Improvements in Balance and Gait with Therapeutic Riding: A Case Report

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Improvements in balance and gait with therapeutic riding and rhythmic auditory stimulation: a case report.

ABSTRACT

Purpose: To investigate the effect of therapeutic riding on gait in a client with gait impairments of orthopedic nature.

Case Description: 59 year old Caucasian female with grade I spondylolisthesis at L4/L5 and multi-level lumbar spinal stenosis in central and foraminal canals. The client had an anterior cervical fusion of C3-C7.

Examination and Evaluation: The client has been ambulating with a straight cane due to her history of frequent falls. Gait, agility, strength, range of motion and balance testing were performed. The client had impairments of bilateral lower extremities with an ataxic gait and a Dynamic Gait Index score of 16.

Diagnosis and Prognosis: Diagnosis 4F: Impaired joint mobility, motor function, muscle performance, range of motion and reflex integrity associated with spinal disorders. 5A: Primary prevention/risk reduction for loss of balance and falling. Prognosis is good due to the client's level of motivation and interest in the proposed intervention.

Intervention: Therapeutic riding sessions 3x/week for 20 minutes for 3 weeks. Each riding session was immediately followed by a 10 minute independent walking program with a metronome for rhythmic auditory stimulation.

Outcomes: Improvements in gait speed, agility, lower extremity strength and range of motion were noted. Dynamic Gait Index score improved to 20, placing the client out of the risk for falls category.

Clinical Relevance to Physical Therapy: Therapeutic riding followed by rhythmic auditory stimulation may improve gait, agility and lower extremity strength and range of motion in patients with gait impairments.

Key Words: therapeutic riding, hippotherapy, rhythmic auditory stimulation, metronome, spinal stenosis, gait training, balance.

INTRODUCTION

Humans and horses have been intertwined throughout history on a multitude of levels. The horse has been established as the most important animal ever domesticated by man.[1] Horses have allowed early explorations of America and cultivated changes in Native American lifestyle with improved hunting, increased travel and trades among nations. Horses have also been instrumental in the development of agriculture, herding of cattle, ranch work and served as predecessors to the automobile. Horses carried man to war and into the Renaissance ages for improvements in riding and development of highly schooled movements at specialized training schools.[2] Over time the horse has been replaced by technology for its duties in travel, war and agriculture.[3] Since then, the continued relationship between man and horse has led to the creations of athletic sports such as dressage, racing, fox hunting, team roping and jumping.

Horses are now beginning to serve humankind again on a new level in the realms of physical therapy with the advent of therapeutic programs incorporating the horse into multiple health related treatment strategies. Horses have a natural need for continual movement[4] and a majority of physical therapy treatment strategies are designed to improve movement. Therefore, incorporating the horse into physical therapy can have amazing possibilities. A recent special exhibit on the horse was organized by the American Museum of Natural History in New York, NY. In the exhibit, therapeutic riding was highlighted as one of three video documentaries entitled “An Enduring Bond” which captured the popularity and impact of partnering horses with humans to improve a person’s physical, mental and emotional well-being.[1]

The history of organized therapeutic riding has been relatively recent as compared to our extensive history with horses. A female rider from Denmark by the name of Liz Hartel continued on with her riding regardless of decreased mobility from polio. In 1952, Ms. Hartel won the silver medal for Grand Prix dressage at the Helsinki Olympics. This grand accomplishment has been historically credited for the motivation to form therapeutic riding centers throughout Europe. The centers were further promoted as medical and equine professionals began to understand the positive effects riding can have on a person's physical abilities.[5] The interest in this subject has expanded over many other countries, especially here in the United States.

There are two main governing bodies in the United States which have developed the current standards of practice: the North American Handicapped Riding Association (NAHRA) and the American Hippotherapy Association Inc. (AHA, Inc.).[6] Both of these organizations are recognized by the American Physical Therapy Association as liaisons to improve the physical condition of patients with a variety of physical impairments.[7] These organizations are also recognized by the American Occupational Therapy Association (AOTA) and the American Speech-Language-Hearing Association (ASHA) due to the improvements seen in these areas when the horse is incorporated in the treatment strategies.[6]

Hippotherapy, horse-back riding therapy and/or therapeutic riding are the terms used to describe physical therapy interventions which incorporate the horse's ability to assist people to improve their physical impairments. There is a slight difference between Hippotherapy and Horseback Riding Therapy (HBRT) or therapeutic riding. The North American Handicapped Riding Association makes the distinction between these two

terms in order to discriminate between the medical or rehabilitative use of the horse from other equine activities.[5] Hippotherapy is internationally known as "treatment with the help of the horse" and named from the Greek word "hippo" which means horse.[6] Hippotherapy is conducted by licensed health care professionals, such as physical and occupational therapists. According to the American Hippotherapy Association, Inc. hippotherapy is considered a treatment strategy and not a modality. Modalities are applied to the body to produce a change in biological tissue and are systems such as ultrasound and electrical stimulation. Hippotherapy is a treatment strategy since it capitalizes on the movement of the horse to enhance the therapeutic exercises in a similar manner as medicine balls, bolsters and wedges.[6]

Hippotherapy services are billed according to the Current Procedural Terminology (CPT) codes as published by the American Medical Association. Patient/client diagnoses are documented according to the International Classification of Diseases, 9th Revision (ICD-9 codes). Therefore, hippotherapy does not require a separate code, yet may be included within existing CPT codes.[6] A therapist does not code for the aides (such as balls or bolsters) used in a treatment session, rather they record charges according to the purpose of the treatment. The following CPT codes are currently being used when hippotherapy is included in the overall physical or occupational plan of care. Examples are listed to help describe them in more detail.

(Code) Title: example.

(97110) Therapeutic exercise: postural and strengthening exercises performed on the horse.

(97112) Neuromuscular education: the therapist manipulates the horse's movement to facilitate balance, righting, equilibrium and protective extension reactions of the patient/client while on the horse.

(97530) Therapeutic activities: the patient sits on a dynamic surface (i.e. the horse) while throwing, catching, writing or performing other fine motor tasks.

(97533) Sensory integration: the patient/client practices grading pressures with their legs and hands to make the horse walk and halt (stop) in coordination with their voice (saying "walk on" or "whoa"), types of pitch (higher to go and lower to slow down) and visual focus on a distant object.

Hippotherapy should be documented in the same manner as any other physical or occupational therapy session. Therapists refer to the use of the movement of the horse in medically relevant terms, explaining the clinical benefit derived from the treatment session. All treatment notes are documented in SOAP (Subjective, Objective, Assessment, and Plan) format for physical therapists and in respective formats for speech and occupational therapists. "HPOT" is the commonly accepted acronym for hippotherapy. The movement of the horse is tailored to each individual's impairments and functional limitations, with the goal of achieving measurable functional outcomes. Advanced training in this area is available and highly recommended. Therapists must pass a certification exam after a minimum of 100 hours of hands on experience in order to become a Hippotherapy Clinical Specialist (HPCS).[6]

Horseback riding therapy (HBRT) and therapeutic riding is provided by horseback riding instructors, who may not be licensed health care professionals. However, these teachers can be certified through NAHRA to earn accreditation in quality and safe

instruction for people with special needs. Due to the inherent nature of horses and the knowledge needed to work with them, most successful programs have both a riