard Brennan as well as many physical therapists from Pittsburgh and the surrounding area. This gave everyone the opportunity to share many fond memories of Dick, some serious, some light-hearted, and some that cannot be repeated here.

For me, Dick was an amazing clinician who was able to integrate what the patient said, what his eyes observed, and what his hands felt to provide the right treatment for the patient. While known for his manual therapy skills, what set Dick apart was his ability to integrate exercise and patient education with manual therapy to enable patients to overcome and manage their problem. Personally I benefited from his treatment several times; and more importantly, he treated my wife which got me off the hook more than once! Dick was an extraordinary teacher in the classroom, but perhaps even more so in the clinic. Dick was able to impart his knowledge and manual therapy and clinical decision making skills to students; his clinical teaching skills served as a model for clinical residency programs. Dick had the unique ability to excite students to learn, and he was responsible for a countless number of individuals who became skilled orthopaedic manual physical therapists. Dick viewed every patient as an opportunity to learn and teach.

Dick's contributions to clinical practice far exceeded the care he provided to patients and the students that he mentored. Together with Rick Bowling and Tony Delitto, with the prodding of Steve Rose, Dick developed treatment-based classification guidelines for low back pain, which have subsequently been validated by individuals at the University of Pittsburgh and elsewhere in the United States and around the world. One of his earliest contributions to clinical practice was an article that he published together with Rick Bowling in 1977 in the Orthopaedic Bulletin entitled "Recognition and Management of the Pelvic Component of Low Back and Sciatic Pain." Today, this is the most frequently requested reprint from the Orthopaedic Section and to honor Dick and Rick it is reprinted in this edition of *Orthopaedic Physical Therapy Practice*.

Dick had a zest for life and he brought out the best in those around him. He will be sorely missed. Dick, may you rest in piece and God bless your family.

The Recognition and Management of the Pelvic Component of Low Back and Sciatic Pain

Richard Erhard, PT
Richard Bowling, PT

This article, originally from the Bulletin of the Orthopaedic Section, APTA 1977 Vol. 2- No. 3, pages 4-14, is being reprinted in a modified version of the original article to meet current editorial requirements.

INTRODUCTION

Low back pain and sciatica have been an enigma to practitioners dealing with these entities as evidenced by the waxing and waning of the various theories of etiology throughout the years. We have witnessed the incrimination of the lumbar intervertebral disc following the work of Barr and Mixter,[12] and have observed the current shift of attention toward the articulations of the posterior arch.[13,17,19] The joints of the pelvis have been most notable in that they have been all but excluded from consideration in the ongoing investigation of the perplexity.

It will be our attempt to present a hypothesis that in the lumbar spine and pelvis, a system of functionally interdependent joints exists. Dysfunction in any unit of the system will result in the delivery of abnormal stresses to the other segments of the system with the development of a subsequent dysfunction here as well. Thus, lumbar pain syndromes, especially in chronic cases, may well have more than one source of painful stimuli, each contributing to the clinical picture. This, we feel, accounts for the fact that many approaches to the treatment of the painful back are successful to a greater or lesser extent.

Since the pelvis is the supporting base of the spine, we feel that dysfunction in the sacroiliac joint complex can have a most profound effect on the lumbar spine. The primary focus of this paper will be devoted to a description of the structure, function, examination, and treatment of this area.

STRUCTURE

The bony pelvis in man represents the supporting base of the spine. Functionally, it serves to transmit the force of body weight from the trunk to the lower extremities, as well as to provide a supporting mechanism for the abdominal viscera. Structurally, the pelvis is comprised of 3 bones and 3 joints. The bones are the 2 paired innominates and the sacrum; the joints are the 2 sacroiliac articulations and the symphysis pubis. The shape and dimensions of the pelvis vary significantly in the sexes, with the female generally being described as being broader, shorter, and having a wider pelvic brim for the provision of an efficient birth canal.

ARTICULAR SURFACES

The sacrum is a wedge shaped bone when viewed in the frontal plane with the superior aspect, or base, wider than the inferior apex. However, the sacral articular plane does not follow the general shape of the bone. Krukenberg[8] noted that the sacral articular surface is wedge shaped only in its upper part formed by the first sacral segment and half of the second. Below this, the joint surfaces run nearly vertically and then diverge somewhat, making a flare which tends to lock the sacrum against sliding upward between the ilia. This view is supported by Solonen,[20] who states that as body weight is borne by the sacrum, the downward tapering wedge in the upper part of the joint tends to resist the ventral and caudal movement of the sacral promontory while the upward tapering wedge in the caudal portion of the joint resists the dorsal and cranial movement of the sacral apex. Solonen further states the sacrum, when viewed in horizontal section, converges dorsally in the cranial aspect of the articular surface and ventrally in the majority of cases in the caudal portion of the joint. He also noted that, when viewed in the frontal section, the general shape of the articular cavity is convex laterally so that the greater portion of weight bearing is in the inferior aspect of the joint (Figure 1).

When the articular cavity, or slit, is aligned in a more vertical manner, the body weight is not concentrated in the caudal extent of the joint and the joint is relatively unstable with increased stresses applied to the ligaments. The above description of the joint planes show considerable variation from individual to individual and even from joint to joint. Additionally, there are numerous depressions and elevations on the articular surfaces that effect function. When viewed from the lateral aspect, the sacral articular surface is crescent shaped; forming somewhat of an inverted "L" with a superior and an inferior arm (Figure 2). According to Weisl,[21] the sacral surface has 2 primary elevations, a cranial elevation on part of the lateral aspect of the first sacral segment, and a caudal elevation, which is less prominent. These two primary elevations are separated by a saddle shaped depression in young subjects. In addition to these two primary elevations, others can be present and tend to develop with advancing age.

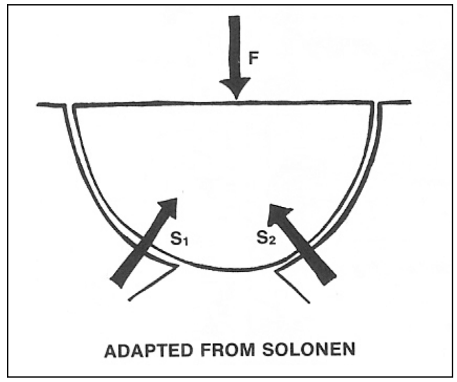


Figure 1.

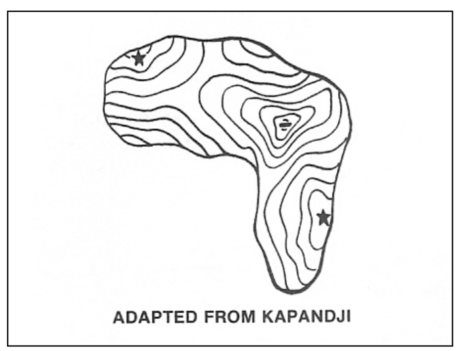


Figure 2.

The iliac articular surfaces are reciprocally shaped to those of the sacrum although they are not identical mirror images. They also tend to be somewhat smaller in area than those of the sacrum.

The articular cartilage is described variably as being hyaline or fibrous and on the sacral side of the joint varies in thickness from 1mm to 3mm. The thickness of the iliac surface is less and is in the range of 1mm. After the third decade, the articular cartilage becomes frayed and roughened.[18]

LIGAMENTS

The intrinsic ligaments of the sacroiliac joint are divided into 2 main categories by Weisl,[22] the capsular ligament and the dorsal accessory. The capsular ligament completely surrounds the joint and its fibers, except in the caudal extent, are continuous with the periosteum.

Dorsally, the fibers of the capsule and the accessory ligament are blended. In other regions the capsule can be distinguished from the overlying structures. The dorsal ligaments are generally accorded as lying in deep, intermediate, and superficial planes, but Weisl has noted that in adults, this stratification is not as striking as the distribution of the fasciculi into cranial and caudal components. The cranial group is directed dorsally and laterally from the sacral attachment while the caudal fasciculi pass in a cranial direction (Figure 3).

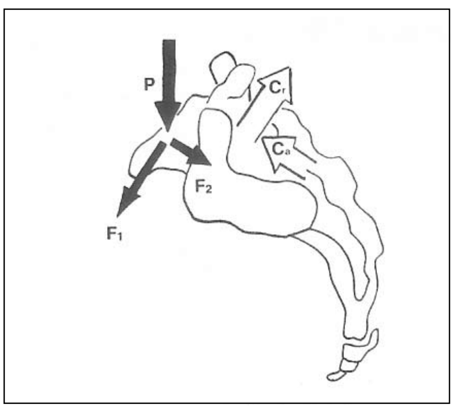


Figure 3.

This arrangement is most pronounced in the deep, interosseous portion of the dorsal ligament. The sacrum is also stabilized by the extrinsic sacrotuberous and sacrospinous ligaments. Both ligaments are well described in standard anatomical texts (Figure 4). These ligaments are extremely powerful and tend to counteract dorsal and cranial migration of the sacral apex during weight bearing. The ilio-lumbar ligament, considered by Grant[3] to be a thickening of the fascia of the quadratus lumborum, attaches to the transverse process of the fifth lumbar and occasionally the fourth lumbar vertebra to the ilium. The effect of this ligament on mechanics will be considered later.

INNERVATION

Solonen,[20] investigated 18 sacroiliac joints and found the innervation of the joint to be variable with the ventral aspect being supplied from L3 to S2 and dorsally from S1 and S2. This wide range in origin of innervation accounts for the diffuse pain patterns observed in the patient with sacroiliac dysfunction, with pain felt in the anterior, lateral, and posterior aspect of thigh and leg as well as the gluteal region.

FUNCTION MOVEMENT

The fact that movement does occur at the sacroiliac joint has been well documented in the literature. Some authors have described only sacral motion,[23] while others cite that only movements of the innominate are possible.[1] The number of theories in the literature concerning motion in the pelvic joints attests to the fact that measurement of these small movements is difficult, and suggests that different types of motion occur from individual to individual. Weisl[21] demonstrated a consistent motion of the sacral promontory in the ventral direction in living subjects cineradiographically. He determined that the motion at times is angular with the axis of motion lying approximately 10 centimeters below the sacral promontory. He also described a linear displacement of the sacrum in a ventral direction, apparently taking place along the longitudinal axis of the inferior arm of the sacral articular surface. His apparatus, however, appears to have precluded the possibility of iliac motion. Colachis et al[1] demonstrated motion between the iliac spines of medical students by embedding Kirschner pins in both posterior superior iliac spines and performing active trunk movements in sitting and standing. They found that movement up to 5 millimeters took place between the iliac spines and that motion was both angular and linear.

In view of the conflicting accounts of pelvic mechanics in the literature, we feel that it is practical to attempt simplification in the manner described by Kaltenborn;[6] who, as does Solonen, feels that the sacral articular surface can be considered in the same manner as any vertebrae possessing a convex articular surface. The only similar articulation within the spinal joints exists at the atlanto-occipital articulation. When gross spinal motions are observed, the only articular surfaces obeying the rules of a convex articular surface will be motion of the occiput and the sacrum. With flexion and extension movements the sacrum glides in the opposite direction of the gross spinal movement. During lateral flexion of the spine (side-bending), the sacrum tilts or side-bends in the opposite direction of the gross movement. Furthermore, this sacral lateral flexion is accompanied by a rotation of the sacrum, ie, gross left side-bending of the lumbar spine results in the right side bending of the sacrum and right rotation of the sacrum. During flexion, the sacrum assumes a more vertical position or extends between the ilia, while on spinal extension the sacrum becomes aligned in a more horizontal position or flexes. These phenomenon can be observed in stress view (flexion/extension or sidebending) radiographs

The motion study conducted by Weisl also seems to support this view since the ventral motion of the sacral promontory he observed as subjects went from the supine to the standing position indicates a sacral flexion as the spine assumes the lordotic or extended position. Moran and Pruzzo[14] describe a similar movement, but feel that this only occurs at the extreme of the range of movement.

Further simplification of the sacral motion is possible if one considers that for practical purposes the only motions permitted are gliding in a ventral and caudal direction (nutation) and the return to the resting position (counter-nutation). Movement beyond this is limited by bony opposition. The ventral movement appears to take place along the superior pole. These gliding movements are limited respectively by the caudal and cranial portions of the accessory ligament (Figure 3).

Sacral motion, except on flexion and extension, is accompanied by paired antagonistic motion of the innominates.[16] The principle movement of the innominate is one of rotation. Many axes have been described for this movement and it appears to lie somewhere in the vicinity of the joint surfaces.

Both types of motion, sacral and innominate, are evident on walking. During stance phase, the innominate on the weight bearing extremity rotates posteriorly at heel strike and remains in this position through mid-stance. From mid-stance to toe-off the rotation converts to an anterior rotation and remains in this position until the next heel strike. The posterior rotation occurs as the result of force transmission via the femur to the acetabulum, which is anterior to the axis of rotation of the innominate (Figure 5). The anterior rotation from mid-stance to toe-off is due to the effect of muscle tension as the hip flexors are passively stretched and exert a downward pull on the anterior aspect of the ilium. There is also a sacral component of pelvic motion during stance phase. As weight is borne on the limb, the sacrum moves in a caudal and ventral direction in relation to the innominate on the weight bearing side.

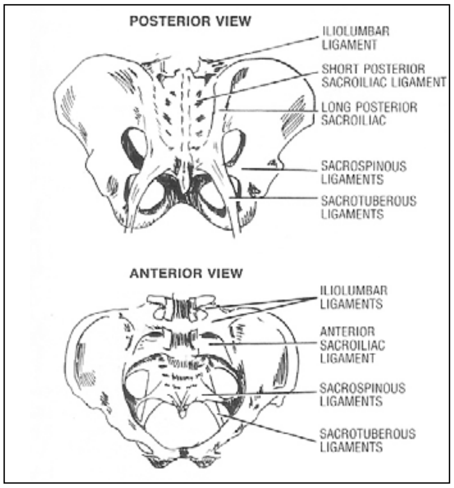


Figure 4.

ILIO-LUMBAR LIGAMENT

The ilio-lumbar ligaments exert an effect on the lower lumbar segments when the pelvic joints are in a state of dysfunction. Consider the patient with a posterior innominate. With posterior movement of the iliac crest, tension is increased in the ilio-lumbar ligament on the side of the posterior rotation. This will result in a posterior migration of the transverse process of L5 and possibly L4, or a rotation of these vertebrae to the same side. Furthermore, there is also a lateral shift of the involved vertebrae to the side of the posterior innominate, and effective lumbar lateral flexion to the opposite side. It is not difficult to envision the deleterious effect that maintenance of this abnormal posture will have on pre-existing lumbar disc or lumbar synovial joint disease (see Figure 4).

LEG LENGTH DISCREPANCY

Leg length discrepancy must be carefully evaluated since it may be either of an anatomical or functional origin. The functional discrepancy may be the result of pelvic imbalances such as an anterior innominate (functional lengthening)

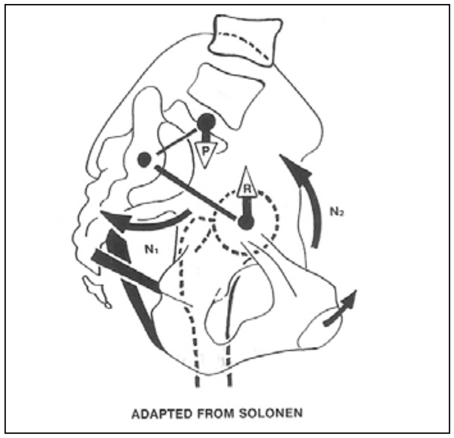


Figure 5.

or a posterior innominate (functional shortening). Any functional component must be corrected before an anatomical or true leg length discrepancy is determined with the standing A-P radiograph of the pelvis. Technical error is a problem, but can be minimized according to the procedure described by Willman.[24]

There is a possibility that anatomical and functional leg length discrepancies will co-exist in the same patient. In fact, this is a rather common finding since a posterior innominate may develop as a compensatory mechanism for a true "long leg". Additionally, when a long leg is present, the pelvis will become inclined in the frontal plane, downward away from the long side. This will cause the articular slit of the sacroiliac joint on the high side to assume a more vertical position and results in abnormal stresses being concentrated at that joint.

INCLINATION OF THE SACRUM IN THE SAGITTAL PLANE

Gutmann[5] has postulated that the sacral inclination can have an effect on the adjacent joints (ie, hip, lumbar) due to an alteration of position of the weight bearing line of the body. He feels that the sacrum in the horizontal position (Figure 6) most likely will result in increased stress on the hip joints and will tend to protect the lumbar spine. The hips are stressed since the line of weight bearing is moved anteriorly and the lumbar spine is spared because with the sacrum in a flexed attitude, it is less stressful for the individual to reach forward to the ground. We feel that it is more likely that the lumbar spine is protected by strong ilio-lumbar ligaments since the horizontal sacrum appears to be deeply set between the ilia. Additionally, in this type of sacrum, providing the facets are in a coronal or oblique plane, they are in a position to bear

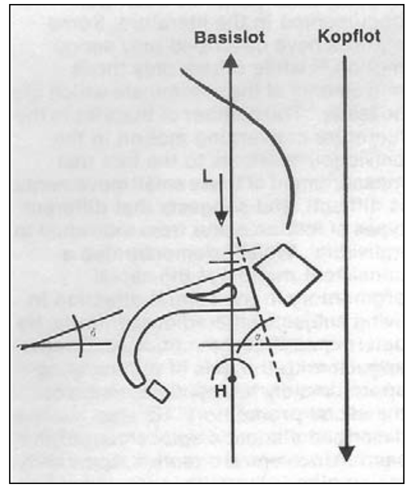


Figure 6.

weight and resist the shearing tendency of the spine to slip anterior into the pelvis. The vertical sacrum, conversely, increases the stress in the lumbar joints and this type of sacrum is usually high-riding between the ilia and is afforded little protection from the ilio-lumbar ligaments (Figure 7). This appears to agree with the findings of Farfan.[4] Farfan reviewed 100 patients with positive myelographic defects proven to be discal in origin with subsequent surgery but failed to find a single prolapse of an L5/S1 disc when the iliac crest was at or above the level of the upper third of the fourth lumbar vertebra.

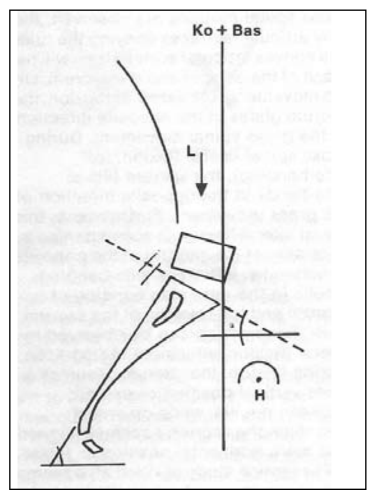


Figure 7.

MUSCLE ACTION ON THE SACROILIAC JOINTS

Although most authors state that there are no muscles acting directly on the sacroiliac joint, these joints are surrounded by the strongest muscles in the body, and it is difficult to dispute the assumption that these muscles can exert an effect on the joint. Consider the iliacus muscle acting on a fixed femur with the lumbar spine stabilized. The resultant motion will be an anterior rotation of the innominate. This sort of muscle activity can be seen in the lower extremity during gait as the soleus has been shown to extend the knee, a joint that it does not cross.[11] In addition to the above type of muscle action on the sacroiliac, insufficiency in muscle length can affect the balance of the pelvic joint system. Using the example of the iliacus, an inadequate or shortened muscle length will necessitate and accentuate an anterior rotation of the innominate during gait.

Another type of muscular influence on the sacroiliac joints is also conceivable. Numerous muscles are attached to the extrinsic ligaments supporting the joint (sacrotuberous, sacrospinous, ilio-lumbar) and activity in these muscles can convert these ligaments into active ligaments to dynamically support the joint or even to move it. The biceps femoris attaches to the sacrotuberous ligament as does the gluteus maximus, while the piriformis arises partially from the sacrospinous ligament and the ilio-lumbar ligament is a fascial thickening of the quadratus lumborum.

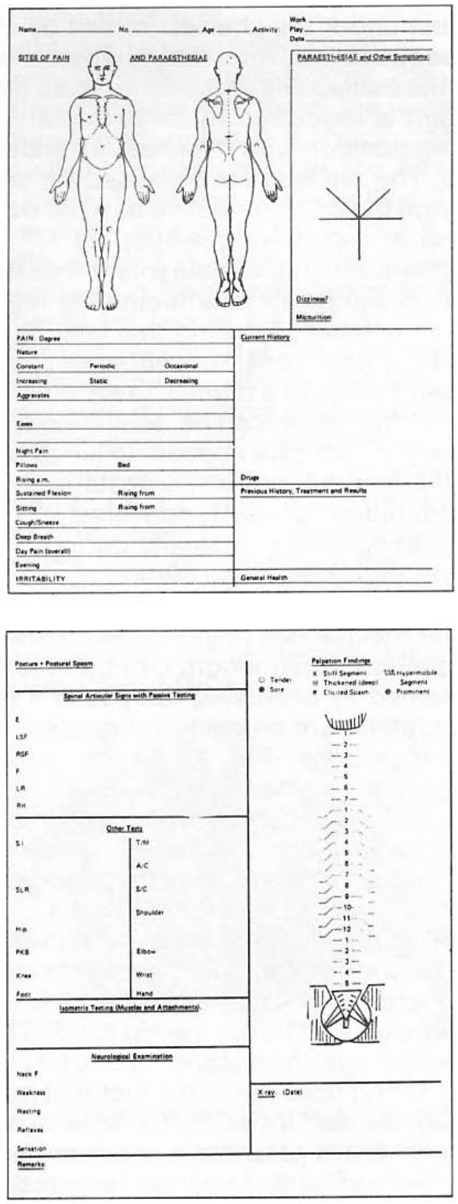
EXAMINATION

Subjective (History)

In the taking a subject history, certain traumatic incidents can lead one directly to the joints of the pelvis. Among these incidents are an unexpected heel strike such as that which occurs when stepping down from a curb or stair; a golf swing; or abnormal stresses with activities such as hurdling or punting a football. The majority of patients, however, present with the typical history of acute or chronic back pain, with or without sciatica, which may arise from the lumbar intervertebral disc, the posterior articulations, or the pelvic joints. Of course, a complete history is indicated; but due to the intent of this article, we will focus on the following pertinent questions. A sample of the examination form we use is provided (Figure 8).

What Effect Does Sitting Have On Your Pain?

An increase in pain with prolonged sitting is not particularly common in the patient with sacroiliac dysfunction. Rather, this response is typically indicative of pathology in one or more intervertebral discs. This observation is supported by the findings of Nachemson,[15] who experimentally demonstrated that the intradiscal pressure is at a maximum in the sitting position, especially when the trunk is in a posture of slight flexion.


Name ________ No. ________ Age ________ Activity: Work ________ Play ________ Date ________

SITES OF PAIN AND PARAESTHESIAE

PARAESTHESIAE and Other Symptoms:

Dizziness?

Micturition

PAIN Degree
Nature
Constant Periodic Occasional
Increasing Static Decreasing
Aggravates
Eases
Night Pain
Pillows Bed
Rising a.m.
Sustained Flexion Rising from
Sitting Rising from
Cough/Sneeze
Deep Breath
Day Pain (overall)
Evening
IRRITABILITY

Current History

Drugs

Previous History, Treatment and Results

General Health

Posture + Postural Spasm

Palpation Findings
□ Tender
● Sore
X Stiff Segment
/// Thickened (deep)
\# Elicited Spasm
Hypermobile Segment
● Prominent

Spinal Articular Signs with Passive Testing
E
LSF
RSF
F
LR
RH

Other Tests
S I
SLR
Hip
PKB
Knee
Foot
T/M
A/C
S/C
Shoulder
Elbow
Wrist
Hand

Isometric Testing (Muscles and Attachments)

Neurological Examination
Neck F
Weakness
Wasting
Reflexes
Sensation

X-ray (Date)

Remarks

Figure 8.

What Effect Does Standing Have On Your Pain?

Pain exacerbated by standing, again, is usually not indicative of the sacroiliac lesion unless the patient stands with the major portion of body weight borne on the involved extremity. The patient with pain increased on standing and relieved by sitting and walking, most likely has dysfunction in a lumbar segment with over-riding of the articular processes, ie, segmental hyperextension.[10] The relief of pain on sitting usually occurs when the patient assumes a kyphotic posture in the lumbar spine with a reversal of the abnormal resting position. Walking necessarily involves rotation and sidebending in the lumbar spine which is accompanied by flexion within the segment.[9] Additionally, the aforementioned motions within the segment activate mechanoreceptors which can inhibit the perception of painful stimuli.[25]

What Effect Has Walking On Your Pain?

Typically, walking will aggravate the pain arising from a pelvic joint, in most instances during stance phase on the involved extremity. This we feel is the result of innominate rotation as well as a caudal and ventral movement of the sacrum.

INTERPRETATION

It is imperative to interrogate the patient in detail with respect to the effect of these three activities on their symptoms. Equally, it is important to correlate quantitatively, the response to all queries, as there may be more than one pathological condition present. Proper interpretation of the above questions is extremely helpful in the assessment of the patient with back and sciatic pain and in planning the treatment routine of the present condition. Remember, however, that there is a functional interdependence in the joints of the lumbar-pelvis-hip complex, and long term management dictates attention to all components of the system.

OBJECTIVE EXAMINATION

The objective examination begins with observation of the patient as he arises from sitting in the waiting room and walks into the clinic. This is best accomplished with the patient unaware of the examiner's scrutiny.

Standing Posture

With the patient standing, posture is observed first from the posterior aspect, noting the position of the thoraco-lumbar spine for such abnormalities as scoliosis, kyphosis, and/or lordosis. The posture of the feet (pronation/supination) and knees (hyperextension, varus, valgus) are also noted at this time. Variations in the resting position of these joints can be the result of compensation for a long standing leg length discrepancy.

The position of the cervical spine is best observed from the anterior aspect. Abnormal mechanics in the pelvic-lumbar region may be compensated in the upper cervical region with variations of the resting position (rotation, side-bending) in order that the eyes remain level.

STATIC PELVIC EXAMINATION

Static evaluation of the pelvis in the standing position is performed by comparing the levels of the posterior superior iliac spines, iliac crests, and the anterior superior iliac spines. In assessing the levels of the posterior superior and anterior superior spine, the examiner must place the thumbs inferior to the respective landmarks and move in a cranial direction so that the thumbs come to lie under the ledges formed by the posterior superior and anterior superior spines. Only in this manner can an accurate estimation of the relative levels be made. To compare the levels of the iliac crests, soft tissue must be pushed out of the way in order that the index fingers lie as closely to the crests as possible. The most common finding in this examination is the posterior innominate. In this patient, provided there is no anatomical leg length discrepancy, the posterior superior spine will be lower than the opposite side. The reverse will be found with the anterior innominate (Figure 9).

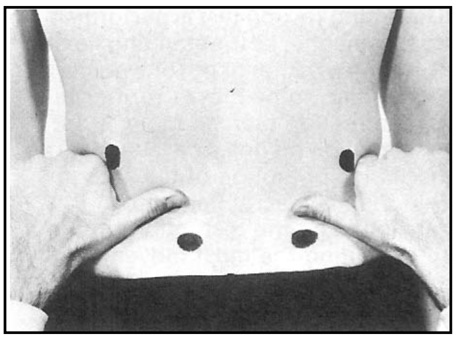


Figure 9.

ACTIVE MOVEMENT OF THE LUMBAR SPINE

In the standing position, the movements of the lumbar spine are observed, including backward-bending, side-bending bilaterally, and finally forward bending. In most cases of sacroiliac dysfunction, the patient will experience an exacerbation of pain with side-bending toward the painful side, although this is not uniformly observed.

STANDING FLEXION TEST

The thumbs are placed under the ledges of the posterior superior iliac spines and the patient is requested to bend forward as far as possible while the extent of cranial movement of each point is observed. If one posterior superior spine moves further in a cranial direction than the other, a motion restriction is present on that side. This finding must be correlated with the static pelvic examination, long sitting test, and prone knee flexion to 90° in order to determine what lesion is present. This test is specifically used to study the movements of the ilia on the sacrum.

TOE WALKING

The patient is requested to walk on his toes in order to quickly assess the strength of the triceps surae and rule out the possibility of interference of conduction via the S1 and S2 nerve roots.

HEEL WALKING

Heel walking ability is dependent on the integrity of ankle dorsiflexion power and inability to do so suggest involvement of the L4 and L5 nerve roots.

SITTING POSITION

In the sitting position, spinal posture is again observed, thus the effect of a leg length discrepancy can be noted by comparing the observations in sitting to the previous observations of the patient in standing.

SITTING STATIC PELVIC EXAMINATION

The same bony landmarks, anterior and posterior, are observed as in the standing examination of static pelvic posture.

SITTING FLEXION TEST

The sitting flexion test is performed in the same manner as the standing flexion test, noting whether or not one posterior superior iliac spine moves further in a cranial direction than its mate. More cranial motion on one side, suggests an abnormality of motion of the sacrum within the ilia (sacral flexion or extension), and the restriction is on the side exhibiting the most movement cranially. This test must then be correlated with the findings of sacral position palpation and the provocation test of the sacrum.

SITTING ROTATION

Active and passive trunk rotations are performed in the sitting position. This test is most useful in assessing the state of the thoracic spine and will not be discussed in detail here.

KNEE JERK

The status of the deep tendon reflex of the quadriceps is observed to determine the state of the L3 and L4 nerve roots. (There should be some reference made to the testing of the Ankle Jerk (Achilles Reflex), as this is typically done here in the seated position, not where it is later included during the prone examination)

STRAIGHT LEG RAISING

Straight leg raising is perhaps the most important examination procedure in assessing the patient with lumbar or sciatic pain. In the performance of the test, the examiner grasps the patient's ankle on the side to be tested while palpating the medial hamstrings with the opposite hand. It must be remembered that one is looking for limitation of movement during the test and not merely for pain. The patient is requested to report when and where pain is felt, but the examiner must persist in the movement carefully in order that a painful arc will not be misinterpreted as an actual limitation. We feel that limitation of straight leg raising to 35° or less is a frank neurological sign, highly suggestive of nerve root involvement secondary to a herniated nucleus pulposus. Limitation of the movement above this point is usually due to soft tissue contracture or a mechanical dysfunction, either at a lumbar joint or a pelvic joint.

RANGE OF MOTION OF THE HIP JOINT

The range of motion at the hip is determined in flexion, medial rotation, and lateral rotation. The presence or absence of a capsular pattern is noted. At this present time the examiner will also note a Cyriax sign of the buttock if present,[2] which is limited straight leg raising, limited hip flexion with the knee flexed, and a noncapsular pattern of restricted movement at the hip. If the sign of the buttock is found, serious pathology must be ruled out in the gluteal region as well as the upper femur.

MUSCLE BALANCE

The sufficiency in length of the musculature about the hip is tested with passive movements noting any shortening. Assessing the range of motion permitted by the rotators of the hip necessitates using both the flexed (seated) and extended (prone) position as different muscles perform the function of rotation in each position. If shortening or insufficiency is found, the muscles are stretched with any of the conventional techniques. We prefer contract-relax or hold-relax techniques. Attention to this detail is important in the long term management of the patient.

KEY MUSCLES

A key muscle from each myotome in the lower extremity is examined with manual resistance in a search for weakness indicative of impaired conduction via its respective nerve root. The following muscles are tested:

- Iliopsoas L1-2

- Quadriceps L3-4
- Tibialis Anterior L4
- Extensor Hallucis Longus L5
- Peroneus Longus and Brevis S1

SENSORY EXAMINATION

The sensory examination is performed in the supine position in a search for any alteration in sensibility in the dermatomes of the lower extremities.

LONG SITTING TEST

The long sitting test is an indicator of abnormal mechanics of rotation of the innominate on the sacrum and is used in conjunction with the standing flexion test to determine the presence of an anterior or posterior innominate. The patient lies supine on the table while the examiner observes the relative levels of the medial malleoli. This is done by placing the thumbs just distal to the prominences of the malleoli so that they lie just under the shelves formed by these structures. After noting whether or not the malleoli lie at the same level, the patient is requested to come into a sitting position with the knees extended fully. The malleoli are observed for any change in position relative to what was found in supine lying. Abnormal mechanics of innominate rotation on the sacrum will result in a fluctuating leg length imbalance during this test. By recalling which posterior superior spine moved further in a cranial direction during the standing flexion test, the side of the lesion can be determined. If the leg on that side appears to lengthen on the long sitting test, a posterior innominate is present; conversely, shortening of the extremity during sitting indicates the presence of an anterior innominate.

The mechanism responsible for the fluctuation of leg length can be readily explained by observing the position of the acetabulum on posterior rotation of the innominate (Figure 10). As the innominate rotates in a posterior direction, the acetabulum moves in a superior and also in a ventral direction. The superior migration is responsible for the apparent shortening of the involved limb in the supine position and the ventral displacement accounts for the increase in leg length when the patient sits and flexes the hip at 90°. The disadvantage of the standing flexion and long sitting tests lies in the fact that they cannot be performed by the acute patient. If this presents a problem, the prone knee flexion to 90° represents the alternate test, and additionally is used to corroborate the findings of the two preceding procedures.

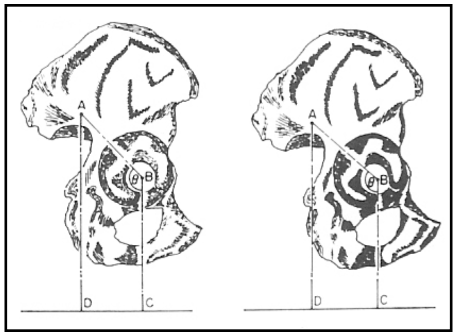


Figure 10. The diagram on the left is the neutral position. The right illustrates posterior rotation, Line A.D. is shorter (short in supine position) and line D.C. is longer (long sitting position).

PRONE KNEE FLEXION TO 90° (LEG LENGTH FLUCTUATION)

The patient lies prone with the cervical spine in the neutral rotation position and the arms resting comfortably at the sides. The test is best performed with the shoes on. The examiner stands at the foot of the table, and grasps the patient's feet with the thumbs passing transversely just anterior to the heel of the shoe and the index fingers just posterior to the lateral malleoli and distal fibular shafts. The feet are held in the same degree of pronation/supination and slightly externally rotated. At this point, the relative apparent lengths of the lower extremities are noted. The shorter of the two will be considered to be the side of the lesion. The knees are now flexed to 90° and any change in the apparent length is noted. If the short leg appears to increase in length and becomes the longer of the two as the test is performed, we consider this to represent a posterior innominate on that side. Conversely, if the short side stays or becomes even shorter, an anterior innominate is present. It is extremely helpful to have a table with a drop away foot plate to eliminate as much error as possible in this test. The mechanics of this test are not clear, but seem to be related to the state of the rectus femoris and the tensor fascia latae (Figure 11).

OBSERVATION OF THE GLUTEAL TONE

In the prone position, the examiner stands at either the foot or head of the table and observes the gluteal region for flattening of diminished mass when compared to the opposite side. The two sides can then be palpated and the flattened side will often possess a "mushy" feel. These two findings may be present with sacroiliac dysfunction

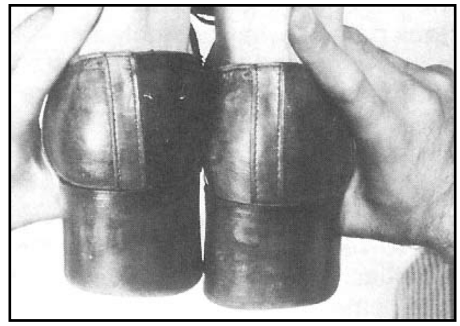


Figure 11.

although root involvement at L5 - S2 must be ruled out as well as hip joint disease.

FEMORAL NERVE STRETCH

The femoral nerve stretch is analogous to the straight leg raising test, and must be performed in 2 parts. First the patient is placed in the prone position and the knee is passively flexed as far as possible, comparing the range from side to side. The patient is asked to report the production of pain and it is extremely important to determine exactly where the pain is felt. At times the pain is in the mid-lumbar region and alternatively it is at the anterior aspect of the thigh in the third lumbar dermatome. Anterior thigh pain may also result from stretch of the quadriceps femoris and the second portion of the examination is done for this reason to avoid misinterpretation. This consists of flexing the patient's knee to 90° and passively extending the hip, a movement which also stretches the femoral nerve. The location of pain on this maneuver is again determined. The provocation of thigh pain on this portion of the femoral nerve stretch would be considered to be positive although the presence of back pain only is a questionable sign since this procedure necessarily involves passive movement in both the pelvic and lumbar joints.

RESISTED KNEE FLEXION

Resistance is applied to the hamstrings in search of weakness to further corroborate any findings on toe walking, resisted ankle eversion or the ankle jerk, all of which point to the interference of conduction along the S1 nerve root.

PASSIVE MEDIAL ROTATION OF THE HIP

Passive medial rotation is also tested in the prone position as it is much easier to demonstrate minor restriction, which may be the only indicator of a capsular pattern at the hip. In this position, the test can be done simultaneously on each leg. As previously stated, the muscles performing rotations of the hip change in various positions of hip flexion and extension. Limitation of medial rotation with the hip flexed and disappearing with the hip in neutral may indicate spasm or insufficiency of the piriformis muscle.

ANKLE JERK

The deep tendon reflex of the triceps surae is elicited in the prone position with the knee flexed and the ankle passively dorsiflexed slightly. A diminished or absent reflex is indicative of impaired conduction of the S1 root.

SENSORY

The sensory examination of the posterior thigh is now undertaken with particular attention paid to the saddle region if there has been any indication of bowel or bladder dysfunction in the history.

SPRING TESTING

The examiner places the pisiform (wrist held in extension and the fifth finger abducted) over the sacrum and imparts an anterior thrust to the bone in an attempt to provoke pain. Then a similar movement is done successively over the spinous processes of the vertebrae from L5 up through the thoracic spine. While the spring test is done, one looks for pain, reflex muscle guarding in the paraspinal musculature, as well as the range of movement at the various levels tested (Figure 12).

MOBILITY TESTING

Due to the scope of this paper only the mobility tests of the sacroiliac will be described, although testing is also performed in the thoraco-lumbar spine as well as the hip joint. If pain is provoked on spring testing over the sacrum, we now proceed to mobility testing of the sacroiliac joints. With the patient in the prone position, the examiner places the heel of one hand over the apex of the sacrum. The other hand is positioned to palpate movement in each sacroiliac successively, by placing the tip of a finger just medial to the PSIS first one side, and then on the other. The movement is imparted by the heel of the hand pressing the sacral apex forward toward the table. Although the sacroiliac joint cannot be directly palpated, the palpating finger is used to assess the relative motion that occurs between the PSIS and the dorsal aspect of the sacrum (Figure 13).

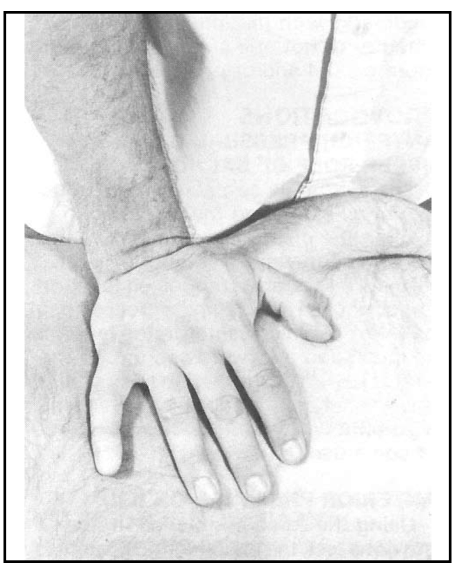


Figure 12.

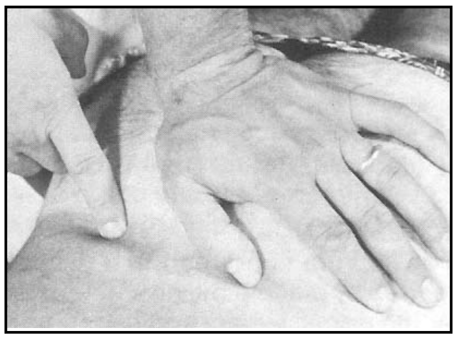


Figure 13.

PALPATION OF SACRAL POSITION

Sacral Sulci

The depth of the sacral sulci, just medial to the PSIS is compared bilaterally. If one side is felt to be apparently deeper than the other, this may be interpreted as either a forward position of the sacrum on that side or a posterior position of the ilium (posterior innominate).

Inferior Lateral Angle

The relative prominence of the inferior angles of the sacrum is then compared. The examiner assesses the position of these landmarks with particular attention to whether or not one side appears to be more caudal and/or posterior.

PROVOCATIONS

ANTERIOR PRESSURE ON THE UPPER POLE OF SACRUM

The sacrum is contacted at its upper extent by extending the wrist and placing the pisiform just medial to the PSIS and applying an anteriorly directed thrust. The patient is requested to report any change in symptoms. Increased pain on this maneuver is interpreted by some as indicating a forward sacrum on the side of pain. In our experience, however, this has not proven to be a highly reliable sign, although in difficult cases it may be of some use.

ANTERIOR PRESSURE ON ILIUM

Using the same contact as in the previous test, the examiner now applies an anterior thrust over the PSIS. Interpretation of the findings is carried out in the same manner and again is not highly reliable in our opinion.

SACRUM CRANIAL

Movement on the lower pole of the sacrum can be assessed by contacting the sacrum, at the inferior lateral angle with the ulnar border of the hand. While stabilizing the ilium with the opposite hand, the sacrum has moved in a caudal direction, which is usual, and would indicate the direction of reduction (Figure 14).

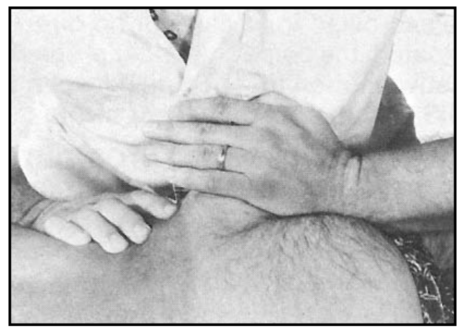


Figure 14.

SACRUM CAUDAL

The sacrum is pressed in a caudal direction by placing the heel of the hand over the dorsal aspect and taking up the skin slack. The examiner now thrusts the sacrum caudally. Increased pain is interpreted as resulting from a caudally placed sacrum. As indicated in earlier discussion, the palpation of sacral position and the provocation tests are not highly reliable signs of sacroiliac dysfunction and must be interpreted with caution. When correlated with the findings of the preceding examination, they may be of some help in the investigation of the difficult patient (Figure 15).

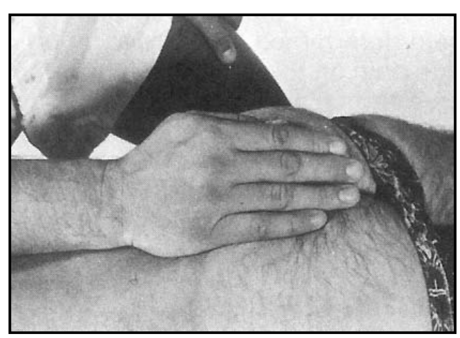


Figure 15.

RADIOLOGY

The erect pelvic A-P view is very helpful in assessing the components of the lumbar, pelvic hip unit. The hip joints are visualized as are the joints of the pelvis along with at least L4 L5. The acetabular rims and head of femurs are compared first to determine actual leg lengths, since subsequent findings must be interpreted in light of that impression. The hip joints are examined next then the following landmarks are compared:

(1)The shape and size of the obturator foramen
(2) Levels of pubic bones at symphysis
(3) Widths of the ilium
(4) Heights of the iliac crests
(5) Pelvic brim for asymmetry

The lumbosacral complex is then examined for tilting of the sacrum in the frontal plane.

(1) The level of L4 in relation to the iliac crests
(2) The presence of scoliosis
(3) The size of the transverse processes of L5
(4) The direction of the facets

Inclusion of L3 is necessary in interpreting the last 3 points.

INTERPRETATION OF ILIAC ROTATION

Providing the legs are of equal length, the x-ray could have the following appearance, the obturator foramen on the side of posterior rotation is larger than its fellow. The pubic bone is higher at the symphysis. The ilium appears narrower and the crest is higher with resulting asymmetry of the pelvic brim. The sacrum is tilted to the side of rotation.

Unfortunately, all of these appearing in the same subject are rare. Usually there are other variables, such as leg length discrepancies and sacral torsion problems, ie, sacrum moving in fixed pelvis which confuses the viewer. In any case, the radiological findings should be used to confirm the diagnosis or aid in the examination rather than substitute.

LUMBO SACRAL INTERPRETATION

Farfan has stated, "we therefore, conclude that a large transverse process on the fifth lumbar vertebra protects the lumbo sacral joint from degeneration. We also conclude that the very stability of the fifth lumbar vertebra may induce early degeneration of the L4-5 joint." A large transverse process is when they are larger than most of L3.

Clinically, we have seen the difficulty in finding the lowest mobile segment in managing the patient with deep set L5, horizontal sacrum and hypermobile L4 with or without large transverse process. An x-ray then is a necessity before interpreting mobility testing in this body type. We have not seen a tilted sacrum without some degree of scoliosis. The facets at the lower levels can be visualized. In addition to looking for asymmetry, their directions can be determined allowing more effective mobilization as well as an indication of possible pathology. Farfan reported that in 100 positive myelograms, 51 cases were proven unilateral of which 49 had disc protrusion on the side of the more oblique facet. The remaining cases were bilateral or central, and in 28 of those cases facet asymmetry was obvious.

POSTERIOR INNOMINATE

The patient presents with unilateral buttock pain. He may possibly also have pain in the posterior, lateral, or anterior thigh. At times all of these areas are painful. The pain is usually well defined in the region of the posterior superior iliac spine on the involved side. The static pelvic examination reveals a PSIS that is lower on the side of involvement and an iliac crest and ASIS that is higher on the same side. The presence of an anatomical long leg may confuse this issue, but careful observation will reveal that the relative difference in the heights of the crests and ASIS are greater than the difference observed at the PSIS although all three are elevated on the same side. This is an attempt by the body to compensate for the leg length discrepancy. In long standing cases one may also observe variations in the posture of the knees and feet which we also consider to be compensatory in nature.

On active movement of the lumbosacral spine, the patient usually experiences an exacerbation of pain on side-bending to the side of pain and also on backward-bending. This, however, is not a constant finding. The standing flexion test is positive and the long sitting test will demonstrate lengthening of the lower extremity on the involved side. Prone knee flexion to 90° will also be positive for a posterior innominate. In the prone position, flattening of the gluteal muscle mass is often observed. Spring testing over the sacrum may produce the pain complained of and should be followed by mobility testing of the sacroiliac joints. The neurological examination will be negative in the absence of co-existing lumbar root disease or cord pathology at a higher level. On occasion, the sacral position palpation and provocation tests may be utilized if further information is sought.

MUSCULAR CORRECTION OF POSITION

The patient lies supine with the involved extremity resting just over the side of the treatment table. The operator stands on the side of involvement facing the patient. The pelvis is stabilized on the opposite side by reaching across the patient with the hand nearest the patient's head. The hip on the involved side is not permitted to extend as far as possible while allowing the knee to flex comfortably. The operator's opposite hand is now placed just proximal to the knee and the patient is requested to attempt to flex the hip against the therapist's unyielding resistance. The contraction is maintained for 3 to 5 seconds and as the patient relaxes, the slack is taken up by pushing the hip into further extension. This maneuver is repeated 4 to 5 times and the salient portions of the examination are repeated to determine if any change has been made in the clinical signs. If needed, the procedure is repeated (Figure 16).

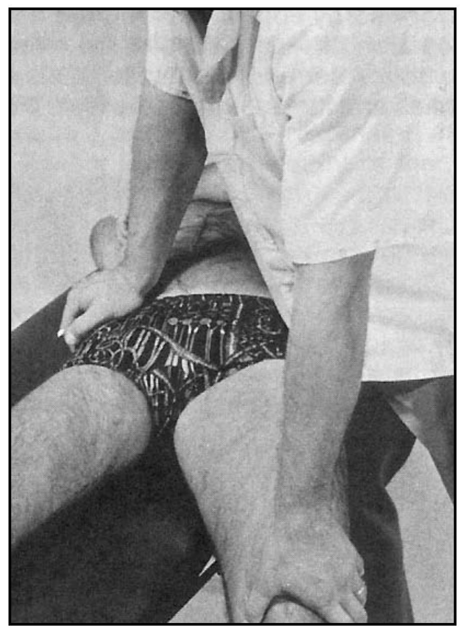


Figure 16.

PRONE MOBILIZATION

The patient is placed prone on the treatment table with the noninvolved leg over the side of the table in order that he may kneel on a padded stool. The therapist positions a folded towel under the ASIS on the noninvolved side and also under the upper thigh on the involved side. Now, by standing on the noninvolved side, the therapist grasps the involved extremity proximal to the knee and extends the hip while maintaining the hip in 15° to 20° of abduction. The hand closest to the head of the patient now is placed over the iliac crest, just lateral to the PSIS and a series of mobilization thrusts are performed, directed in an anterior, lateral, and superior direction. The patient is re-examined following the procedure (Figure 17).

SUPINE MANIPULATION

With the patient in the supine position, the therapist stands on the side of the posterior innominate and places the patient in a position of lateral flexion away from the involved side. The patient now places his hands behind his neck and the therapist interlaces the arm nearest the patient's head in the manner shown in Figure 18. The patient is rotated toward the therapist while the opposite hand prevents the pelvis from coming up from the table on the opposite side. Care must be taken in positioning the patient not to lose the sidebent position of the lumbar spine.

Once the slack is taken up, the thrust is made over the contralateral anterior superior iliac spine in a lateral, superior, and posterior direction (Figure 19). In our experience, this has proven to be the most beneficial technique. However, some patients particularly in the acute phase, are unable to tolerate the positioning prior to the thrust. In addition, if there is strong clinical evidence of lumbar disc disease, we feel that this procedure is contraindicated due to the rotational component involved in positioning.

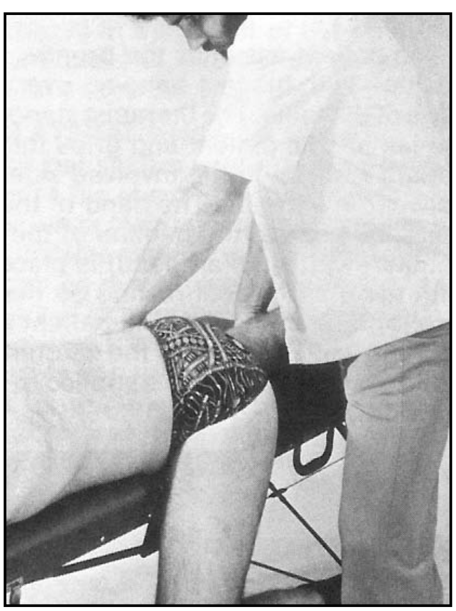


Figure 17.

ANTERIOR INNOMINATE

Quite often the patient with an anterior innominate presents with a pain pattern not at all unlike the distribution described for the posterior innominate, although leg pain may not be as well defined nor as severe. The static pelvic examination demonstrates a posterior superior iliac spine will be higher. The standing flexion test will be positive on this side and the long sitting test will demonstrate an apparent decrease in leg length on the involved side as the patient assumes the sitting position. The prone knee flexion test to 90° will be positive for an anterior innominate. Interestingly, these patients quite often complain more severely of cervical pain with the lumbar symptoms mentioned only casually. As in the case of posterior innominate, lumbar disc disease must be ruled out by the absence of neurological and other localizing signs.

MUSCULAR CORRECTION OF POSITION

The patient assumes the supine position with the therapist standing on the side of the anterior innominate. The patient flexes the hip and knee as far as possible and the therapist now positions his hand most caudal to the patient under the ischial tuberosity and the opposite hand over the anterior iliac spine. While maintaining this hand position, the therapist's chest is placed over the anterior aspect of the leg and the slack is taken up in the hip and knee flexion. At this point, the patient is requested to attempt hip extension while the operator resists the movement with his chest. The patient then relaxes and the slack of hip and knee flexion is again taken up, while simultaneously a posterior rotation is produced by a downward pressure on the anterior superior iliac spine and an upward pull on the ischial tuberosity. A series of 3 to 5 movements are repeated and the patient is re-examined (Figure 20).

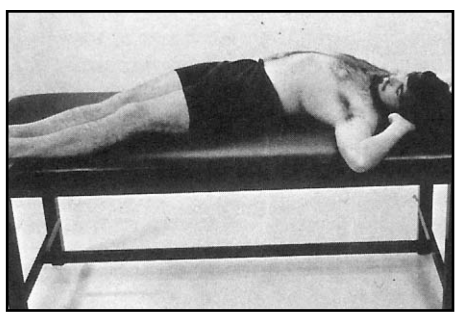


Figure 18.

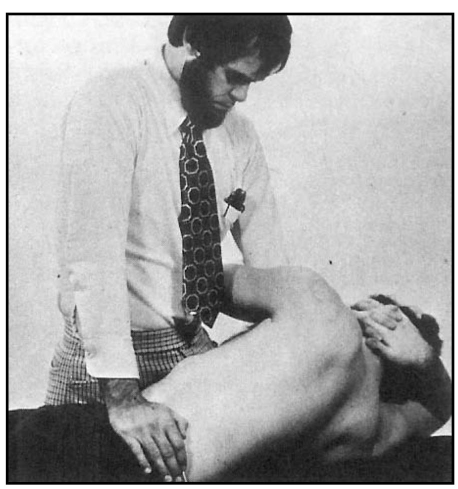


Figure 19.

SUPINE MOBILIZATION

The therapist stands on the side of the lesion with the patient supine on the table and the ilium just resting off the edge of the table. The hand most caudal to the patient is placed under the ischial tuberosity and the opposite hand over the anterior superior iliac spine. The therapist places his chest over the anterior aspect of the patient's leg with the hip and knee flexed in much the same manner as the previous technique except that his body is turned so that he faces the patient's opposite shoulder. The mobilization is performed by pressing posteriorly on the anterior super iliac spine while at the same time pulling forward on the ischial tuberosity with the opposite hand (Figure 20).

A series of 6 to 8 mobilizations are performed and the patient is re-examined.

SUPINE MANIPULATION

This technique is identical to the manipulative procedure described for the posterior innominate except that the therapist now stands on the opposite side of the lesion (see Figure 19).

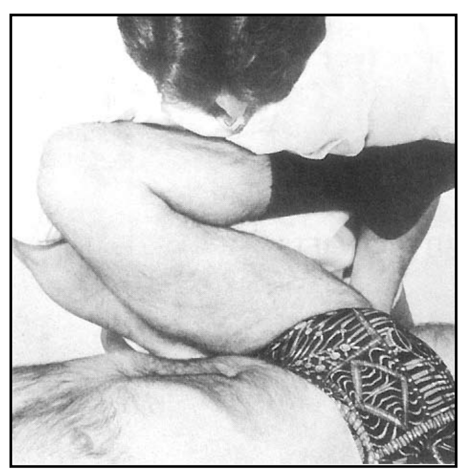


Figure 20.

SACRAL POSITION

If during the static pelvic examination the positional relationships appear to be normal and the patient exhibits sacroiliac signs, the sitting flexion test is useful in detecting abnormal mechanics of sacral motion within the ilia. The sacral position is palpated and followed by the provocation tests. As indicated in the section under examination, these tests are vague at times, but a trial treatment is warranted. In addition, if either the posterior or anterior innominate proves resistant to treatment, an in depth examination of sacral motion is indicated as a larger than usual sacral component may be present. Since the direction of sacral motion is nearly always in a caudal or ventral direction, only the treatment of these conditions will be discussed.

SACRUM CRANIAL (ILIUM CAUDAL)

The patient assumes the prone position with his feet hanging over the edge of the table. The therapist stands at the feet of the patient and grips the patient's ankle on the involved side between his thighs. The hand of the therapist nearest the midline of the patient (right side/left hand) is placed with the ulnar aspect resting on the inferior lateral angle of the patient's sacrum. This hand fixes the sacrum while a longitudinal pull is applied to the leg via the ankle (Figure 21).

DIRECT POSTERIOR-ANTERIOR THRUST OVER SACRUM

The patient is in the prone position with the therapist standing at the side of the table. If the position test and provocation test corroborate one another, the thrust is applied over the most posterior inferior lateral angle. The therapist places the heel of the hand most cranial to the patient over the

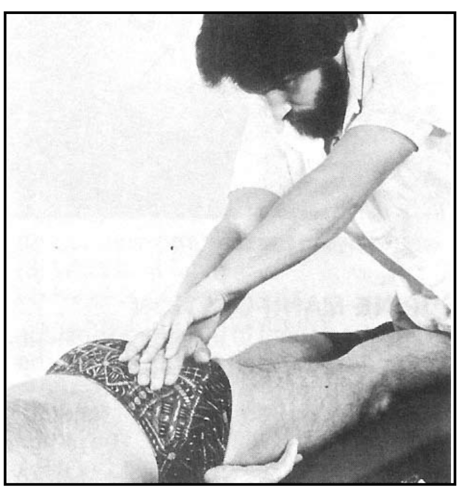


Figure 21.

inferior lateral angle of the sacrum with the opposite hand superimposed transversely over his hand. The slack is taken up and a low amplitude high velocity thrust is applied. If the positional and provocational tests do not correlate, then the thrust is delivered over the midline at the distal extent of the sacrum (Figure 22).

Figure 22.

LUMBAR-PELVIS-HIP SYNDROME (L-P-H)

The patient usually presents with unilateral lumbar, buttock, and posterior thigh pain. Occasionally groin pain is present as well. The active lumbar movements may be painful, passive movement of the hip, especially medial rotation, provoke the pain and a capsular pattern of Cyriax may be present at the hip. Spring testing over the sacrum and/or lumbar spine is often positive. At times it is extremely difficult to determine from what region the symptoms are eliminating, and herein lies the value of the following procedure as it at once exerts an effect on all three components.

UNILATERAL LEG PULL

The patient is positioned supine with the therapist standing at the foot of the table on the involved side. He grips the involved extremity just proximal to the ankle and positions the hip in approximately 30° of flexion, 15° to 20° of abduction, and slight lateral rotation. The mobilization procedure is performed by applying a longitudinal force along the long axis of the femur and tibia. A series of 8 to 10 pulls are applied and the patient reassessed (Figure 23).

ACTIVITIES OF DAILY LIVING RESTING POSITION (NONWEIGHT BEARING)

We have found the supine resting position advocated by Fahrni to be clinically efficacious in the vast majority of patients.

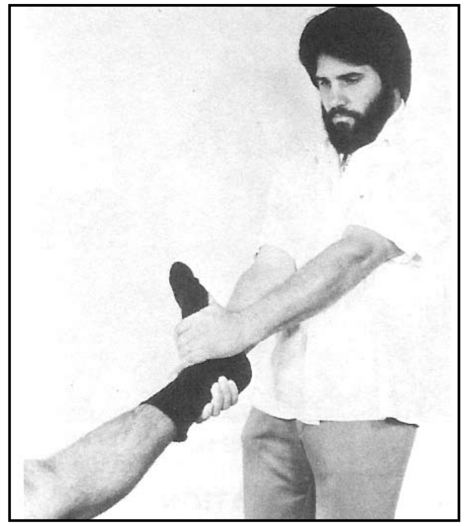


Figure 23.

Rarely a patient is found who is exacerbated by this position and the alternative is supine lying with the lumbar lordosis supported by a pad in the manner described by Cyriax and MacKenzie.

WEIGHTBEARING (SITTING)

The patient is instructed to sit with a maintenance of the lumbar lordosis, not so much for influence on the sacroiliac joint as for the lumbar joints as this is the position of least intradiscal pressure in the sitting position. Sustained leg crossing is discouraged as this seems to predispose to a posterior innominate, especially so in the case of a hypermobile sacroiliac joint.

STANDING

Again, the patient is encouraged to maintain the lumbar lordosis; and additionally, prolonged standing on one leg is discouraged.

WALKING

When the sacroiliac or hip components predominate, walking is discouraged in the acute stage. As the condition improves when the patient does resume walking, he is instructed to avoid hard heel striking and to shorten the stride length. Walking is encouraged when the lumbar component is present.

HOME EXERCISE ROUTINE PRONE PRESS UPS

The patient is instructed to lie prone on the floor and position his hands as though he were going to do a push up. With the hands in this position, he extends the elbows, pushing the head and shoulders up while the pelvis remains on the floor. The object is to produce a passive hyperextension at the lumbar joints. The weight of the pelvis also appears to produce a traction component. If the range of extension is insufficient initially, the patient merely rests on the elbows in the prone position and maintains this posture for 5 to 10 minutes several times a day. These exercises are repeated 8 to 10 times per day and 10 to 12 repetitions done at each session. Pain may be produced by the exercise, and the patient must be carefully instructed that the pain must be felt centrally. Any peripheralization of pain warrants discontinuation of the program. Press ups are extremely valuable in the management of lumbar pain when properly performed. They are also beneficial in treatment of the posterior innominate and the sacrum which is ventral or caudal (Figure 24).

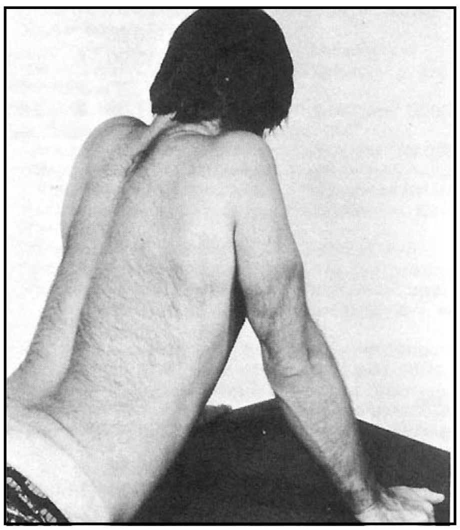


Figure 24.

UNILATERAL KNEE TO CHEST

The patient lies supine and draws one knee to his chest and fixes it with his arms while maintaining the opposite hip in complete extension. As a progression, he can lie more toward the side of the table and hyperextend the opposite hip as he draws the knee to chest. This exercise is performed on the ipsilateral side for an anterior innominate and on the contralateral side for the posterior innominate.

LONG AXIS EXTENSION

This may be done passively with a buck's extension apparatus on the patient's bed. The patient may also incorporate this in an automobilization procedure in the standing position by nailing an old high top shoe or boot to a board. The other shoe is attached to a second thicker section of board (double thickness). The patient is instructed to extend the hip and knee on the non-affected side and lean away from the involved extremity, thus producing the long extension. This is indicated principally for hip conditions and is also beneficial in the sacral problems, posterior innominate and L-P-H syndrome.

HEEL LIFTS

The use of a heel lift must be approached with caution since improper utilization may in fact compound the problem. The sacroiliac conditions or functional short leg must be differentiated from the anatomical short leg. If the two exist simultaneously, it must be determined whether the shortening is of a recent or long standing nature. The static examination may be useful in arriving at this determination since in long standing leg length discrepancies one may see a foot pronated on the long side or a knee on the same side in recurvatum, varus or valgus. It must be stressed again that the standing AP radiograph of the pelvis is invaluable in assessing the leg lengths.

As a general rule, build ups of ½ inch or less can be applied to the heel only. Any more than a ½ inch buildup must be applied to the sole as well. Females also tend to tolerate the equinus position of the foot and ankle more readily than males, if the leg-length inequality is of a recent nature; the entire difference in length is added to the build up. In the long standing condition, about one half the difference is added and can be increased to three quarters of the difference at a later date. This allows the patient to accommodate or re-accommodate to the alteration. The patient must be followed carefully following application of a heel lift as the mechanics of gait will be altered. This may be desirable in the patient with hip dysfunction, but not so in the patient with a lumbar or sacroiliac dysfunction. Ideally, one should experiment with the heel lift only and the heel and sole lift to arrive at a combination allowing the patient to normalize gait and active lumbar movements in the standing position.

BUTTOCK LIFTS

If the patient has marked flattening of the gluteal musculature on one side, it may be advantageous to add a buttock pad on that side. This is especially warranted if sitting for long periods are required in the patient's daily routine.

BRACING

External support is seldom required for the patient with a sacroiliac problem. If indicated, the history is a familiar one. Males are invariably posttraumatic with a crush injury of the pelvis. Females are by far more frequently hypermobile and usually seen following or during late stages of pregnancy, although some women taking birth control pills show a tendency toward hypermobility. Another group of females susceptible to sacroiliac problems are those with generalized hypermobility and a history of dancing, gymnastics, tumbling, etc. A clinical sign that may also be useful in determining the hypermobile patient is compression and distraction of the iliac crests. In our experience these tests are only positive in the presence of hypermobility of the joint or in the presence of serious pathology.

A most effective manner of supporting the sacroiliac joint is the use of a broad-man's belt. The belt is applied around the pelvis in the supine position and the patient assumes the standing position with both feet striking the ground simultaneously. The gait should include short deliberate steps. Ascending and descending of stairs must be done slowly and carefully.

SUMMARY

A method of evaluation and treatment is outlined for patients with lumbar and/or sciatic pain from mechanical origin. The emphasis is placed on the joints of the pelvis because these are often overlooked in the examination and treatment of the above conditions.

It is the authors' belief that all of the areas, lumbar spine, pelvis, and hips are anatomically and functionally related and all should be examined in detail and treatment should be applied based upon these findings. Most often this will result in treatment to more than one area. It is difficult to determine which problem is primary and which is secondary. However, it is suggested that treatment be initiated at the sacroiliac joints since it is relatively easy to treat, and treatment applied there seems to be safer. The patient should then be reassessed after treatment both subjectively and objectively and the findings should dictate the rest of the treatment plan.

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The Effect of Trunk Strengthening on Chronic Low Back Pain: A Systematic Review of the Literature

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ABSTRACT

Background: Chronic low back pain (CLBP) is a significant problem that produces quality of life issues and financial implications. Strengthening exercises are one of many interventions currently used to treat CLBP. However, it is unclear what specific types of strengthening exercises are most effective to address this condition. **Purpose:** To investigate the effect of various trunk strengthening techniques in treating CLBP. **Methods:** A systematic literature review was conducted. All selected papers were assessed and given a grade for the level of evidence and the strength of the recommendation. **Clinical Relevance:** Incorporating trunk strengthening into the plan of care for patients with CLBP appears effective in decreasing pain and improving functional levels. General and specific trunk strengthening exercises appeared to be equally effective. The best advice for patients with CLBP is likely to stay active and include some type of trunk exercise as part of a regular fitness program.

Key Words: low back pain, core stabilization, strengthening, therapeutic exercise

INTRODUCTION

Chronic low back pain (CLBP) constitutes one of the greatest factors limiting activity in adults under the age of 45 and is also one of the most expensive ailments to treat.[1] Low back pain is commonly classified as chronic if its duration is longer than 3 months.[2] It is estimated that approximately 10% to 20% of all patients who experience an acute episode of low back pain (LBP) go on to develop CLBP.[3] Nykanen et al[4] reported that patients with CLBP are responsible for 80% of the total cost of treating LBP. In addition, a study by Wheeler[1] in 2007 found that CLBP in the United States accounted for production losses of approximately $28 billion. Chronic low back pain can persist well beyond 3 months. Approximately 40% of patients with CLBP still experience pain at 6 months with 33% still reporting pain 1 to 2 years later.[2] Chronic low back pain is a significant problem with major quality of life and financial implications associated with it.

Although there are a variety of interventions used by health care providers in treating CLBP, no one approach has emerged as the most effective. One crucial factor in treating this population may be to identify patients with acute LBP that will go on to develop chronic pain. This identification process may be challenging as most patients with acute onset of low back pain feel better over time and without treatment. According to Lewis et al[2] approximately 70% of patients with acute onset of low back pain improve within one month and 80% to 90% will feel better in 6 weeks without any form of health care intervention.

Unfortunately, there is currently no clear predictive criteria for who will develop CLBP and consequently no specific treatment approach that is known to alleviate this chronic pain. Patients with CLBP receive a wide variety of interventions depending on the health care provider they see for treatment. These nonspecific, and often multifaceted, interventions are a key factor contributing to the escalating costs associated with CLBP.[5]

Some of the frequently used intervention approaches used by physical therapists for CLBP include: trunk strengthening, general exercise, preferential repeated movements, Pilates exercises, group rehabilitation, patient education, manual therapy, modalities, and back school programs. Maher[3] stated that due to the lack of guidance on the best treatment approach for CLBP there are a multitude of exercise programs currently available to patients. Despite the many interventions available to patients with CLBP, the best advice seems to be to increase ones activity level.[3]

There are a variety of ways to increase ones activity level. A common approach used for CLBP in many physical therapy clinics is trunk strengthening. There is reason to believe that trunk strengthening may decrease pain and improve the function of patients with CLBP in completing their daily activities.[6] Due to the widespread use of trunk strengthening and its purported benefits for patients with CLBP, the purpose of our systematic review of the literature was to investigate the effect of trunk strengthening on CLBP.

METHODS

Literature Search

The papers included in this literature review were obtained by searching OVID Medline, CINAHL, Scopus, and Cochrane Database of Systematic Reviews. The following words or combination of words were used to locate papers meeting the inclusion criteria:

Low Back Pain
Back Pain
Chronic
Core Stabilization/Strengthening
Trunk Stabilization/Strengthening
AbdominalStabilization/Strengthening
Therapeutic Exercise
Interventions
Physical Therapy
Outcome Measures
Spine
Back School
Pilates
Conservative Treatment

The following inclusion and exclusion criteria were used to select papers:

Inclusion criteria:

1. Trunk strengthening was included in the intervention
2. Age group ≥ 18 years old
3. Duration of LBP > 3 months
4. Paper in English language

The exclusion criteria were as follows:

1. History of spinal surgery
2. History of scoliosis requiring bracing

Originally the search included papers published from 1998 to 2008. During the

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course of the initial search, a literature review by Slade et al[7] was found that included papers describing the effect of trunk strengthening on chronic low back pain in studies through February 2004. After reading this literature review, we limited our search to include only papers published after the Slade et al[7] search and through August 2008 to see if additional studies had been published on the topic. The results of the literature search are illustrated in Figure 1.

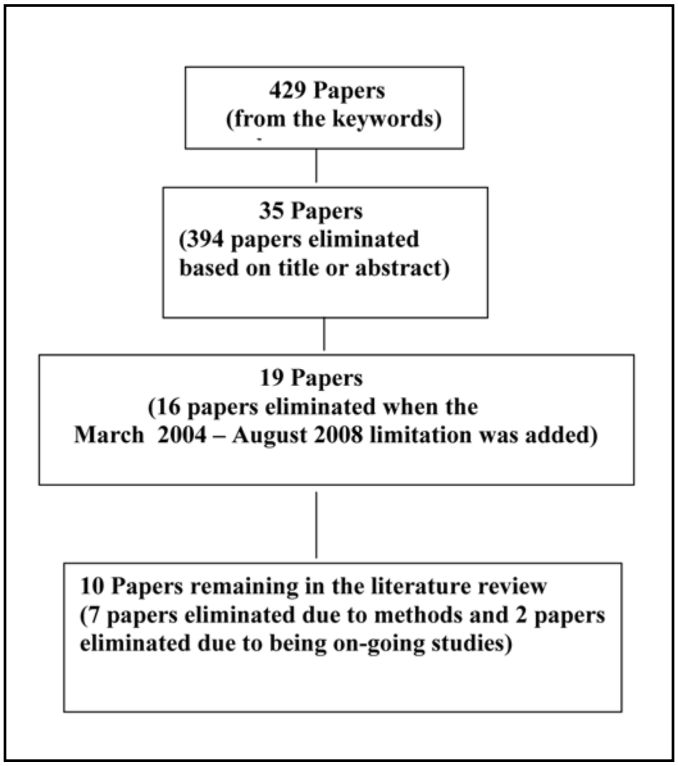

Figure 1. Flow chart of the literature search.

The literature search began with a keyword search, yielding 429 papers. Next, the titles and abstracts were read and 394 papers were eliminated. Of the 35 remaining papers, 16 papers were removed from the review because they were either included in the literature review by Slade et al[7] or published before March 2004. Lastly, 9 more papers were eliminated after reading the methods section and either did not meet the inclusion/exclusion criteria (7) or were preliminary reports describing on-going studies (2). Finally, 8 RCTs and 2 prospective cohort studies were remaining in our literature search. These 10 papers were reviewed and graded.

Assessment

All papers were read by each group member. The group then held a meeting for a discussion of each paper. The discussions were led by prearranged primary and secondary readers from the group. The primary and secondary reader positions were rotated for each paper. The discussion for each paper was guided by the format presented in a chapter entitled, "Evaluating Research Reports" by Portney and Watkins.[8] The group then used the assessment process used by the Philadelphia Panel[9] (see Appendix) to evaluate each paper. Using this assessment, each paper was assigned a grade for the level of evidence and a grade for the strength of the recommendation. Grades were agreed upon by group consensus after a thorough discussion of each paper.

RESULTS

The literature search yielded 10 papers addressing the effect of trunk strengthening on chronic low back pain. The study designs of these 10 papers included 8 randomized controlled trials and 2 prospective cohort studies.

DISCUSSION

Ten papers were reviewed. A combined total of 1,369 subjects were treated from 4 to 12 weeks in these papers. A variety of interventions were used in addition to trunk strengthening. When other interventions were included in a study it made it impossible to discern the effect that trunk strengthening contributed to the patients' outcomes. Three studies isolated trunk strengthening compared to alternative treatments.[12,13,17] Two studies used Pilates to activate trunk stabilizers compared to control groups.[10,14] The remaining 5 papers used one or more of the following interventions in addition to trunk strengthening: general strengthening, body mechanic training, anatomy education, manual therapy, physical modalities, massage, aquatic therapy, relaxation, group exercises, individual exercises, endurance training, preferential movements, and flexibility exercises.[2,4,11,15,16]

The outcome measures for evaluating patients with CLBP were consistent among most of the studies. The most common tools used were the visual analogue scale (VAS) for pain (0-10),[4,11-13] Roland Morris Disability Questionnaire,[10,12-14,17] Oswestry Low Back Pain Questionnaire,[4,14,15] and the SF-36 (or part of the instrument).[12,14,17] These outcome measures are well documented for patients with CLBP to be valid and reliable in their assessment of health status, including function, pain, and quality of life.

Overall the strength of the studies reviewed was good with 8 RCTs and 6 of the studies achieving rankings of good evidence (A) to support findings. However, 4 studies did not consistently find trunk strengthening to be the most effective means of treating CLBP as compared to general strengthening, preferential movements, manual therapy, or no treatment.[4,15-17] When manual therapy was performed in the treatment, the outcomes demonstrated no significant difference compared to trunk strengthening.[2,13,16] One study however did have a difference in VAS of pain with the manual therapy group achieving greater pain relief.[12] In 2 studies involving Pilates, improved function was demonstrated with Pilates as compared to general trunk strengthening or a control group.[10,14] The control group in both studies was defined as the use of previously used methods to treat CLBP.[10,14]

Gladwell[14] describes the use of Pilates as the activation of core muscles (transverse abdominis, multifidus, pelvic floor muscles, and diaphragm) with slow progression into more dynamic motions. Pilates trains these muscles submaximally to increase tone and strength of the core muscles. A key difference between Pilates and current trunk stabilization exercises is that Pilates, as stated by Ryneard,[10] increases mind-body awareness, control of movement, and posture. This may have led to better outcomes as functional practice of core stabilizers increases the likelihood of decreasing abnormal muscle recruitment and compensation strategies over time.

Eight studies measured the long-term effects, 12 months or greater, of the groups receiving multiple interventions.[2,10-13,15-17] Two articles demonstrated improvements in outcome measures at the end of treatment, but no significant difference compared to the 12-month follow-up.[13,15] Petersen did not collect immediate results after treatment but demonstrated no differences at 14 months after treatment.[16] Five other articles revealed improvements at the end of treatment that were maintained when follow-up at 12 months was performed.[2,10-12,17] Four articles collected information regarding their postintervention to a 12-month follow-up treatment for CLBP.[2,12,15,16] In the 4 papers that monitored the outcomes after intervention,[2,12,15,16] participants were permitted to engage in other interventions after completion of the 4 to 12 week study. In all studies, the patients still experiencing pain at the end of the study intervention could pursue additional care to alleviate their CLBP. However, reassessing long term outcomes of patients who have continued self-treatment or saw other health providers for treatment may confound the effects of the studies. We recommend that future studies gather more information regarding care after intervention in order to have more meaningful long term follow-up data.

Another concern when reviewing the 10 papers was the inconsistency in classifying patients with CLBP. Currently, LBP is classified as chronic based on the time frame of symptoms. The Philadelphia Panel[9] classified low back pain into 3 categories: acute, subacute, and chronic. Multiple episodes of LBP can increase the difficulty in making an accurate diagnosis. Also the amount of variance within these broad classifications makes diagnosis and treatment challenging since patients within these broad categories appear to have subgroups. Inadequate classification of patients with LBP likely affects the cost and efficiency in treating these patients. The difficulty in determining the effectiveness of trunk strengthening was increased by this inadequate classification system. For example, 4 studies we reviewed reported including patients with recurrent back pain.[10,11,15,17] Three of the studies admitted patients with multiple episodes of CLBP.[10,11,15] An improved process of classifying LBP should be addressed in future research.

Research has commenced in the area of classifying LBP. Fritz et al[18] in 2003 presented a treatment categorization for patient with LBP. The 4 categories presented were: mobilization, specific exercise, traction, and immobilization. Fritz et al produced evidence supporting a treatment focused classification had better outcomes and was more cost effective in treating acute LBP than a time based approach for classification. This approach to LBP treatment should be studied in patients with CLBP to see if similar results are obtained. A new classification for patients with CLBP may make intervention more specific. For example, perhaps a method could be developed to screen patients to see if they are strengthening responders. Psychosocial factors, such as fear-avoidance beliefs, have also been shown to have an impact on recovery and return to work[19] and therefore also need to be considered in any new classification system. Clearly our current system of classifying patients with CLBP is inadequate.

Cost is always a concern when confronting treatment in health care. Our sample of papers illustrated some of the differences in cost of treatment and the variety of health care systems. Generally, we found the cost of group therapy was less expensive and just as effective as individual treatment. In the United Kingdom, where there is a National Health Service, one study found group treatment generated a 40% savings while producing similar outcomes compared to individual therapy.[2] In a study from Finland with the Finnish Social Insurance Institute financing rehabilitation, Nykanen[4] found that group and individual treatments produced similar results in patients with LBP. Current research appears to support group treatment as effective and efficient and incorporates general strengthening, trunk stabilization, flexibility training, and manual therapy in the treatment of CLBP.[2,4] More research is needed to further examine the benefits of group versus individual treatment.

CONCLUSION

Current evidence regarding the treatment of chronic low back pain suggests that trunk strengthening is as effective as general strengthening and manual therapy. Upon further investigation there did not appear to be widespread agreement in regards to a specific treatment for chronic low back pain and no gold standard treatment was found. The systematic literature review, including 8 RCTs and 2 cohort studies, produced support that incorporating trunk strengthening into a plan of care is effective in decreasing pain levels and improving functional ability for patients with CLBP. Most studies incorporated many interventions making it impossible to know the exact effect of each intervention. The current classification of patients with CLBP appears to be inadequate to render the most effective and efficient treatment. Also, the use of group therapy versus individual therapy appeared to offer similar benefits but requires further investigation.

BEST CLINICAL PRACTICE

Based upon our literature review, a plan of care including trunk strengthening appears to be effective in improving function and decreasing pain in patients with CLBP. The specific method of trunk strengthening, whether it is Pilates, stabilization exercises, or general strengthening does not appear to have a significant effect on the outcomes. Any form of trunk strengthening and activity appears to improve function; however, further research is warranted. Although the use of manual therapy demonstrated similar outcome measures as trunk strengthening, it may not be the most cost effective method to treat CLBP since a skilled clinician is necessary to perform this intervention. For most patients the best advice may be to become more active on a daily basis and incorporate a nonspecific trunk strengthening program as part of a daily lifestyle.

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Appendix[9]
Data Sheet

Intervention: ______________________________

Title: ______________________________

Author: ______________________________

Was subject selection randomized? YES NO

Was there a control group? YES NO

Total number of subjects: ______________________________

Subject Description: ______________________________

Outcomes Used: ______________________________

Grading of Evidence (circle one) I II – III – 2 II – 3 III

Grading of Evidence	
I	Evidence from at least 1 properly randomized controlled trial (RCT)
II – 1	Evidence from well-designed controlled trials without randomization
II – 2	Evidence from well-designed cohort or case-control analytic studies, preferably from more than 1 center or research group
II – 3	Evidence from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments could also be included here.
III	Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees
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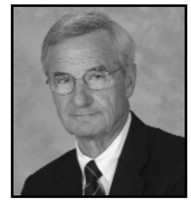

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Use of Shoulder CPM and Physical Therapy for Early Rehabilitation Following Rotator Cuff Repair: A Case Report

Scott Hyldahl, PT, DPT

ABSTRACT

Background and Purpose: Rehabilitation following rotator cuff repair surgery is frequently provided by physical therapists that work in an outpatient orthopaedic and sports setting. During the immediate postoperative phase of rehabilitation for rotator cuff repair, techniques continue to evolve to improve the healing potential, and facilitate the return of shoulder motion and function. The purpose of this case study is to describe how continuous passive motion, in conjunction with physical therapy during early rehabilitation following rotator cuff repair, contributed to reestablishing full, pain-free range of motion and improved function. **Case Description:** The patient was a 58-year-old female who sustained a complete, full-thickness tear of the rotator cuff, and underwent subsequent arthroscopic rotator cuff repair surgery. Her rehabilitation included the use of a home CPM unit that was used 3 to 4 hours a day, for a 3-week time frame. Physical therapy was initiated one week after surgery, with the patient being treated over a 3-month time period. **Outcomes**: Over the course of the 12 weeks of physical therapy, the patient demonstrated marked improvements in function as measured by the QuickDASH outcome measure. Pain had completely abolished by the third week after surgery. Full, pain-free passive range of motion for shoulder flexion, abduction, and external rotation was achieved by the fourth week following surgery. **Discussion**: This case report illustrates how improvement in pain-free range of motion and function can be achieved during early rehabilitation with use of continuous passive motion, in conjunction with physical therapy, following rotator cuff repair surgery.

Key Words: continuous passive motion, physical therapy, rehabilitation, rotator cuff repair

INTRODUCTION

Rotator cuff repair surgery is performed to decrease pain, improve range of motion (ROM), and increase function.[1] Rehabilitation following rotator cuff surgery is a common referral to an outpatient orthopaedic and sports physical therapy (PT) setting. Rehabilitation goals following rotator cuff repair are to achieve healing of the cuff, while restoring pain-free shoulder motion and function.[2,3] Restoring passive motion safely and expeditiously is of utmost importance during early rehabilitation, and can assist with preventing potential negative outcomes associated with rotator cuff repair.[2] According to Gore et al,[4] residual postoperative pain and stiffness often remain despite an adequate surgical repair. It was reported by Warner and Greis[5] that a loss of passive motion is not uncommon following rotator cuff repair surgery.

After rotator cuff repair surgery, aggressive early motion that stresses the repair and exceeds the mechanical strength of the repair should be avoided.[3] Millet et al[3] recommends that "in all but the smallest tear," the shoulder be immobilized in a sling for 4 to 6 weeks after surgery to protect the surgical repair. Due to the lack of data on the loads that develop across the repair during the perioperative period, their recommended postoperative rehabilitation does not differ whether the surgery was performed via arthroscopy or open technique. The authors used an evaluation-based approach to compile a set of rehabilitation guidelines based on the 4 phases of healing during rehabilitation following rotator cuff surgery. The first phase, immediate postoperative period (weeks 0 to 6), involves passive exercises that minimize loads across the repair. Passive motion can be initiated and gradually progressed to prevent stiffness, or adhesive capsulitis. The rehabilitation goal during this time is to promote soft tissue healing and regain early mobility, without overstressing the healing tissue.

Dockery et al[6] found that continuous passive motion (CPM) and therapist-assisted passive range of motion (PROM) may increase the safety margin for obtaining early PROM without disrupting the rotator cuff repair. In the study, the authors used electromyographic analysis to measure rotator cuff activity during various exercises commonly used postoperatively following shoulder surgery. The exercises tested were CPM, pulley, pendulum, self-assisted bar raise using the contralateral arm for power, self-assisted internal and external rotation, therapist-assisted elevation in plane of the scapula, and therapist-assisted internal and external rotation. Results showed that the pulley exercise, and self-assisted flexion with a bar, showed statistically more rotator cuff muscle activity than the CPM exercise ($P < .05$). Therapist-assisted PROM, self-assisted internal and external rotation using a bar, and Codman's pendulum exercise all showed muscle activity with no difference compared to the use of the CPM machine. The authors concluded that the traditional interventions of pulleys and bar raises, which are used to increase PROM postoperatively, showed a significant increase in muscle activity compared with the CPM and therefore may potentially increase the risk for failure of a recent rotator cuff repair.

Continuous passive motion has beneficial effects on joint function and can be used to counteract the deleterious effects that can occur with prolonged immobilization.[7] In a review of literature regarding the physiological basis of CPM, Salter[7] found that CPM is significantly superior to either immobilization or intermittent active motion in preventing joint stiffness, as well as stimulating the healing and regeneration of articular tissues. While much clinical research has focused on CPM following surgeries involving the knee,[8-11] there is very little research on effectiveness of shoulder CPM following rotator cuff repair.[12-14]

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To this author's knowledge there has only been one study that attempted to determine the early (3 month) postoperative effect of CPM, combined with PT, on functional outcome after rotator cuff repair. In a prospective, randomized, blinded, controlled study performed on patients postoperative rotator cuff repair, Raab et al,[12] compared a control group who underwent a standard PT protocol versus a study group that underwent a similar PT protocol with the addition of CPM commencing in the recovery room and continuing for 3 weeks. At 4 weeks, both the study and control groups underwent a similar postoperative PT program. Results at 12 weeks showed a statistical significant (P = 0.0138) increase in ROM was found in patients using CPM with PT, compared to PT alone. The use of CPM also showed significant improvement in pain relief in female patients (P = 0.0185), and pain relief in patients greater than 60 years of age (P = 0.0364). Postoperatively at 3 months, both the CPM group and PT group demonstrated overall shoulder score improvement. No overall difference in shoulder score between the two groups was noted. The shoulder score used emphasized functional results and pain relief while still including ROM and strength. It was based in part on portions of the Hospital for Special Surgery System for Assessing Shoulder Function and the Mayo Clinic Pre- and Postoperative Analysis of the Shoulder. There are several significant limitations to this study. First, the rehabilitation protocol used served only as a guideline, with no control over the actual rehabilitation provided to the patient; only the use or absence of CPM. Specific PT interventions that were implemented were not addressed in the study, creating an uncontrolled variable. Secondly, the authors state that "Several patients reported using the CPM to obtain pain relief outside their assigned times." This brings into the question another uncontrolled variable: the actual frequency and duration which the patients used the CPM unit at home was not monitored. Finally, all patients were immobilized for only 3 weeks after surgery, and surgeons who desired a longer period of immobilization did not participate in the study. As stated previously, a recent rehabilitation protocol by Millet et al[3] recommends the shoulder be immobilized in a sling for 4 to 6 weeks after surgery to protect the surgical repair. Therefore, results cannot be generalized for patients who are immobilized for a longer period of time, when physicians desire a more conservative approach.

In a prospective, randomized study, LaStayo et al[13] compared the functional outcome after CPM with that of a manual PROM exercise program for patients who had undergone rotator cuff repair. The use of CPM was carried out for the first 4 weeks following surgery. Use of the CPM unit began once the patient was discharged home, and patients were told to use the device 3 to 4 sessions a day, each lasting 1 to 1 ½ hours, for a total of 4 hours per day. After the first 4 postoperative weeks, both groups received the same rehabilitation. Results demonstrated the patients who received CPM had significantly less pain during the first postoperative week (p = 0.046). No significant difference in ROM was found at 6 weeks, 12 weeks, 6 months, 12 months, or at 24 months. Overall, at the mean duration of follow-up at 22 months, no significant differences in outcomes were noted between the two groups with respect to visual-analog pain scale, active and PROM, strength or validated outcome measure (Shoulder Pain and Disability Index.). Clinically, both the CPM and manual PROM exercises by a third party group did well across all outcome measures. The authors stated "Our primary finding is that continuous passive motion is a safe technique that results in little disability and an excellent or good outcome after a repair of a small, medium, or large tear of the rotator cuff." A main drawback to this study is that the authors did not evaluate self-directed PROM exercises but used manual passive exercises that were carried out by a trained relative, friend or home-nurse, and not a licensed physical therapist. This would not be an option for many patients, and also raises concerns about safety. In addition, the authors noted another limitation of the study by stating, "It is difficult to assess the effects of two different interventions during the first four weeks after the repair of the rotator cuff and then to analyze the effects of those treatments at twenty months." Many variables could have influenced the outcome including consistency and compliance with patients' home exercise program. This was exemplified during the first 4 weeks when patients were asked to record a daily log of time using the CPM machine. Even though patients were instructed to use the device 4 hours a day, actual duration of CPM averaged 3 hours a day according to the patients' reports in a diary.

During the immediate postoperative phase of rehabilitation for rotator cuff repair, techniques continue to evolve to improve the healing potential, facilitate the return of shoulder motion, and accelerate functional return. It is up to physicians and physical therapists to choose the correct rehabilitation interventions to achieve optimal outcome. The purpose of this case study is to describe how CPM, in conjunction with PT during early rehabilitation following rotator cuff repair, contributed to reestablishing full, pain-free ROM and improved function.

CASE DESCRIPTION

Subject History

The subject of this case report was a 58-year-old female who had sustained a right rotator cuff (RTC) tear. The patient was injured when slipping and falling on ice, subsequently landing on the right upper extremity. Evaluation was performed by an orthopaedic surgeon, and an MRI revealed a full-thickness rotator cuff tear. As pain continued, and was refractory to conservative treatment including injections, surgery was pursued 2 months later. A copy of the surgical operative report was obtained which described a large, retracted tear of the supraspinatus muscle, with avulsion off the greater tuberosity, as well as a partial thickness tear of the infraspinatus muscle. The size of the RTC tear was 2.5 cm. Surgical operations performed were: (1) right shoulder arthroscopy with mini-open rotator cuff repair and (2) subacromial decompression. Shoulder CPM was ordered to begin the day following surgery, and physical therapy was initiated one week following surgery. She presented in a sling. The referring physician's order was for PROM for 3 weeks, active-assisted range of motion (AAROM) to begin at week 4, with active range of motion (AROM) to begin at 6 weeks postsurgery.

The patient's self-reported past medical history included diabetes mellitus Type II, osteoarthritis, sleep apnea, and a left total knee replacement 5 years ago. She denied any previous right upper extremity dysfunction. Current medications were OxyContin and Percocet. The patient was married, right-hand dominant, and employed as a realtor and owner of a local realtor group. Recreational activities include swimming and weight lifting.

The patient's chief complaint was intermittent shoulder pain and inability to perform daily tasks with the right upper extremity. Subjective functional limitations included inability to comb her hair, bathe, dress independently, type on the computer, or perform light household cleaning with use of the right upper extremity. Pain was described as an ache over the right anterior and lateral shoulder, with occasional sharp pain experienced with movement of the right upper extremity. She denied any tingling or numbness, and reported keeping the right upper extremity in a sling at all times other than when bathing and exercising as per physician's recommendations. Her goals in coming to PT were to regain full movement, eliminate pain, and be able to use the arm again the same as prior to her injury.

PHYSICAL EXAMINATION

Systems Review

The patient was 5 feet, 5 inches tall and weighed 144 pounds with a body mass index of 24. At the time of the initial visit, the patient's blood pressure was 128/86, heart rate was 70 beats per minute, and respirations were 14 per minute. Visual inspection of the shoulder revealed that the surgical incisions were healing well. No drainage, discoloration, or signs of infection were present. Skin temperature was normal. She reported intact to light touch throughout the right upper extremity.

Tests and Measures

Pain intensity level

At the time of physical therapy examination, a 0 to 10 visual analogue scale (VAS) was used to quantify pain intensity,[15] with 0 being "no pain" and 10 being the "worst pain imaginable." She reported a current resting pain level of 0, which would increase to a level of 3, when putting on her shirt and when moving the arm during bathing.

Range of motion

Shoulder ROM was measured passively in the supine position for forward flexion, abduction, and external rotation, with a universal goniometer and standardized measurement techniques as described by Norkin and White.[16] All measurements were taken by the author. Goniometric measurements of shoulder PROM have high intratester reliability.[17] With the shoulder abducted 45°, initial PROM for external rotation was measured at 40°. Initial PROM for shoulder flexion was 120°, and abduction was 92°. Comparing the contralateral upper extremity, ROM for left shoulder flexion (0 - 180), abduction (0 - 180) and external rotation (0 – 90) were all normal, as defined by the American Academy of Orthopaedic Surgeons,[18] as well as Kendall and McCreary.[19]

Palpation

Palpation revealed tenderness and myofascial restrictions over the right upper trapezius muscle and supraspinatus muscle. Tenderness was also present over the rotator cuff tendon. No scar tissue restrictions were noted.

Functional disability questionnaire

The 11-item QuickDASH (Disabilities of the Arm, Shoulder and Hand) questionnaire was used as the outcome measure. The QuickDASH is a self-report outcome measure, which has been proven to be both highly reliable and valid.[20] The scale is used to measure physical function and symptoms in persons with any or multiple musculoskeletal disorders of the upper limb. A higher score indicates greater disability. The patient initially completed the QuickDASH 2 days preoperatively and had a score of 42. At the time of initial evaluation, the questionnaire was filled out again, and had a score of 73.

DIAGNOSIS

According to the *Guide to Physical Therapist Practice*, 2nd edition,[21] this case is associated with a patient diagnostic classification of a musculoskeletal condition having "impaired joint mobility, motor function, muscle performance, and range of motion associated with bony or soft tissue surgery" – pattern 4I. The patient had a 2.5cm size tear of the RTC, therefore placing her in the medium to large tear category.[2] Due to her age and active lifestyle, she had excellent rehabilitation potential for full return to daily activities and good rehabilitation potential for return to recreational activities.

Figure 1. The KS2 shoulder CPM. Reprinted with permission from Kinex Medical.

Figure 2. The KS2 Shoulder CPM synchronizes scapular elevation with external rotation. Reprinted with permission from Kinex Medical.

INTERVENTION

The patient was instructed in the proper use of a home CPM device (Figure 1), the KS2 Shoulder CPM (Kinex Medical, Waukesha, Wisc), by a vendor representative prior to surgery.

The patient was instructed to initiate CPM 24 hours postoperatively.[13,22] The shoulder CPM was positioned at 30° to 45° in the scapular plane, and used for elevation and external rotation of the shoulder. In a cadaveric study performed by Hatakeyama et al,[23] it was reported that "during passive rotation exercise, external rotation up to 60 degrees, but not internal rotation, seems to be safely performed with the arm elevated 30 degrees in the coronal or scapular plane." The Kinex Rotator Cuff CPM uses scapular elevation synchronized with external rotation (Figure 2). The patient was advised to only use the CPM in a pain-free arc of motion to protect the repair. The patient was instructed to use the CPM device for 3 to 4 hours a day (3 to 4 periods of continuous motion, each lasting for a 1 hour interval),[13,22] for a total of 3 weeks. The 3-week time frame was determined as per physician order. Initial ROM within the CPM unit for scapular elevation was a 30 to 45° arc, with external rotation in a 0 to 10° arc. The patient was instructed to progressively increase the PROM 5° elevation and 2° external rotation a day as tolerated, maintaining a pain-free arc.

Physical therapy interventions began immediately following the initial evaluation, commencing 7 days following surgery. The patient was verbally informed of the evaluation findings and proposed interventions were explained. She voiced understanding of her precautions following rotator cuff repair, and agreed with the PT plan of care. When new home exercises were introduced throughout the course of PT, exercise sheets were provided with text instruction and illustration. Verbal instruction and demonstrations were provided as well. She then performed the activity at which time verbal and/or manual cues were given as needed.

For the first 3 weeks of PT, manual PROM was performed to the shoulder for 30 minutes. The patient was supine and PROM in the scapular plane for shoulder flexion, as well as external rotation and internal rotation, was performed to tolerance. The patient was also instructed to perform 2 sets of 10 repetitions of the following exercises at a frequency of 3 times per day: Codman's pendulum exercises, self-assisted internal and external rotation with a bar, and elbow, wrist, and finger AROM exercises. The self-assisted internal and external rotation with a bar was performed in the scapular plane with the patient supine. The humerus was abducted 45°, with pillows propped under it maintaining proper alignment. The patient was instructed to move the arm to the point of tolerance, but not to push into pain. Over subsequent days, she continued to gradually increase ROM. The two aforementioned shoulder exercises were chosen based on the study by Dockery et al,[6] which demonstrated that PROM exercises performed in the supine position showed the least EMG activity in the deltoid and rotator cuff musculature. Additionally, the authors found no difference in cuff activity level between the use of CPM compared to therapist-assisted PROM, Codman's pendulum exercises, or self-assisted internal and external rotation using a bar.

Cryotherapy was also used at the end of therapy sessions, as well as incorporated into the home exercise program (HEP). Patients often complain of pain after rotator cuff repair surgery that limits their program of rehabilitation.[2] In a prospective, randomized, controlled clinical trial conducted by Speer et al[24] examining the efficacy of cryotherapy after shoulder surgery, the authors noted at 10 days after surgery, patients who received cryotherapy exhibited less pain, greater movement, less swelling, and were better able to tolerate their rehabilitation. Therefore, the patient was instructed to use cryotherapy for 15 minutes after exercising at home as well as in the clinic, during the first 2 weeks of PT, and to continue thereafter as needed for pain control.

When the patient was 4weeks postoperative, AAROM exercises were introduced. The use of overhead pulleys into flexion, supine self-assisted flexion with a bar (therapist provides assistance by supporting arm), sidelying therapist-assisted flexion, and wall walks to 90° (patient used contralateral upper extremity to lower shoulder) were initiated. All exercises were performed 2 sets of 10 repetitions, 2 times per day. Additionally, submaximal pain-free shoulder isometrics were initiated into flexion, abduction, extension, adduction, internal rotation, and external rotation. Rhythmic stabilization exercises in the supine position were also performed as described by Wilk et al[2] with the shoulder between 100° and 110° of elevation, and approximately 10° of abduction. Manual PROM was performed as needed, to maintain full ROM into flexion, abduction, and external rotation. The patient discontinued use of her sling at 5 weeks postsurgery.

At 6 weeks postsurgery, AROM was initiated as per physician order. These exercises included: forward flexion, scaption (abduction in the scapular plane), internal rotation, and external rotation. All AROM and strengthening exercises were performed 2 sets of 10 repetitions, 2 times per day. Specific strengthening exercises were: prone rows to neutral arm position, isotonic elbow flexion, and shoulder external rotation and internal rotation using elastic tubing at 0° of abduction. Sidelying internal rotation and prone horizontal abduction isotonic strengthening were initiated at week 7. At week 8, sidelying external rotation, full can in scapular plane, lateral raises, prone shoulder extension, and elbow extension strengthening exercises were initiated. At week 10, exercises were progressed to 3 sets of 10 repetitions, continuing to progress with light isotonic strengthening and flexibility exercises. At 12 weeks, the patient was progressed to the "fundamental shoulder exercise program" as described by Wilk et al[2] and discharged. Table 1 briefly summarizes the postoperative rehabilitation protocol used in this case study.

OUTCOMES

The patient was seen for a total of 20 treatment sessions over a 12-week time period. The outcomes of the interventions are outlined in Table 2. She had ceased with the use of pain medications after the first 10 days following surgery, and reported that her pain had completely abolished to a level of 0 on the VAS pain scale by the third week after surgery. Passive range of motion for shoulder flexion, abduction, and external rotation were all full and pain-free by the fourth week postsurgery (Table 3). Full, pain-free AROM for flexion and abduction were achieved at the end of the ninth week following surgery. At the conclusion of the 12-week rehabilitation program, the patient demonstrated improvement in functional outcome as compared to her presurgical score (Table 4). At the time of discharge, the QuickDASH score was a 5, indicating almost no functional disability or symptoms with the upper extremity. Furthermore, she reported no pain and had returned to all work and activities of daily living without limitation. She was independent with her HEP, and planned on returning to the gym.

Table 1. Description of Postoperative Rotator Cuff Protocol

Weeks Postsurgery	Treatment
0	CPM
	Cryotherapy
1	CPM
	Manual PROM
	Codman's exercises
	Self-assisted internal and external rotation ROM with bar
	Elbow and wrist AROM
	Cryotherapy as needed
4	AAROM exercises: pulleys, self-assisted flexion with bar, sidelying therapist-assisted flexion, wall walks
	Shoulder isometrics and rhythmic stabilization
5	Discontinue use of sling
6	AROM exercises
	Gradual progressive resistive strengthening: prone rows, bicep curls, shoulder internal and external rotation with elastic band
7	Initiate sidelying internal rotation and prone horizontal abduction strengthening
8	Initiate sidelying external rotation, full can in scapular plane, lateral raises, prone shoulder extension, and elbow extension strengthening
12	Progress to "fundamental shoulder exercises" for HEP discharge from PT

Table 2. Chronological Description of Outcomes

Measure	Baseline Initial Examination (1 Week Postsurgery)	4 Weeks Postsurgery	Discharge (12 Weeks Postsurgery)
Pain Intensity	3	0	0
Shoulder PROM	Flexion = 120° External rotation = 40° Abduction = 92°	Flexion = 180° External rotation = 90° Abduction = 180°	Flexion = 180° External rotation = 90° Abduction = 180°
QuickDASH Score	73	45	5

Table 3. Chronological Description of Shoulder Passive Range of Motion (PROM)

Weeks Postsurgery	PROM (degrees)		
	Flexion	Abduction	External Rotation*
1	120	92	40
2	155	135	77
3	175	170	90
4	180	180	90
12	180	180	90

*External rotation measured with the arm abducted 45°s.

Table 4. QuickDASH (Disabilities of the Arm, Shoulder, and Hand) Outcome Score

Weeks Postsurgery	Score
Preoperative	42
1	73
4	45
12	5

DISCUSSION

Rehabilitation following rotator cuff repair surgery is often a challenge for both the patient as well as the treating physical therapist. This study provides descriptive information regarding how a patient achieved early improvements in pain-free shoulder ROM and function during rehabilitation, following rotator cuff repair surgery. The use of a home CPM unit, in conjunction with PT, may have facilitated these rapid, positive outcomes. Although we instituted no control group in this study, past studies have demonstrated that the use of CPM in combination with PT following rotator cuff repair surgery, resulted in earlier improvement in ROM, as compared to PT alone.[12,14] Michael et al[14] performed a prospective, randomized multicenter study that demonstrated that a postoperative rehabilitation protocol combining physiotherapy and CPM can achieve 90° active abduction earlier than physiotherapy alone. Their results were statistically significant, and showed that patients in the CPM group reached the primary endpoint on average 12 days earlier than the control group. In their study to determine the effect of CPM on functional outcome after rotator cuff repair, Raab et al[12] concluded that CPM had a beneficial effect on ROM for all patients, however, no effect on overall shoulder score and function at 3-month follow-up. LaStayo et al[13] also found no significant difference in clinical outcomes when comparing CPM against manual PROM exercises, following rotator cuff repair surgery. They did conclude "CPM and manual PROM exercises contributed positively to the ROM, strength, function, and relief of pain."

The use of CPM following rotator cuff repair surgery has other benefits during rehabilitation. Continuous passive motion use has been shown to decrease pain postoperatively following rotator cuff repair.[12,13] Raab et al[12] reported that several patients used the CPM to obtain pain relief outside of their assigned times. This beneficial effect may lead to high compliance with home exercise use, and should be the focus of future studies. Furthermore, with the use of a daily shoulder CPM unit at home, the patient in this case report was seen in the PT clinic at a frequency of 2 times per week, and not the accustomed 3 times per week. This led to maximizing the effectiveness of limited insurance visits, and allotting enough visits to focus on AROM, strengthening, and functional training. Finally, since full ROM was obtained within a desired goal of 4 to 5 weeks postsurgery,[3] as treatment protocol progressed, the patient was able to spend more valuable home and clinical exercise time focusing on rotator cuff and scapular musculature strengthening, and less time with range of motion exercises.

While undergoing rehabilitation following rotator cuff repair, it is important that the immediate postoperative exercises be performed passively, as well as in a plane of motion that does not stress the repair. It has been demonstrated by Dockery et al[6] that CPM and therapist-assisted modes of passive shoulder exercises most closely approach true PROM. Improper positioning of the arm during passive exercise may apply tension that is significant enough to result in failure of the repair.[3,23] The shoulder CPM unit used in this case report maintains the patient's shoulder in the safest range of motion after rotator cuff repair as described by Hatakeyama et al.[23] In a cadaveric study, the authors concluded that more than 30° of elevation in the coronal or scapular plane and rotation ranging from 0° to 60° of external rotation compose the safe range of motion after repair of the rotator cuff. This justified the use of CPM as the main component of the home exercise program during the initial 3 weeks of therapy, as other frequently used exercises (self-assisted flexion with opposite arm, pulleys, self-assisted flexion with bar) often do not fall within this least stressful plane, and have demonstrated higher EMG activity on the rotator cuff muscles.[6]

There are several aspects of this case report that serve as limitations and could have been improved. First of all, there was no formal documentation to monitor the patient's compliance with her HEP including consistency with ROM and strengthening exercises. In addition, the frequency and duration of time spent using her home CPM unit was also not recorded. These variables may have influenced the outcomes, and were limitations to this study. Future studies should address these concerns. Furthermore, additional research is needed on long-term outcomes and cost analysis of PT and CPM interventions during rehabilitation, following rotator cuff repair surgery.

In conclusion, this case report explains interventions that were used to obtain a positive, short-term outcome following a common surgical procedure seen in outpatient orthopaedic and sport physical therapy clinics. More precisely, it illustrates how improvement in pain-free range of motion and function can be achieved during early rehabilitation with use of continuous passive motion, in conjunction with physical therapy, following rotator cuff repair. It is hoped that it may serve to assist the physical therapist in the clinical decision-making process when treating patients after rotator cuff repair surgery.

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The Use of Low-Intensity Pulsed Ultrasound for Bone Healing in Physical Therapy

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ABSTRACT

Low-intensity pulsed ultrasound (LIPUS) (frequency 1.5 MHz; burst width 200µs; frequency 1 KHx; intensity 30 mW/cm^2) has been shown to accelerate fracture healing in acute, non-unions, and stress fractures. Nonetheless, it is not being used clinically by physical therapists as a treatment option. Additionally, only 20.6% of senior physical therapy students believe that LIPUS is effective for fractures, while another 20.5% believe that ultrasound is an absolute contraindication over a fracture site. With the ever important need for evidence-based practice, students as well as practicing therapists should be aware of this treatment alternative. The purpose of this systematic literature review is to provide evidence in support of LIPUS for acute, non-union, and stress fractures, as well as establish the parameters used to establish effectiveness.

Key Words: low-intensity pulsed ultrasound (LIPUS), acute fracture, non-union fracture, stress fracture, modality

INTRODUCTION

Ultrasound (US) is a form of mechanical radiation that can be transmitted into the body as high-frequency acoustical pressure waves. These micromechanical strains entering the body's tissues can result in biochemical events at the cellular level.[1] Ultrasound has been shown to have a positive influence on the 3 key stages of the healing process: (1) inflammation; (2) repair; and (3) remodeling by enhancing angiogenic, chondrogenic, and osteogenic activity.[2] Many different medical applications of US are available in a wide range of frequencies and intensities including therapeutic, operative, and diagnostic. Therapeutic ultrasound uses intensities of 1 to 3 w/cm^2 and can cause heating in the tissues. Physical therapists use such levels of ultrasound to decrease joint stiffness, reduce pain and muscle spasms, and to improve muscle mobility. Operative US involves much higher intensities of 5 to 300 watts per square centimeter with bursts of energy to fragment calculi and ablate diseased tissues such as cataracts. Diagnostic US uses much lower intensities of 5 to 50 milliwatts per square centimeter to construct diagnostic noninvasive images.[2,3]

Therapeutic US has been considered an absolute contraindication over a fracture site based on animal studies performed in the 1950s that showed delays in healing, damage to the bone, and pain aggravation in the area of the fracture.[4-8] These studies used high US intensities of 5 to 25 watts per square centimeter.[4,7] However, more recent studies not only suggest that low-intensity pulsed ultrasound (LIPUS) actually accelerates bone regeneration and the healing of fractures decreasing healing time, but also establish the most efficient parameters for treatment .[1,2,8,9] Xavier and Duarte reported that application of LIPUS (30 mW/cm^2) for 20 minutes per day in humans provided a successful treatment for non-unions in 70% of cases observed without harmful effects.[2,3,10] Duarte demonstrated that ultrasound treatment delivered at an intensity of 200 mW/cm^2 successfully accelerates cortical bridging by 28% when compared to the control with the use of a rabbit fibular osteotomy model.[2,3] Pilla et al reported that LIPUS significantly accelerated the recovery of torsional strength and stiffness in a placebo-controlled study of bilateral mid-shift fibular osteotomies in rabbits when used for brief periods (20 min/day) at a 200 µs burst of 1.5 MHz sine wave and a repetition rate of 1 kHz. This study indicated that by the seventeenth day, the treated fracture was as strong as the intact fibula; however, untreated contralateral limbs did not retain full strength until the 28th day.[2] Chang and colleagues demonstrated that LIPUS not only increases new bone formation by 36%, but also an 80% increase in torsional stiffness at the osteotomy site when compared to the untreated limb in adult rabbits.[10] *In vitro* studies have also suggested that LIPUS produce significant effects ($p < 0.05$) that are directly relevant to bone formation and resorption.[1] These preliminary studies have led to *in vivo* investigations using adult human populations.[1-3,8,9,13]

In October of 1994 the Food and Drug Administration approved the use of LIPUS for the accelerated healing of fresh fractures based on 2, double-blind, placebo-controlled clinical trials, that showed the healing rate of fresh fractures was accelerated by ultrasound treatment.[1-3] However, with few exceptions, the most commonly used physical therapy modality books, continue to list ultrasound as being an absolute contraindication for fracture sites.[5] Despite the more recent findings, a survey performed by Busse and Bhandari reported that 20.5% of senior PT students believe that ultrasound is contraindicated above fracture sites and may be harmful to healing bone; whereas another 20.6% believe that US is proven to reduce healing time. The remaining 58.8% believe that could possibly, in some cases, be beneficial to fracture healing.[5] Even though 20.6% of senior PT students report that it does reduce healing time, only 2.9% report using US at all over fracture sites and 88.2% report never using therapeutic US for fracture healing. When asked why US was not used for fracture healing, 58.8% responded with lack of availability, 17.6% responded with risk of harm, and 11.8% responded both with lack of evidence and limited efficacy.[5]

LIPUS units are small and portable and can easily be used by the patient in their own home. Resembling a TENS unit, the LIPUS device consists of 3 components: (1) a plastic retaining and alignment fixture which allows the transducer module to be held in place by incorporating it into the cast or using a Velcro strap, (2) battery operated treatment module which supplies the low-

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intensity pressure waves, and (3) the control element which is a 110/220 V AC powered main operating unit.[1,3,11,12] Coupling gel is applied over the specified area and then the device is strapped into place. The unit produces a warning signal if it not properly coupled to the skin. The control unit can be set to monitor treatment time and will automatically turn off after the session is complete.[3,11,12] Thus, parameters can be set by the physical therapist and then the device could be issued to the patient for at home use.

With the emphasis for evidence-based practice, students of physical therapy should be educated on this method of treatment over acute fractures, stress fractures, and non-union fracture sites. Information included in this review will include: (1) how LIPUS affects healing time of acute fracture sites; (2) how LIPUS affects established non-union fracture sites, (3) the use of LIPUS with stress fractures; and (4) parameters used for LIPUS treatment in acute, stress, and non-union fracture sites.

REVIEW METHODS

Three electronic databases including PubMed, Medline-MeSH, and Wiley Science were searched to determine evidence regarding the use of low-intensity pulsed ultrasound for the acceleration of fracture healing in acute, stress, and non-union fractures. References for studies were obtained from the bibliographies of already acquired studies and researched further using one of these databases.

Inclusion Criteria for Selection of Studies

Several conditions were incorporated into the literature search. No publication date was set prior to reviewing the literature because many of the fundamental studies were performed as early as the 1950s and those needed to be obtained for this review. Also, only English articles were considered. Articles had to be accessible as a pdf file, or full text html, and available at Angelo State University, or through interlibrary loan.

Priorities in this search are listed as follows:

1. The use of low-intensity pulsed ultrasound to treat acute fractures.
2. LIPUS for the treatment of stress fractures.
3. How LIPUS affects established non-union fractures.
4. Parameters of LIPUS for treatment in fracture sites.

Exclusion Criteria for Selection of Studies

Articles were omitted by discretion based on the following criteria:

1. Language other than English.
2. Pertaining to electromagnetic fields and not LIPUS.
3. Use of LIPUS as a diagnostic tool.
4. Use of LIPUS for conditions other than fractures.

Search Strategy

Table 1 outlines the key search terms used in the literature review, the electronic databases, the number of articles found in each database, and how many of those articles were relevant to the search criteria. Typing in the word "ultrasound" produced a voluminous amount of results; thus the need to narrow down the findings. This was done by adding the words "low intensity pulsed" to each database. This produced a more confined and suitable list of results in the PubMed database (12 results) and one relevant article was obtained; however, still a large number in both Medline-MeSH and Wiley Science were generated. "Stress Fracture" was then added to "ultrasound" and one article was obtained through the Wiley Science database. When "nonunion" was entered along with "ultrasound, Medline-MeSH produced 2 pertinent articles. Adding the term "fractures" and "low intensity pulsed" to "ultrasound" also produced 2 articles through Medline-MeSH. PubMed produced one article for review, Medline-MeSH produced 4 relevant articles, and Wiley Science also produced one. These results gave 2 articles in each of the following categories: (1) acute fractures, (2) stress fractures, and (3) non-union fractures.

SYSTEMATIC LITERATURE REVIEW

Several studies have been investigated examining the effectiveness of LIPUS over acute, stress, and non-union fracture sites. The following studies examine parameters, duration, and healing time of fractures using LIPUS as treatment.

Acute Fractures

Kristiansen and colleagues used a multicenter, prospective, randomized, double-blind, placebo-controlled clinical trial to test the efficacy of LIPUS for shortening the healing time of the distal aspect of the radius with dorsal angulation fracture. Sixty patients (61 fractures) were enrolled in the study within 7 days postfracture. Ten males and 50 females were divided into 2 groups. The mean age of the treatment group was 54 ± 3 years and 58 ± 2 years for the control group.[1]

Thirty patients used an active ultrasound device and the other 30 used a placebo device at home for 10 weeks. A fixture was incorporated into the cast to hold the treatment head module. The US pressure-wave signal was composed of a pulse burst width of 200 µs containing approximately 300 sine-wave pressure pulses, each approximately 0.67 nanoseconds in duration. This is equivalent to a frequency of 1.5 MHz. The 200 µs burst of pressure was followed by an off-time of 800 µs and repeated every millisecond which is indicative of a repetition time of one kHz [1:4 pulse ratio]. The device was programmed to remain on for 20 minutes and automatically shut off after the treatment was finished. The placebo device was identical to the treatment module, but it had a disconnected ultrasound transducer

Table 1. Key Search Terms and Relevance

			Pub Med	Medline - MeSH	Wiley Science	Total
Ultrasound			26,916	104,048	23,477	
	+ Low Intensity Pulsed		12	207	98	
		# Relevant	**1**	----	----	1
	+ Stress Fractures		**73**	**26**	**1**	
		# Relevant	**0**	**0**	**1**	1
	+ Nonunion		**35**	**29**	**0**	
		# Relevant	**0**	**2**	**0**	2
	+ Fractures and Low Intensity Pulsed		**11**	**55**	**1**	
		# Relevant	**0**	**2**	**0**	2
Total Number of Relevant Articles for Review						6

and therefore emanated no ultrasound pressure wave.[1]

Results of this study show that the time to union was significantly shorter ($p < 0.0001$) for the fractures treated with ultrasound than those with the placebo. The treated fractures averaged 61 ± 3 days to heal; whereas the placebo group averaged 98 ± 5 days to heal. No adverse reactions or complications were reported during the study. At 42 days after the fracture, 6 (20%) of the 30 fractures treated with the active US had healed compared with only one (3%) of the fractures treated with the placebo ($p < 0.05$). At 56 days, 15 (50%) of the fractures treated with US were healed; whereas only 4 (13%) of the placebo group had healed ($p < 0.002$). On day 70, 21 (70%) of the US group had healed compared with 6 (19%) of the placebo ($p < 0.0001$). At 84 days, 27 (90%) of the US group had healed; however, only 10 (32%) of the placebo group had ($p < 0.0001$)[1] (See Table 2).

Table 2. Healing Rate of the Kristiansen Study

	Ultrasound Group		Placebo Group	
Day	# Healed	Percentage	# Healed	Percentage
42	6	20%	1	3%
56	15	50%	4	13%
70	21	70%	6	19%
84	27	90%	10	32%

Heckman and colleagues performed a multi-institutional, prospective, randomized, double-blind, placebo-controlled study to investigate LIPUS on the rate of healing fractures when used in patients as an adjunct to conventional orthopaedic management. Sixty-seven patients with closed or grade-1 open fractures of the tibia participated in the study. The active treatment group contained 25 males and 8 females that had an average age of 36 ± 2.3 years and the placebo group contained 29 males and 5 females with an average age of 31 ± 8 years. The fractures were treated conventionally with closed reduction and immobilization in an above-the-knee cast.[3]

A retaining and alignment fixture was inserted into a window in the cast centered above the fracture site that held the treatment head module in place during the treatment. Treatment was started within 7 days of the fracture and consisted of one 20-minute period per day for 20 weeks or until the investigator believed that the fracture was healed. The treatment head module produced an US signal with a burst width of 200 µs containing 1.5 MHz sine waves, with a repetition rate of one kHz and a spatial average intensity of 30 milliwatts per square centimeter.[3]

The mean fracture healing time for the active treatment group was 86 ± 5.8 days compared to 114 ± 10.4 days for the placebo treatment group ($p < 0.0001$). At 120 days after the fracture 88% of the treatment group had completely healed compared to 44% of the placebo group. At 150 days, 94% of the US treatment group had healed, where as only 62% of the placebo group had. The mean time to discontinue the cast was 94 ± 5.5 days for the active treatment group compared to 120 ± 9.1 days for the placebo group (p= 0.008, 0.005, 0.01). Only one adverse reaction was reported during this study with the active treatment. One patient reported muscle cramping at 1 week, but it resolved, without treatment, by the second week.[3]

Stress Fractures

The repair process for a complete fracture is different from the process the body uses to repair stress fractures. A complete fracture heals via callus formation. It begins with the formation of a cartilage callus and proceeds through stages of endochondral ossification to consolidate and mineralize. However, the healing of stress fractures works directly through bone remodeling. First, there is reabsorption of the damaged region and then a replacement of new bone.[14] Limited research has been done examining the use of LIPUS for the treatment of stress fractures. Brand and colleagues performed a study with no control group examining the use of LIPUS in 8 human adults and found evidence to support its use for decreased pain and increased performance.[6] Li and colleagues examined the use of LIPUS compared to anti-inflammatory drugs in stress fracture repair on adult female rats in a randomized, controlled trial in 2007.[14] Their findings also supported the use of LIPUS to accelerate the healing of stress fractures.

Brand and colleagues explored the use of low intensity pulsed ultrasound in treating stress fractures. Eight patients with radiographic and bone scan confirmed tibial stress fractures participated in this study. All patients, except 1, were involved in high school or college soccer and basketball. Two males and 5 females had a posterior-medial tibial stress fracture and one female basketball player had an anterior tibial stress fracture.[6]

Prior to treatment, the subjects completed a 5 question, 10 cm visual analogue scale regarding pain level and were assessed for functional performance by testing number of step downs in one minute. Subjects received daily 20 minute LIPUS treatments with a frequency of 1.5 MHz, radiating area of 3.88 cm^2, pulse width of 200 microseconds and temporal average power of 117 mW. The treatments were administered 5 times a week for 4 weeks. All patients maintained functional activities during the treatment period. The patients with the posterior-medial stress fractures participated without bracing; however, the patient with the anterior stress fracture used an AIRCAST™ pneumatic tibial brace with an anterior pad to decrease the risk for fracture during activities. Subjects were retested after 4 weeks of treatment.[6]

No subjects were removed from participating in athletic activities because of their injuries and all patients resumed or maintained prior level of activities. Although the level of intensity of practice was diminished in some instances, no time off from sports was prescribed for the patients. Mann-Whitney U tests and paired t-tests assessed statistical significance ($p < 0.05$) between the pre- and post-testing scores (see Table 3). Subjects demonstrated the ability to perform more step downs in 1 minute ($p = 0.02$) and reported less pain with palpation ($p = 0.02$) after treatment with LIPUS.[6] The treatment showed to be successful in the posterior-medial, stress fractures. The patient with the anterior stress fracture did not respond to LIPUS and had to undergo an intramedullary nailing at the end of the season; thus indicating that LIPUS may not be useful in anterior tibial stress fractures, but more research needs to be done regarding this.[6]

Table 3. Summary of Functional Testing Before and After LIPUS

	Stepdowns / 1 min	Pain with Palpation
Pretreatment	28 ± 7 reps	7.5 ± 2
Posttreatment	36 ± 5 reps	3.3 ± 3
Mean difference	8 ± 6 more reps	4.3 + 3 reduced pain
P Value	0.02	0.02

Li and colleagues compared the use of nonsteroidal anti-inflammatory agents (NSAID) to the use of LIPUS in 48 adult rats. Bilateral stress fractures were induced in the ulnas of the rats and they were randomly assigned to 1of 4 groups: (1) inactive LIPUS and inactive drug (control) group, (2) active LIPUS and inactive drug group, (3) inactive LIPUS and active drug (NSAID) group, and (4) active LIPUS and active drug [NSAID] group.[14]

Parameters and treatment time for the LIPUS was chosen based on previous studies done by Kristiansen et al,[1] Heckman et al,[3] and Mayer et al.[13] A daily 20-minute session of 2 ms burst of 1.0 MHz sine waves repeating at 100 Hz and 100 mW/cm^2 was used for 5 days unilaterally. The contralateral limb received an inactive LIPUS daily for 20 minutes as well. The NSAID used in this study was Celebrex® at a dose of 5mg/kg for 5 days per week.[14]

Results of this study indicate that LIPUS significantly enhanced bone formation rate (BFR) at both 4 and 8 weeks in comparison with the control. At week 4, the NSAID group showed no effect on BFR (p=0.59), where as the US treatment group increased the formation of bone significantly (p=0.002). When coupled together, no significant increase was seen in the BFR. Findings indicate that the BFR increase due to ultrasound is related to an increase in osteoblast recruitment (p=0.021) and individual activity (p=0.011). At week 8, the NSAID group showed a significant negative effect on BFR (-51%, p=0.035) compared with the control; however, the ultrasound group continued to show a significant positive effect on BFR (+51%, p=0.023). These effects indicate that LIPUS may be used to facilitate stress fracture repair whereas NSAID use may delay healing of the bone.[14]

Non-Union Fractures

Nolte and colleagues examined the effect of low intensity ultrasound for the treatment of established nonunions. Twenty nine patients with a nonunion located in the tibia, femur, radius/ulna, scaphoid, humerus, metatarsal, and clavicle having a minimum of 6 months from fracture time were recruited and used as their own control with the prior failed treatments as the basis for evaluating the effectiveness of US. Seventeen males and 12 females with an average age of 47 ± 2 years participated in the study. These patients had an average fracture age of 1.2 years, an average of 1.4 failed surgical procedures, an average prior surgical interval of 1 year, and the cessation of any healing progress at the start of the treatment.[11]

Each patient applied the US for a 20 minute treatment session daily. The ultrasound device consisted of an attachment that allowed the module to either be incorporated in the cast (if present) or used a Velcro strap to hold the module in place on the skin over the non-union site. The surgeon marked the skin at the site to assist the patient in positioning the module. Coupling gel was used to ensure an effective transfer of the pressure wave to the tissue. The treatment device had a pressure wave signal of 200µs burst of 1.5 MHz acoustic sine waves that repeated at a modulation frequency of 1 kHz. The device controlled the 20-minute period.[11]

Low intensity pulsed ultrasound treatment showed effectiveness in the treatment of non-unions by demonstrating an 86% (25 of 29 cases) healed rate. This was significantly better ($p < 0.0001$) than the assumed rate of 5% for the prior failed treatment period. The average healing time was 152 days (22 wks) and the average fracture age for healed cases was 429 days. The healed rate by bone was 100% in the tibia (10 cases) and other long bones [2 cases; one humerus and one metatarsal), 80% in the femur (5 cases), radius/ulna (5 cases), scaphoid (5 cases), and 50% in other cases (2 cases; one clavicle (healed), and one ankle (failed)]. Three of the 4 failed cases were active smokers and lends support to the negative effect of smoking on bone healing. No side effects were reported with the use of US in this study.[11]

Gebauer and colleagues also examined the use of LIPUS for treatment of non-union fractures. Sixty-seven cases with a minimum of 8 months from the fracture date were investigated. Radiographs indicated that the fracture healing had not progressed for at least 3 months and the fracture line was clearly visible on the radiograph. Also, all subjects had been without surgical intervention for at least 4 months before starting the LIPUS treatment. The average patient age was 46 ± 1.9 years and the mean fracture age was 39 ± 6.2 months. The average number of failed surgical procedures was 2.0 ± 0.3 and included bone grafts, arthroplastys, osteotomys, external fixation, dynamic condylar screws, hip replacements, electrical shockwave therapy, intramedullary nails, braces, plates, screws, dynamization, arthrodesis, casting, reconstruction, curettage, and debridement. Twenty-six women and 41 men participated in the study. Fracture sites varied and included the tibia, clavicle, femur, metatarsal, ulna, fibula, humerus, ankle, scaphoid, pelvis, calcaneus, rib, and knee.[12]

The prescribing physician indicated the treatment site based on radiographic evaluations. The patients applied ultrasonic coupling gel to the surface and placed the treatment module on the site. The effective radiating area of the transducer was 3.88 cm^2 and the pressure wave signal was a 200-µs burst of 1.5 MHz acoustic sine waves that repeated at a modulation frequency of 1 kHz. The operating unit monitored treatment time and automatically turned off the session at 20 minutes.[12]

This study reported an 85% heal rate for the non-unions (57 out of 67) with a highly significant ($p < 0.00001$) effect. The mean heal time was 168 ± 10.2 days with a median of 143 days and a range of 57 to 375 days. Of the patients, 25% were healed by day 108 and 75% were healed by day 212. The fracture age for the healed cases was an average of 31.2 months with a median of 14.1 months and a range of 8 to 197 (16.4 years) months. Of the 10 failed cases, 4 were located at the scaphoid (average fracture age of over 10 years), 2 were at the tibia (average fracture age of 4.9 years), one ulna epicondyle (fracture age of 13.9 years), 1 at the femur (fracture age of 4.8 years), one ankle arthrodesis (fracture age of 1.2 years), and 1 located at the humerus (fracture age of 9 months). Cases with fracture ages of over 5 years only indicated a healing rate of 50%. No adverse reactions were reported during the duration of the study.[12]

DISCUSSION

The analysis of these studies indicates that LIPUS therapy is beneficial to fracture healing by reducing healing time and could possibly yield substantial savings in health care costs and decrease patient disability. Approximately 5.6 million fractures occur annually in the United States and these injuries are associated with substantial morbidity and socioeconomic costs. Tibial fractures are most common resulting in a total of 569,000 hospital days and 825,000 physician visits per year.[5] Based on the Kristensen et al[1] study that found a reduction of 37 days (placebo - 98± 5; treatment – 60 ± 3) when treated with ultrasound over the placebo group, one study indicated savings of more than $15,000 when treated conservatively with LIPUS.[5] Not only did LIPUS show to decrease healing time in acute fractures and stress fractures, but also in established non-union cases.

Acute Fractures

When examining low intensity pulsed ultrasound for treatment in new fractures, both studies showed a significant improvement in healing time when compared to similar control groups.[1,3] When combining the 2 studies together, there was equal number of males and females as well as similar ages between the 2 groups.[1,3] The Kristiansen et al study showed a decrease in healing time of 37 days and the Heckman et al study demonstrated a reduction of 28 days. When combined, these studies reveal a reduction in healing time of 32.5 days when using LIPUS over the fracture site[1,3] (See Table 4).

Both the Kristiansen and the Heckman studies demonstrated a significant difference between the treatment group and placebo group when observing healing time. The Kristiansen et al study reported the treatment group's healing time as 61 ± 3 days and the placebo group as 98 ± 5 days. [1] This is a difference of 37 days to heal. The Heckman study presented a heal time for the treatment group at 86 ± 5.8 days, but 114 ± 10.4 days for the placebo group.[3] This is a difference of 28 days. One dissimilarity that could account for the difference in healing time is that the Kristiansen study was examining the distal radius, where as the Heckman study observed the tibia. The tibia is a much larger bone and therefore could take a longer time to heal. Regardless of the difference in healing time between the 2 studies, both studies showed a significant reduction in healing time for the LIPUS group over the placebo group.

Stress Fractures

Examining the available research of LIPUS for the treatment of stress fractures indicates that it could possibly be an effective treatment, but more research needs to be done to support these findings. Both Brand et al and Li et al found evidence to support the use of LIPUS in the treatment of stress fractures.

Brand and colleagues examined the use of LIPUS in small adult human population (8 subjects) and found that a 20-minute session of 1.5 MHz and pulse width of 200 µs both decreased pain and increased functional performance in the 7 posterior-medial stress fractures (p=0.02). The anterior stress fracture did not respond to the treatment in this study.[6] No control group was used, however, and there was no randomization to the study. In one month's time, some healing to the fracture will occur naturally and therefore pain would decrease. A prospective, controlled randomized trial of a much larger magnitude needs to be performed in order to determine if LIPUS is truly beneficial in decreasing pain and optimizing performance among patients with stress fractures.

Li and colleagues used similar parameters to unveil the reason for LIPUS being affective in stress fracture treatment. A 20-minute session of 1.0 MHz and pulse width of 200µs was used unilaterally in 48 adult rats. LIPUS treatment significantly enhanced the bone formation rate (BFR) at both 4 and 8 weeks by increasing osteoblast recruitment and individual activity. Li and colleagues based their parameters on previous studies; however, were unclear as to the reason why they were not identical to those studies. Also, this study was performed on rats and therefore can be projected to apply to humans, but not without some uncertainty. Rats do not remodel inrtacortically naturally, as do humans; thus the nature and timing of fracture repair will be obscure when comparing humans to the rat model. Studies need to be carried out on adult, human populations to determine the efficacy of this treatment on BFR and osteoblast recruitment for the healing of stress fractures.

Non-Union Fractures

When examining LIPUS for the treatment of established non-union fractures, Nolte and colleagues had a smaller sample size than Gebauer et al, but demonstrated a shorter healing duration (see Table 5).Both the Nolte and Gebauer studies demonstrated significant improvement in healing time when using LIPUS for the treatment of established non-unions. The Nolte study showed an 86% healing rate with 25 out of 29 cases regenerating ($p < 0.0001$) and an average healing time of 152 days. The Gebauer study showed an 85% healing rate with 57 out of 67 cases mending ($p < 0.00001$) and a mean healing time of 168 days. The Gebauer study had a much larger sample size (67 compared to 29); however, demonstrated similar results regarding healing rate. The healing time was longer in the Gebauer study. This could be due to the fact that the time since the fracture reported by Nolte was at least 6 months, but the Gebauer et al study only recruited fractures of at least 8 months prior. The longer fracture time could account for the longer healing time in the Gebauer study.

When examining the cases that did not heal in these 2 studies (see Table 6), several factors stand out as possible reasons for the failures. Of the 14 cases that failed, 35.7% (5 out of 14) were located at the scaphoid. Of all the scaphoid cases reported between these 2 studies, only 54% were successful in healing (6 out of 11). This indicates that the scaphoid could be a difficult bone to heal

Table 4. Summary of Trials using LIPUS for New Fractures

		# of Fx; Sample Size		Mean age [and SD]				Mean time to Heal [and SD] in Days	
Trial	Fx Location	Treatment Group	Control Group	Treatment Group	Control Group	Male:Female ratio	Time since Fx	Treatment Group	Control Group
Kristiansen et al	Distal radius	30	31	54 [3]	58 [2]	10:51	< 7 days	61 [3]	98 [5]
Heckman et al	Tibial shaft	33	34	36 [2]	31 [2]	54:13	< 7 days	86 [5.8]	114 [10.4]
TOTALS		63	65	45	44.5	64:64	< 7 days	73.5	106

Table 5. Summary of Trails using LIPUS for Established Non-Union Fractures

Trial	Fx Location	# of Fx: Sample Size	Mean Pt Age	Male:Female ratio	Time since Fx	Time to Heal [Days]
Nolte et al	Various	29	47 [2]	17:12	> 6 mths	152
Gebauer et al	Various	67	46 [1.9]	41:26	> 8 mths	168 [10.2]
TOTALS		96	46.5	58:38		160

using LIPUS. Fracture age could also prove to be a factor in the success of LIPUS on treatment. In the Nolte study, the average fracture age of the subjects who did not heal was 363.5; but the average fracture time of the healed fractures was 428.64. This does not indicate that fracture time is a factor; however, in the Heckman study the average age of the healed fractures was 951.2 days, where as the average age of the fractures in the nonhealed fractures was 2569.8 days. This is a large difference in fracture time from a larger sample of patients and could possibly indicate that fracture age plays a role in healing time as well. Only 21% of these subjects never smoked, and 50% reported being active smokers; thus indicating the importance of not smoking in healing time.

LIPUS Parameters

All 6 studies used similar parameters that have been previously researched by Xavier, Duarte, and Pilla to be the most effective treatment factors.[1-3,11-13] Daily 20-minute sessions composed of a burst width of 200μs containing 1.5 MHz sine waves, and a repetition rate of 1 kHz were used by all studies involving human populations. The preliminary study involving rats used a 1.0 MHz frequency instead, but was unclear as to the reason why. Treatment duration varied from 4 weeks to 24 weeks depending on the location, type of fracture, and the time since initial fracture (Table 7).

CONCLUSION

Low-intensity pulsed ultrasound has shown to be clinically significant in the healing of acute fractures, stress fractures, and established non-union cases. Currently, physical therapists are using ultrasound at intensities of 1 to 3 w/cm^2 to decrease joint stiffness, reduce pain and muscle spasms, and improve muscle mobility.[2] Several studies have indicated that using a LIPUS unit set at 0.03 w/cm^2 and a frequency of 1.5 MHz can reduce healing time of fractures and could generate considerable cost savings while decreasing possible disabilities associated with delays and non-unions.[1-3,11,12] However, only 20.6% of senior physical therapy students believe that US can reduce healing time and only 2.9% report ever using it for fracture healing.[5] Evidence based practice along with emphasis on decreasing medical costs while optimizing patient care is what physical therapists should base treatment on. LIPUS offers an alternative treatment for fractures that can be done safely and effectively by the patient in their own home with set-up instruction provided by physical therapists.

Table 7. Characteristics of Low-intensity Pulsed Ultrasound

Frequency:	1.5 MHz
Wave shape:	Sine wave
Signal type:	Pulsed
Length of signal:	200 μs
Off period:	800 μs
Repetition rate:	1 kHz
Intensity	30 mW/cm^2

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Table 6. Failed Cases in the Nolte et al and Heckman et al Studies

Study	Location	Gender	Fracture Age	Smoking Status
Nolte et al	Medial Malleolus	Male	333 days	Smoker
Nolte et al	Femur	Male	716 days	Smoker
Nolte et al	Scaphoid	Female	239 days	Stopped
Nolte et al	Ulna	Female	466 days	Stopped
Heckman et al	Ulna	Female	4740 days	Smoker
Heckman et al	Femur	Female	1767 days	Never
Heckman et al	Ankle	Male	452 days	Smoker
Heckman et al	Humerus	Male	272 days	Never
Heckman et al	Scaphoid	Male	485 days	Smoker
Heckman et al	Scaphoid	Male	3690 days	Stopped
Heckman et al	Tibia/Fibula	Male	585 days	Smoker
Heckman et al	Scaphoid	Male	5893 days	Smoker
Heckman et al	Scaphoid	Male	4808 days	Never
Heckman et al	Tibia	Male	3006 days	Stopped

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Finance Committee Report

Steven R. Clark
Chairman

The Finance Committee met in August to review financial operations and to make recommendations for the 2010 budget. The Gillette & Associates audit of the 2008 Section income/expenses has ascertained that Section operations and its cash flow is in conformity with accepted accounting principles through December 31, 2008.

Audit Report 2008.

STATEMENT OF ACTIVITY

Years Ended December 31, 2008 and 2007

UNRESTRICTED NET ASSETS	2008	2007
Unrestricted Revenues, Gains, Losses		
Membership dues	$706,763.00	$697,619.00
Registration, meetings	$566,785.00	$522,620.00
Advertising income	$44,609.00	$47,266.00
Shipping and handling income	$23,736.00	$20,701.00
Publishing and administrative	$54,802.00	$55,865.00
Sale of promotional items	$1,606.00	$1,282.00
Miscellaneous	$10,381.00	$13,591.00
Investment income	$86,501.00	$126,358.00
Rental income	$52,585.00	$51,388.00
Sale of assets	($12,055.00)	$24,136.00
Total Revenue	$1,535,713.00	$1,560,826.00
Less: Administrative Expenses	($323,618.00)	($231,850.00)
Program Expenses	($1,047,298.00)	($1,117,890.00)
Add: Unrealized Gain (loss)		
on Investments	($579,692.00)	($20,585.00)
Change in Unrestricted Net Assets	($414,895.00)	$190,501.00
Net Assets at Beginning of Year	$3,019,776.00	$2,829,275.00
Net Assets at End of Year	$2,604,881.00	$3,019,776.00

MARKETABLE SECURITIES	**FAIR MARKET VALUE**		
	2007	2008	10/27/09
LPL Investment Reserve	$716,183.00	$524,846.00	$776,618.20
Wells Fargo - Research, Practice, and Education Fund	$1,081,479.00	$757,369.00	$930,585.89

The 2008 audit demonstrates a decrease in net assets from 2007 of $414,895.00. This loss relates to the NATA lawsuit legal fees and investment losses. Although the Section's investments demonstrated a decrease in value, the Sections investment consultants demonstrated better returns than the 2008 market indices. This loss could have been even greater had the Finance Committee not chosen to move Section dollars into laddered certificate of deposits versus investing in the market. This allowed the Section to have a cash position to allow for participation in the stock market (LPL Financial) advance starting in March 2009.

In addition, the following operating budget for fiscal year 2010 has been approved by the Section Board of Directors. In order to meet the expenses required to perform strategic planning initiatives, the Board of Directors approved an increase in independent study courses as follows: 3 monograph courses $10, 6 monograph courses $25, and 12 monograph courses $50. This represents the first increase in the Orthopaedic Section member rate for independent study courses since the inception of this program. This course of action will allow the Section to continue offering membership dues at the $50.00 level signifying no increase since 1990. An additional Finance Committee recommendation that was passed by the Board of Directors will establish a $25,000 capital expense fund. With the aging of the Section building in La Crosse, this will assure that funding will be available for major repairs.

2010 Operating Budget.

	2010 Proposed Expenses	2010 Proposed Income
GOVERNANCE	$228,847.00	$14,000.00
OPERATIONS	$291,253.00	$47,382.00
MEMBER SERVICES	$380,123.00	$686, 235.00
EDUCATION	$117,538.00	$177,600.00
JOURNALS/NEWSLETTERS	$233,304.00	$145,795.00
INDEPENDENT STUDY COURSES	$278,248.00	$475,696.00
NOMINATING COMMITTEE	$4,895.00	$0.00
OCCUPATIONAL HEALTH SIG	$2,500.00	$0.00
FOOT AND ANKLE SIG	$2,500.00	$0.00
PAIN MANAGEMENT SIG	$2,500.00	$0.00
PERFORMING ARTS SIG	$2,500.00	$0.00
ANIMAL REHABILITTION SIG	$2,500.00	$0.00
	$1,546.708.00	$1,546,708.00

If you have questions regarding the audit report or 2010 operating budget, feel free to contact me at Steven@clarkphysicaltherapy.com.

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

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

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

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

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

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

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

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

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

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

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

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

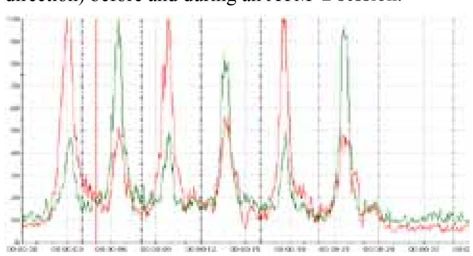
Now that we have established the importance of exercising the particular movement that is deficient, the next question is how to exercise it.

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

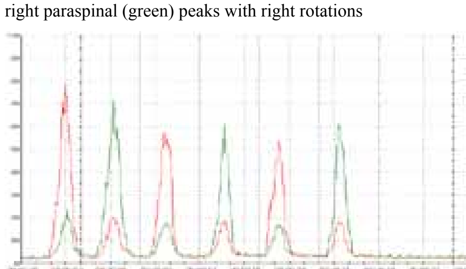
Similarly, before we embark on core stability exercises, we need to first be sure that the movement is correct. In other words, pain-free and with correct muscle activation patterns.

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

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



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



__On ATM2__ – Paraspinal Muscle Activation during spinal rotations. Left paraspinal (red) peaks with left rotations and right paraspinal (green) peaks with right rotations.

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

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

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

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14. Stanton R, Reaburn PR, Humphries B. The effect of short-term Swiss ball training on core stability and running economy. *J Strength Cond Res*. 2004 Aug;18(3):522-8.
15. Lee D. *The Pelvic Girdle.* 3rd ed; 2004.

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Occupational Health

SPECIAL INTEREST GROUP

GREETINGS AND HAPPY NEW YEAR OHSIG MEMBERS!

We hope you had a wonderful holiday season with family and friends.

OHSIG has an ambitious agenda for 2010. Some of the things we are working on for members include the following:

1) CSM Programming and OHSIG Business Meeting
Plan to attend CSM in San Diego CA, Feb 17-20 for education and business updates related to Occupational Health.

Saturday, Feb 20, 7-8am

General Business Meeting for Membership
Continental Breakfast will be served. Officers will be introduced. An update on Specialty Certification in OH will be presented, along with the OH Three year Strategic Plan. And much more!

Saturday, Feb 20, 8-11am

Occupational Health SIG Education Program CSM 2010 Functional Testing Update: Work Injury Management and Prevention

Functional testing for work injury management and prevention in clinical and employer based situations has continued to grow and gain acceptance as a standard practice in many physical therapy clinics. This 3 hour program will look at best practices and legal considerations related to functional tests such as functional capacity evaluations, fit for duty tests and post offer prework screens. Whether you consult with companies or see employee clients in your PT practice, you will need to understand the importance of keeping up to date on the latest standards of practice and legal developments which can impact your services.

Although there are a range of terms and philosophies related to functional capacity evaluations (FCEs), one of the most used documents by internal and external stakeholders in occupational health has been the APTA Occupational Health Physical Therapy Guideline on Functional Capacity Evaluation. New guidelines reflect updated practice expectations, definitions, recommended test components, guidelines for administration, and evaluative/outcome expectations of therapist performance. This program will also review the results of an international Delphi study on consensus language related to functional capacity evaluation and the potential impact on physical therapist practice, including ICF terminology.

This program will also discuss issues therapists should be aware of when marketing, designing, testing, and implementing functional testing programs (including "prework screens"). Legal risks and challenges for therapists can be costly and you should know how to minimize risks. Case studies will demonstrate the importance of understanding legal risks, illustrating real world positive outcomes and consequences of various functional testing programs.

Session Outline

1. Brief Introduction to Various Types of Functional Testing – FCEs, job specific tests, employment exams (pre and post-offer) and the laws that impact how we deliver these services (ADA/ADAAA), Civil Rights Act, ADEA, Workers' Compensation, Social Security Act
2. Updated APTA FCE Guidelines and New Consensus Terminology
   a. Review of the Delphi study on consensus based language and updated terminology related to FCE (and integration with ICF terminology/taxonomy)
   b. Highlights of the APTA Occupational Health Physical Therapy Guideline: Functional Capacity Evaluation
3. Design of PreWork and Return to Work Screens: How to Avoid Unintentional but Illegal Discrimination
   a. The PT Consultant's role and liability in legal compliance
   b. Difference between pre- and post-offer screenings v. return to work exams (legal content and legal use of results)
   c. Complying with the EEOC Uniform Guidelines on Employee Selection: The importance of test reliability and validity and "disparate impact"
   d. Introduction to the EEOC Guidelines requirements
3. Working with the Company Client: Meeting the Company's Expectations and Assisting the Company with Legal Compliance
   a. Setting the company client's expectations for your services
   b. Designing employment screening exams that comply with EEOC Guidelines
   c. Monitoring test outcomes for a disparate impact
   d. Justifying modifications in test design and qualification (passing) criteria
   e. Common client company issues
5. Panel Discussion of Functional Testing Case Studies and Outcomes: Successes, Limitations and Lessons Learned

Presenters:
Gwen Simons, PT, JD, OCS, FAAOMPT, Simons & Associates Law, P.A.
Drew Bossen, PT, Atlas Ergonomics
Susan Isernhagen, PT, DSI Work Solutions
Margot Miller, PT, WorkWell Systems
Rick Wickstrom, PT, CPE, CDMS, Work Ability Wellness Center

Look for this program in your CSM brochure! We hope to see you there!

2) **OHSIG continues efforts toward Specialty Certification in Occupational Health.**
3) **OHSIG three year Strategic Plan has been developed.**
4) **Updated Work Rehab Guidelines will be available early 2010.**
5) **OHSIG has given input to OIDAP (Occupational Informational Development Advisory Panel) related to the Physical Demand recommendations presented by the Panel.**

Watch for future updates on OHSIG activities in OPTP. If you have interest in writing an article or case study for OPTP, please contact an OHSIG officer. We welcome your feedback and input!

Submitted by Bill O'Grady, OHSIG Interim President
Dee Daley, OHSIG VP/ED Chair
Margot Miller, OHSIG Advisor

The Legal Status of FCEs since Indergard v. Georgia-Pacific Corp

By Gwen Simons, PT, Esq, OCS, FAAOMPT

A recent case in the 9th Circuit of the U.S. Court of Appeals has caused quite a stir in the medical, legal, and employer community producing headlines like "*Does the EEOC Prohibit PTs, OTs from Administering FCEs?" and "EEOC: No FCEs by PTs, OTs?"* (Advance for Occupational Therapy Practitioners, online edition, October 5 and October 9, 2009 respectively). Many people have drawn erroneous conclusions about what this case means, making FCE providers and employers unreasonably fearful of using Functional Capacity Evaluations. The purpose of this article is to provide a legal analysis of the issues raised in this case and discuss how it really impacts FCEs and FCE providers.

A brief history of the Indergard case is as follows. Kris Indergard, an employee at Georgia-Pacific's Wauna mill facility (hereinafter "GP") in Oregon, sued her employer for discrimination under the Americans with Disabilities Act (ADA) and Oregon state law after her employer would not permit her to return to work based on the results of a Physical Capacity Evaluation ("PCE") (for purposes of this article the term "Functional Capacity Evaluation" (FCE) is used interchangeably with PCE).

Indergard had been on medical leave for more than 15 months after surgery for work-related and nonwork-related injuries to her knees. GP had a policy of requiring employees to participate in a PCE before returning to work from medical leave to determine whether the employee could still safely perform the essential job functions. To ensure the PCE was job specific, a PT performed a job analysis of the Indergard's previous job (Consumer Napkin Operator) and the next position she was entitled to bid on (Napkin Operator) under the union contract. From the description of the job analysis procedure in the appeal, the PT made an effort to objectively quantify the essential job functions by interviewing incumbent employees about their job demands and measuring the physical demands of the job. A 65 lb. lifting and carrying requirement was identified for Indergard's former job and a 75 lb. lift requirement was identified for the Napkin Operator job. Both of these lift requirements exceeded the permanent restrictions given to Indergard by her orthopaedic surgeon so she was not permitted to participate in the PCE or return to work. Indergard challenged the lifting requirements as not being accurate while also pursuing a removal of the restrictions from her surgeon.

After Indergard's restrictions were lifted, an OT performed a 2-day PCE. The appeal described a very thorough PCE that included a medical history and a musculoskeletal exam in addition to what appeared to be both standardized and job specific functional tests. Test results indicated that Indergard demonstrated "poor aerobic fitness" and was unable to meet the 65 lb. lifting requirement. The OT recommended, and Indergard's surgeon agreed, that Indergard should not return to either of the jobs tested. Since no other positions were available for which she was qualified (per the employer), Indergard's employment was terminated once she reached the limit of medical leave permitted under the union contract.

Indergard filed suit claiming, among other things, that GP forced her to participate in the PCE "without an objectively reasonable basis for doing so" (alleging that the PCE was a prohibited medical exam under the ADA) and that GP discriminated against her because of a perceived disability or record of disability. (By the time the case went to the appeal, she had dropped her claims that the PCE was improper or discriminatory and that GP had failed to engage in an interactive process to explore reasonable accommodations.) GP filed a motion for summary judgment arguing that the PCE was not prohibited because it was an agility screening, not a medical exam.

Whether you believe a PCE/FCE is a medical exam or not, it was a good legal strategy to try to characterize it as an agility test in order to win the case without a trial. When a motion for summary judgment is made, the judge must decide whether there are any genuine issues of material fact to be decided or whether the case can be decided on the law alone without hearing each side's rendition of the facts and evidence. In this case, a decision that the PCE was an agility screen would mean the defendant employer did not violate the law – no need to hear the facts, case closed, plaintiff loses. However, if the PCE was a medical exam, it may or may not be permissible under the ADA depending on the facts that led to the ordering of the test. The ADA prohibits the employer from requiring a medical exam for current employees *unless* the exam "is shown to be job related and consistent with business necessity." (42 U.S.C. § 12112(d)(4)(A)). Whether GP could justify a business necessity for the PCE is a question of fact for the jury – summary judgment motion would have to fail and the case would have to go to the jury to decide.

The magistrate in the lower court determined that the PCE was an agility test and granted GP's motion for summary judgment, effectively ending the case until Indergard appealed. The Appeals court, relying on the long-established criteria used to distinguish an agility test from a medical test in the EEOC's Enforcement Guide, agreed with Indergard that the PCE was indeed a medical exam. Now the case will go to trial to determine whether the employer had a business necessity for requiring the test and discriminated against Indergard on the basis of a known or perceived disability.

To reach its decision, the court analyzed aspects of the PCE to determine whether they were medical in nature. Some have mistaken this analysis as a criticism of the PCE and an indication that such medical tests are prohibited per se under the ADA. This is not the case. The court did not criticize the quality, reliability, validity, or credibility of the PCE procedure or the provider. However, the court did, through its analysis, give guidance on some legal boundaries for FCEs/PCEs under the ADA. The remainder of this article will discuss some of the questions this case and others have raised about FCEs under the ADA.

1. **If an FCE is a medical test, is it prohibited under the ADA?** No, not if test is job-related and consistent with business necessity. The ADA prohibits the employer from requiring a *medical* exam for current employees *unless* the exam "is shown to be job related and consistent with business necessity." (42 U.S.C. § 12112(d)(4)(A). To meet the business necessity standard, ". . . the employer must demonstrate some reasonable basis for concluding that the inquiry was necessary. That is, the employer must show that it had some reason for suspecting that the employee, or class of employees, would be unable to perform essential job functions or would pose a danger to the health and safety of the workplace."[1] The business necessity of a medical test has been upheld in several cases where employees had known injuries, illnesses or long medical leaves of absence that may have impacted the worker's ability to safely perform the essential job functions.
2. **If an FCE is a medical test, are there any restrictions under the ADA for what tests the FCE can include?** There are no per se restrictions, but case law indicates that even when an employer's medical inquiry meets the business necessity standard, the inquiry must "be limited to an evaluation of the employee's condition only to the extent necessary under the circumstances to establish the employee's fitness for the work at issue."[2] This is to protect the worker against unwarranted inquiries into impairments or disabilities that do not interfere with the worker's ability to perform the essential job functions. However, this public policy should not be interpreted to prohibit a medical professional from performing appropriate tests and measures necessary to ensure a worker's safety and fitness for duty.

The FCE provider's job is to ensure the worker is *safe* to return to work. That assessment requires an analysis of any physical impairment or medical condition that has potential to impact safe work performance. A medical/FCE provider cannot forego performing differential diagnosis or other safety tests for fear that, if negative, the test could be construed as being unnecessary and a violation of the ADA. Most often the necessity of a test is not evident until the test results are returned. Negative or seemingly "unnecessary" tests are just as important to the differential diagnosis or analysis as positive tests.

More importantly, the FCE provider's duty of care to the evaluee requires the provider to adhere to standards of practice. APTA Guidelines for FCEs set that standard of care for PTs to include a systems review and an appropriate musculoskeletal exam to identify precautions and contraindications prior to FCE testing.

The Indergard court characterized the recording of physiological observations and measurements (heart rate, respiratory rate, and aerobic fitness) as being inappropriate <u>for a nonmedical physical agility or fitness test</u>. However, the court did not analyze whether these tests were appropriate as part of a *medical* exam. Although the court was of the opinion that these tests were unnecessary to determine whether Indergard could perform the job tasks, the court actually recognized that these physiological measurements might be medically prudent. Whether these physiological tests were necessary to the FCE provider's opinion, we don't know. But we can infer from the court's opinion that that FCE provider did not make the significance of the tests/observations clear in her report. What's important to note, however, is that the court *did not* say these physiological tests were impermissible. The court instead criticized the release of the information to the employer when it was "unnecessary for the purpose of determining whether Indergard was physically capable of performing her job duties." This distinction leads us to the next issue.

3. **Should the FCE provider limit the information provided to employers in the FCE report?** Maybe. The Indergard court essentially said that the employer does not need to know the results of medically prudent tests that were unnecessary to the work ability determination. FCE providers should not, however, interpret this to mean that they shouldn't document everything they evaluate. They may just need to limit the information that is sent to the employer to consist only of job-related tests. A separate thorough record is necessary to support the FCE provider's opinion and defend the provider against a malpractice claim if the evaluee sustains an injury during the exam. Moreover, many workers' compensation cases turn on whether the work disability is from a work-related injury or pre-existing condition, requiring the medical professional to do a thorough medical exam.

As previously stated, the Indergard court may not have understood the significance of the physiological tests and observations if the FCE provider did not provide the rationale for the test or explain the basis of their professional opinion. Before you consider stripping too much information from your FCE report, consider making modifications to your FCE report to indicate the basis of your opinion and the medical necessity of your tests and measures. If you choose to sterilize the report you send to the employer, keep in mind that the payer may require the full report for payment. Talk to your referral and payment sources first about what information they need for payment v. to resolve any work issues. This way they will also know that there is more to your skimpy report than meets the eye in case the employer wonders why a one-page report costs so much!

Much more could be written on these issues but it would require a legal brief. The take home message from this analysis is that FCEs are not prohibited per se by the ADA or EEOC. Providers need not run for cover if they are doing a good exam and basing their opinions on reliable job-related tests and measures. The Indergard case is a good example of how case law interpretations have potential to impact the provision of our services, but the erroneous interpretations of this case have unnecessarily harmed the perceived value of the FCE. Hopefully this article brings some clarity and solutions to the issues and gives FCE providers confidence in the legal standing of their tests.

REFERENCES

1. Sullivan v. River Valley Sch. Dist., 197 F.3d 804, 811 (6th Cir. 1999)
2. Tice v. Centre Area Transp. Auth., 247 F.3d 506, 515 (3d Cir. 2001)

Gwen Simons practices law at Simons & Associates Law in Scarborough, Maine. She also performs medicolegal FCEs at Orthopaedic Physical Therapy Associates and has written extensively on the legal issues in FCEs. She can be reached at gwen@simonsassociateslaw.com.

FOOT & ANKLE

SPECIAL INTEREST GROUP

President's Report

This is my last official report as the FASIG President as my term will end in February at the next CSM in San Diego. The President of the FASIG can serve a maximum of 2 terms and I am completing this. Therefore, the business meeting will include elections for the replacement of the President and several other positions. Nominations for these positions are open and we need members of our SIG, to attend. Let your voice and your vote count for the advancement of our organization. Health care will be changing and how we fare in the future as PTs with specialized expertise in foot and ankle care will be the next President's main challenge. Being active to help our position as expert foot and ankle providers in an evolving health care arena requires dedicated and assertive action.

This year's CSM in San Diego will include another FASIG educational program of several experts who will speak about the "Examination and Intervention Strategies for Overuse Injuries of the Foot & Ankle." Each year at CSM, the FASIG provides attendees with an evidence-based program concerning the foot and ankle. I expect this one to be extremely valuable. The FASIG business meeting will precede this educational program, so look for the time and place in your CSM planner.

The Orthopedic Section Board and Committee Chairs met in October for the strategic planning meeting held in La Crosse, WI. SIG presidents also attended and we discussed and formulated several key areas of our professions' future including advocacy, reimbursement, education, and research, to name a few. You will be hearing more about this in the near future.

I want to thank all of the committee members who have been completing our clinical and educational survey. This is one of the initial steps in establishing a foot and ankle fellowship. I envision launching the fellowship in 1 to 2 facilities nationally within the next 2 years. Accomplishment of this goal will take considerable time and effort. The fellowship will most likely be geared towards the orthopaedic specialist who wishes to further advance their expertise in the area of foot and ankle. The foot and distal lower extremity chain is most certainly one of the most interesting and intriguing entities that we treat in the human body. I love to learn from the myriad of patients which present with varying pathomechanics, foot types, and functional demands. Each is a clinical challenge as I attempt to correct and progress them in their daily activities. I hope that each of your clinical experiences as a Physical Therapist is enhanced by being a member of the FASIG.

I have enjoyed serving you as the FASIG President these past years and I look forward to meeting you at CSM in 2010.

Respectfully submitted by,
Stephen Paulseth, PT, MS, DPT, SCS, ATC

Hallux Limitus/Rigidus: What Can We Do For These Patients?

Stephen Paulseth, PT, MS, DPT, SCS, ATC

The development of osteoarthrosis in the First Metatarsal-Phalangeal joint (MPJ or MTP) is called Hallux Limitus. This condition presents with painful progressive motion restrictions in the first MPJ complex until possible ankylosing of the joint occurs, hence defined as Hallux Rigidus.[1] The genesis and pathomechanics of this common foot disorder is extremely intricate and multifactorial. For approximately 120 years since it was described, this condition has been treated by clinicians with a common goal of how how to stop or reverse the progression, resultant degeneration, and disability from this condition. Conservative treatment has limited efficacy when there is advanced joint degeneration and dysfunction. In this case surgical intervention must be considered. Frequently, arthrodesis may be imminent and is usually successful.[1] It is unfortunate that earlier detection and subsequent prophylaxis of its advancement cannot be implemented.

The incidence of Hallux (MPJ) dysfunction, aka Hallux Limitus/Rigidus is more prevalent in the elderly. The incidence is 35% to 60% in individuals beyond 65 years of age. In fact 2% of the population between 30 and 60 years of age will devlop this problem.[1] Some cite equal incidence rates between genders; however, it appears females usually are afflicted most.[1] The etiology of this condition can include any of the following:

- Trauma
- OCD
- Systemic arthropathies
- Hypermobile 1st ray
- Abnormal sesamoid position and function
- Long prox 1st phalanx
- Tarsal coalition
- Distal pseudoepiphysis
- Hallux valgus deformity
- Forefoot/rearfoot varus deformity
- Metatarsus adductus or primus elevatus
- Soft tissue contracture
- Accessory navicular
- Short/long 1st MT
- Pes planus
- 1st MPJ morphology
- Family history
- Shoe-wear
- Post-operative foot surgery
- Improper training practices/surfaces.

The first ray and medial column of the foot undergoes enormous stress during walking and running. It has been reported that it requires 60-75° of 1st MPJ extension during gait as a result of heel lift, STJ supination, a 1st MT length shorter than the 2nd MT, and normal sesamoid function.[5] Whereas, recent studies have shown kinematically that we only use less than 45° during gait.[1] During running we utilize even less 1st MPJ ROM due to increased flexor hallicus longus (FHL) and brevis (FHB) activity which can increase compressive forces to the 1st MPJ articular surfaces by 10 fold.[6] Hallux Limitus typically is a result of either structural or functional deformity of the 1st ray. Structural deformity implies a rigid and dorsiflexed 1st ray or short 1st metatarsal. A functional deformity involves elevation of the 1st metatarsal during weight bearing due to excessive pronation.[1] However, the cited factor of excess pronation has not been identified as a factor in a control case series review of 183 articles.[3] The foot anatomical factors reported by these investigators from radiographical studies included a dorsiflexed first metatarsal relative to the second metatarsal, plantar flexed forefoot on the rearfoot, reduced first metatarsophalangeal joint range of motion, longer proximal phalanx, distal phalanx, medial sesamoid, and lateral sesamoid, wider first metatarsal and proximal phalanx, and foot posture/arch height were not found to be significantly different in normal controls vs individuals with Hallux Limitus.[3]

The pathomechanics of Hallux Limitus is related to 3 primary factors. The first factor involves the actual MPJ. The second factor is related to the position of the 1st metatarsal (MT), which is controversial in the literature and philosophically contested between the Orthopaedic and Podiatric professions. The third is related to the function of the sesamoid apparatus.

MPJ arthrokinematic changes have been reported to be caused by foot posture (pes planovalgus, uncompensated varus) which may lead to a spastic contracture of the hallux (hallux equinus). This potentially shifts the axis of movement within the first MPJ, from centrally within the metatarsal head plantarly at the level of the sesamoidophalangeal ligament. Ensuing dorsal articular impingement of the proximal phalangeal base on the metatarsal head leads to either a chronic erosion of the dorsal metatarsal head (chondritis dissecans), or fracture through the subchondral bone plate (osteochondritis dissecans). Progressive arthrosis within the first metatarsophalangeal joint appears as joint space narrowing, dorsal osteophyte proliferation, subchondral cyst formation and sclerosis, and articular flattening. Synovial effusion produces periarticular pain, resulting in chronic splinting of the hallux and eventual auto-fusion of the metatarsophalangeal joint represents the end-stage progression of hallux rigidus.[1]

The apparent instability or hypermobility of the 1st MT, especially dorsally in a more planus foot types further perpetuates the degenerative process. Metatarsus Primus Elevatus is described extensively in the Podiatric literature. Primary metatarsus primus elevatus is encountered in patients with a more proximal level of uncompensated varus, with hallux equinus occurring secondarily in an attempt to provide medial column support during weight bearing. Secondary metatarsus primus elevatus results from the retrograde effects of hallux equinus on the first metatarsal, and occurs in patients with a pes planovalgus foot posture. Flexor stabilization syndrome of the hallux occurs in patients with this foot type, and is analogous to flexor stabilization hammertoe of the toes. Differentiation between primary and secondary metatarsus primus elevatus is made by evaluation of WB and NWB radiographs.[1]

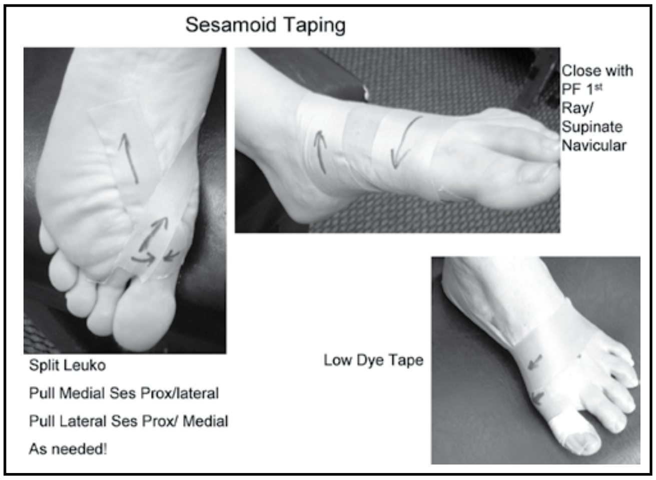
Sesamoid degenerative changes can occur simultaneously through the pathomechanical development of Hallux Limitus. Over time it has been reported that there can be sesamoid immobility from chronic flexor muscle protective activity which leads to traction proliferation of the sesamoid bones (hypertrophy). Subsequently, disuse osteopenia of the sesamoids is an indication of sesamoid-metatarsal degeneration, and parallels degenerative changes of the first metatarsophalangeal joint. Proximal sesamoid retraction reflects the degree of hallux equines[1] and clinically presents as reduced 1st MT plantar flexion mobility, proximal sesamoid retraction, rotation of the long axis of the 1st MT, Metatarsus primus elevatus, FHB guarding, and retrograde 1st MPJ compression.[2] Normally with increased dorsiflexion of the 1st MPJ during the terminal action of gait, there is a greater moment arm of FHB and subsequently the sesamoids reduce or align under the 1st MT.[2]

The goal of physical therapy when presented with a patient who has a lower quarter problem should be to assess all contributing factors for that condition. For example an athlete that experiences hip or patellar tendon pain may have limited dorsiflexion of the 1st MPJ which may have contributed to the development of the problem via reduced heel rise and ankle plantar flexion in gait or jumping. We need to fully evaluate this and other contributing factors in our patient with lower extremity functional deficits. Subtle clinical findings, such as shoe-wear patterns, hyperkeratoses locations, and gait disturbances, precede significant radiographic changes or painful degenerative arthritis by months to years. Patients with Hallux Limitus frequently display local tenderness and swelling and may chronically become deformed.[5] Evaluation should include:

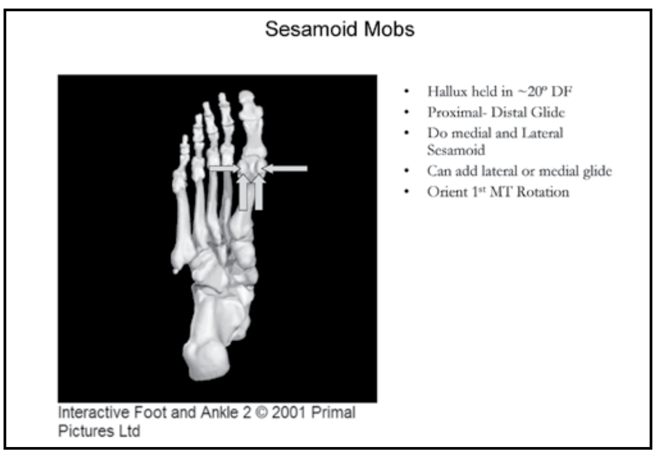
- Passive Plantar/Dorsiflexion 1st MPJ in WB and NWB
- Functional Limitus = discrepancy between WB(dynamic) and NWB ROM
- Gait analysis with special attention to 1st MPJ and medial foot motion
- Standing heel raise test
- Callus concentration
- 1st Ray mobility
- 1st MPJ joint play
- FHL strength through ROM
    - Sesamoid mobility/position
    - Proximal compensations

Once diagnosed and evaluated, what can we do as clinicians to help this patient? The first intervention that typically comes to mind is to provide foot orthoses to the patient, but what is the evidence for this approach? The evidence is weak at best, although numerous patients have done well in certain cases. Long term maintenance requires a multidimensional approach which consists of stretching, manual therapy/self ROM techniques, functional exercises, shoe, footwear and activity modifications, taping, and foot orthoses. In particular, it is vital that we identify proximal compensations and address related dysfunctions such as hip or sacroiliac issues. Modification of activities and training practices should also be considered.

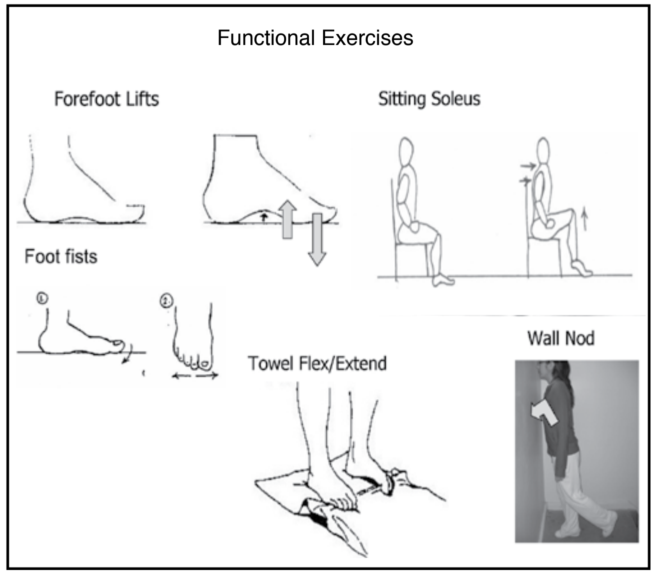
Several techniques and areas of treatment can be applied during the conservative treatment of Hallux Limitus. Taping in the short term or for athletic activities has been useful. Specifically, sesamoid taping, akin to patellar taping, can attempt to reposition the sesamoids and MT. This in combination with low or high dye taping is certainly an excellent test for evaluating the effect of a more permanent orthotic device. It has been recommended by some to include a 1st ray cut out, Morton extension, 2nd-5th forefoot posting within the foot orthosis to alleviate pain in 1st MPJ.[7] The use of a wedge under the hallux has been beneficial. Of course shoe modifications may also be helpful. This includes using a shoe with a wide toe box, a stiffer forefoot/ reinforcing material, or a rocker bottom shoe. Often individuals purchase a shoe that is 1 to 2 sizes larger to take the pressure of the 1st toe. This can create other problems in the foot since the shoe last will not match the actual foot size.



Manual therapy techniques are essential to restore arthrokinematic motion in the 1st MP.[5,10] Joint distraction with anterior-posterior glides or vice versa can be progressed depending upon the joint restriction and chronicity. In combination with stretching and sesamoid mobilization techniques, ROM can be increased significantly. To mobilize the sesamoid apparatus the hallux is held in approximately 20º of dorsiflexion and then a proximal-distal glide is applied to the medial and lateral sesamoids. The clinician can also add lateral or medial glides as needed with special attention to orienting the 1st MT and reducing excessive longitudinal rotation.



The key to success in managing Hallux Limitus is prescribing functional exercises that compliment the manual and taping procedures. A few exercises that I like to teach the patient are shown. The primary goal is to activate and strengthen the FHL along with the soleus and tibialis posterior muscles in a weight bearing condition. Employing any or all of these techniques will provide comfort or improved function in the patient with Hallux Limitus.



A. Inward/Supinatory/Hip IR. Right foot (move left)

B. Lift uninvolved leg Rotate body around the stance hip with knee straight. Resist at mid-line pelvis with pulley or sports cord Press stance foot into floor as you pivot.

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PERFORMING ARTS

SPECIAL INTEREST GROUP

President's Letter

Keep your eyes on the 2010 Winter Olympics, which will be held in Vancouver, Canada. They start February 12, and will be going on during CSM 2010 in San Diego. This should make for some great performing arts viewing and conversation. Hopefully, you have already made plans to attend CSM; if not, perhaps the PASIG Programming and other performing arts presentations listed in this newsletter will entice you.

The PASIG programming is scheduled for **Saturday February 20, 8 – 11 am** and entitled "Physical Therapy Management in Gymnastics-Spine, Shoulder, Wrist, and Hand Injuries coupled with Stress and Eating Disorders - A Performing Arts PT Challenge." We have terrific presentations and presenters, so we look forward to seeing you there.

Besides the excellent programming, one of the most important things you can do at CSM is to attend the PASIG Business Meeting. The meeting is open to all, members and nonmembers. Remember that membership in the PASIG is FREE to Orthopaedic Section members**. The PASIG Business Meeting will be held on Saturday, February 20 at 7am**. Breakfast and coffee will be provided!

As of the deadline for this publication, we have not yet selected the PASIG student scholarship winner. The award will be given at CSM to a student who performs research that contributes to the Performing Arts body of literature. The award is $400 to help defray the cost of presenting your research at CSM.

Coming soon on the PASIG Web site http://www.orthopt.org/sig_pa.php will be a new expanded member directory. *Do you need to search for a PT to cover your troupe when they are touring? Has your performing arts patient been injured at a summer camp? Are they moving permanently?* We hope that the expanded member directory will help you with these efforts. Expect an email in December to update your performing arts profile. **The more you tell us, the more others will find YOU!**

Also coming soon to the Web site, the PASIG will provide performing arts specific information that can be downloaded free to members. *Do you need to know how to evaluate a violinist's posture? What is a lutz versus an axel jump in figure skating? How do you know if a dancer's pointe shoes fit properly or if they are ready to start pointe?* There are many art specific terminology, evaluation and treatment tools, creative progression protocols, footwear techniques, etc. that you can share. **Our members have this expertise; please help share this information with your colleagues.**

Included in this newsletter is something that we call a 'Web site Vision of the PASIG.' This grid is what we are trying to fill in and make accessible on the Web site. You can contact me at Lar@LarPT.com with questions, feedback, and to volunteer.

Finally at CSM, we will be discussing strategic planning. As the Orthopaedic Section just underwent a new Strategic Plan, the PASIG will follow suit by aligning our goals to support the Orthopaedic Section.

There is a lot going on with the PASIG; we hope that you will contribute to these projects! We hope to see you at CSM in sunny San Diego; it is always nice to put faces with names.

Until then, *yours in the arts,*
Leigh A. Roberts, PT, DPT, OCS

Web site Vision of the PASIG

	Circus/Acrobats	Dance	Figure Skating	Gymnastics	Musicians	Others: Vocal, Cheerleading/ Dance Team, Musical Theater
Artist Specific Terminology (ie, jumps, spins, instruments, turns)						
Genre Specific Terminology and definitions (ie, levels of skating and requirements)						
Common Injuries						
Artist Specific Evaluations						
PA Specific Interventions						
Patterns of regional interdependence assoc. with specific injuries/pathologies						
Return to Arts Progressions						
Artist Specific Outcome Measures						
Artist Specific Screenings						
Collaboration and outreach with other PA organizations and resources (USFSA, IADMS, content expert. liaisons)						
Artist environment: structure of arts organizations/contracts/unions/management relationships						
Educational Opportunities for Student Members (Affiliations)						
Residency/Fellowship Training						
Professional Expertise Development Opportunities						
Clinical Guidelines Resource Papers and Fact Sheet (stretching, posture, rehab guidelines, facts about anorexia in PA, etc)						
FAQ for Patients						
Anti-doping regulations						
Bracing and splinting regulations for competitions						
Functional measurement tools for Performing Artists						

Physical Therapy Management in Gymnastics

Spine, Shoulder, Wrist, Hand Injuries coupled with Stress and Eating Disorders

A Performing Arts PT Challenge

Introduction to Pathology Related to the Sport of Gymnastics: Epidemiology and Evaluative screening.
Mark D. Sleeper, PT, MS, OCS

Rhythmic Gymnastics and Spine Injury
Elizabeth Ann Darling, PT, MPT, OCS, ATC

Injuries of the Shoulder, Wrist and Hand-Clinical Pearls
Julie Ann Guthrie, PT, DPT, OCS

Gymnastics Rehabilitation and Progressions
Airelle Hunter Giordano PT, DPT, OCS, SCS

PAIN MANAGEMENT

SPECIAL INTEREST GROUP

President's Message

John E. Garzione, PT, DPT, DAAPM

The PMSIG program for CSM 2010 is: "Factors that Influence Musculoskeletal Pain: Fatigue, Sex, Personality, Psychology, and Genetics." Steve George, PT, PhD; Kathleen Sluka PT, PhD; and Laura Frey Law PT, PhD are the presenters of this extremely interesting and timely topic. The scheduled time is Friday, February 19th from 8:00 AM – 11:00 AM. The business meeting tentatively planned one hour before the program. Please consult the schedule for last minute changes and room assignments.

Thank you to all who took the time to complete the online questionnaire. The results have been tabulated and I will report on the outcomes in the next newsletter.

How Do We Know?

A recent discussion I had with a Physical Therapist brought up the topic of treatment of the chronic pain patient. The question this young man posed was "How do you know if the person is really having a lot of pain or saying so for secondary gain?" This question has haunted practitioners throughout time. There are many questionnaires asking people about their pain levels and impact on function which can be used in any setting to try to measure perceived pain and its effect on function. I was intrigued by a recent article suggesting a 5-panel blood screen to be used to distinguish severe pain levels from mild to moderate pain initially, and track treatment success.[1] Performing a blood test is based on the premise that severe pain affects the pituitary-adrenal-gonad system as well as producing an inflammatory response. Theoretically, a peripheral pain site consists of a damaged nerve, damaged blood vessel, and poor lymph drainage. The site collects plasma exudates, WBC, cytokines, and excess electricity which produce heat and inflammation.

The basic blood panel is: (1) A.M. Cortisol, (2) A.M. Pregnenolone, (3) ESR (Erythrocyte Sedimentation Rate), (4) CRP (C- Reactive protein), and (5) Total Testosterone. Some systemic causes of pain, such as rheumatoid arthritis and hepatitis, will cause an elevated CRP and ESR, but pain unrelated to an underlying disease may also cause these two markers to be elevated. When pain is controlled, these markers will normalize[2] to where low levels rise and high levels decrease. Elevations of pulse, blood pressure, adrenal hormone, and inflammation markers provide biologic evidence of severe pain.

This panel, in addition to a physical exam, should help us more effectively determine which patients truly have severe pain. Cytokine testing has also been suggested as an additional test to confirm chronic pain in our patients. There are 6 basic categories including: interleukins, interferon, chemokines, tumor necrosis factors, colony stimulating factors, and growth factors. Cytokines are a type of signaling molecule that helps with intercommunication between the cells of the body. They are not produced by single organ like hormones and they do not have a narrow normal target range. Elevated levels of certain cytokines suggest that the body is reacting to injury, illness, or threat. Cytokines levels alone are not specific indicators to make a diagnosis, but provide evidence in favor of a diagnosis when used in conjunction with a history and physical examination.[3] While Cytokine testing and research supporting its use is still in its infancy, I believe further study on the usefulness of Cytokine testing will contribute in becoming another very useful piece of the pain puzzle.

Hope your Holidays were happy and healthy.

Looking forward to seeing you at CSM.

John

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ANIMAL PHYISCAL THERAPIST

SPECIAL INTEREST GROUP

Hello and Happy Holidays!

It's hard to believe that 2009 is drawing to a close and that CSM is just around the corner! It has been a busy year for all but especially in regards to legislative issues in animal rehabilitation. It seems that our business meeting at CSM is frequently "monopolized" by these discussions, which obviously, are very important. For this reason, the ARSIG leadership proposed a separate session at CSM 2010 to address these issues, questions, and concerns. It seems that many states have devised legislative language that seems to "fit" with the PT rules and regulations and in cooperation with the veterinarian rules and regulations. The question is, "Can we establish mutually agreeable language (for PT and DVM licensing boards as well as the APTA and AVMA) to regulate the practice of animal rehabilitation/physical therapy of animals by physical therapists?" Details regarding this special session are below. Food will be provided so, we ask that each of you RSVP for this event. We look forward to discussions with our SIG state liaisons, active members, and interested members in attendance and will also have representatives from the Orthopaedic Section, APTA, and FSBPT.

Thanks and hope to see you there!

Amie Lamoreaux Hesbach, MSPT, CCRP, CCRT
forpawsrehab@comcast.net
Carrie Adrian, MS, PT, CCRP
Carrie.Adamson@vcahospitals.com

Let's Lunch and Discuss Legislation in Animal Rehabilitation!
When: Thursday, February 18, 2010 at 12:30pm
Where: To be determined, APTA Combined Sections Meeting, San Diego, California

Our Goals:

- Summarize the "issues"
- Educational requirements beyond "entry level"
- Supervision vs. referral vs. veterinary medical clearance vs. direct access
- Liability issues
- Discuss and edit "legislative language:" a model/position of the ARSIG
- Brainstorm our next steps

Facilitators:
Justin Elliott, Director, State Government Affairs, APTA
Amie Lamoreaux Hesbach, MSPT, CCRP, CCRT, ARSIG President
Carrie Adrian, MS, PT, CCRP, ARSIG Vice President

Please RSVP ASAP to save your seat:
Tara K. Fredrickson: tfred@orthopt.org
Executive Associate
Orthopaedic Section, APTA, Inc.
800-444-3982 x203 608-788-3982 x203
SPACE IS LIMITED!!!

Our plan is to distribute proposed "legislative language" for review and comments approximately 2 months prior to CSM to encourage your collaboration and to facilitate your involvement even if you are unable to attend this event.

Can Ultrasound Help these Conditions?

Jennifer Brooks, PT, MEd, CERP

History: *Summer's Mist* is an 11 yr old Thoroughbred –cross mare who has experienced left forelimb lameness for 2 months. Veterinary examination had positive results for hoof testers on the sole, indicating sole tenderness. Lameness decreased with temporary basi-sesamoid nerve blocking. Digital radiographs of left forelimb reveal moderate to severe periarticular osteophyte formation at the articular margins of the pastern, greatest on the proximal aspect of the middle phalanx. At the distal phalanx, known as the pedal bone, there is mildly irregular solar margin noted. The sole of the hoof is thin, with a toe long.

Question: Can therapeutic ultrasound help correct *Summer's* problems of:

1. Moderate osteoarthosis of LF pastern known as "ring bone"
2. Mild pedal osteitis
3. Long toe, thin sole

(Therapeutic ultrasound (US) is alternating compression and rarefaction of sound waves with a frequency of greater than 20,000 cycles/second. This is a very high frequency beyond what our ears can detect. These sound waves are absorbed primarily by connective tissues: ligaments, tendons, fascia, and scar tissue. Ultrasound works in 2 modes. The thermal mode, in which a constant stream of waves are emitted, is used primarily for heating of tight structures prior to stretching protocols, muscle spasm reduction, and pain relief. A second mode of US is referred to as nonthermal or pulsed US. The pulsed mode is used in acute conditions when swelling may be present, of which inducing more heat would be contraindicated. To put very simply, both methods of US work due to the sound waves causing vibration of the tissues and cells that overall stimulate metabolism. Increasing cell metabolism accelerates the healing process, relieves pain and, in a method called phonophoresis, can push medications transdermally into targeted tissues below the skin.)

Both of these diagnoses occur secondary to increased stresses placed on bone. The irony of this scenario is that ring bone is a result of more bone, osteophyte formation, (radiograph on left) being laid down secondary to stress at the interphalangeal joint, known as the pastern joint. Pedal osteitis is the loss of bone, demineralization, (radiograph below) at the outer margins of the most distal phalanx that is housed within the hoof walls.

To answer if therapeutic ultrasound (US) can correct or cure your horse's condition, the answer unfortunately is "no." The bony changes of ring bone have formed due to the increased stresses at the pastern joint. Bone grows, or makes more of itself, in accordance to the stresses that have been placed on it. Ultrasound will not ablate the bony exotosis commonly known as osteophytes.

What US can address is reduction in your horse's symptoms of lameness, by bringing pain relief to the pastern joint. Applying heat (superficial, such as a moist heat packs or deep heat, such as US) to arthritic conditions can often provide pain reduction. The soft tissue structures that surround the pastern joint (known as the joint capsule, tendons, ligments, fascia are all highly innervated) will absorb the US and therefore recieve pain relief following treatment.

When ultrasound is used in conjunction with a topical anti-inflammatory and or corticosteroid medication, the benefit can become 2-fold. In this therapeutic treatment termed phonophoresis, transdermal penetration of the drug combined with the effects of US can provide a longer duration of pain relief to the joint structures, by pushing the medication in to the painful target tissues. Furthermore, if your horse has experienced some tightening of surrounding structures of the joint capsule, ligaments and tendons, which often occurs secondary to pain and arthritic changes, the US will help warm these tissues, which will allow for greater extensibility of these structures that may be painful because of restricted tissue mobility. Often the compliment of manual physical therapy methods such as joint mobilization and gentle passive stretching of tissues restricting the pastern joints can be an excellent progression of treatment after US application, of which a skilled licensed equine physical therapist is capable of administering for the best outcome.

Another modality that is becoming much more used and accepted in the animal therapy world, more so than in the human world, is the use of Low Level Light Therapy (LLLT), more commonly known as Laser. Laser treatments have gained notoriety of producing excellent results in the area of pain reduction, and healing promotion. Laser may be very helpful for relieving pain of ring bone in this scenario. It is not yet determined if LLLT can penetrate through the dense hoof material to address this horse's pain from pedal osteitis, but Laser treatment at the coronary band (adjacent area of soft tissue above the hoof) could prove beneficial.

Pain reduction and tissue extensibility should be noted after 4 to 5 treatment sessions of phonophoresis, LLLT, joint mobilization, and gentle passive stretching as tolerated. This treatment would be recommended daily for 12 to 15 treatments.

Having an unbalanced hoof in terms of long toe (too much hoof growing in the front of the hoof) and most likely underrun heels, can contribute to the development of both of these ailments. By having a long toe in front of the hoof, there is an increase in the lever arm length in front of the axis of rotation of which the horse's body moves over, as it is propelled forward with each step. Moving break over posteriorly will decrease the moment (lever arm) applied to the distal interphalangeal joint and decreases the maximum tension in the deep digital flexor tendon (attached to posterior pedal bone) which occurs towards the end of the stance phase at the beginning of breakover.

Having a thin sole under your horse's hoof could very well compound these problems. The sole needs to support the arch of the foot. Without sole there is poor support of the arch allowing the pastern to descend, along with the entire bony column (phalanges) within the hoof capsule. This stresses the laminae (internal hoof material) and puts pressure on the pedal bone which develops into pedal osteitis. To address the problem of thin sole, sole toughening remedies may be helpful to promote more sole growth along with packing material for arch support and proper trimming attention given to develop more heel. This approach will provide proper support to the pedal bone and minimize ground reaction concussive forces that propagate these problems of bone remodeling and demineralization. Consulting with a knowledgeable farrier or trimmer for the most appropriate options for your horse's condition is essential for your horse to have the best foundation for proper weight bearing and correct movement.

When I consider your horse's scenario, I question as to why this only is occurring in one of the front feet and not both? Could it be due to conformation (bony alignment) faults, abnormal hoof growth, or poor trimming and shoeing methods? Could the rider have a habit tending to lean more to the involved side? Are the surfaces of which this horse is worked on too hard? All of these are worthy of consideration to terminate the progression of the ring bone and the pedal osteitis.

The world of physical therapy is now combining with equine veterinary medicine here in the United States. Many treatment approaches have not been fully explored in the equine realm, but deem to have much merit. Physical therapists tend to think in terms of "why did this musculoskeletal event happen?" and "how can it be prevented?" We have much to share with our veterinarian counterparts and animal owners in terms of prevention and treatment.

Jennifer Brooks is the **Owner of Equine Rehabilitation Services, LLC in** Brookline, NH www.EquineRehabServices.com. Please email comments to: *jenequinept@charter.net*

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PLEASE NOTE

The article, *Case Study: Border Collie with Sciatica*, that ran in the Animal Physical Therapist Special Interest Group newsletter 2009;21(4):171-172 was written by Tammy Wolfe, PT, CCRP. We apologize that her name was omitted as the submitting author of this work.

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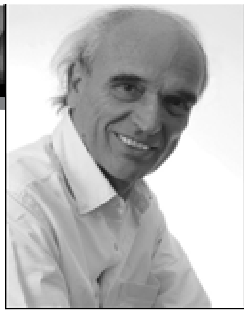


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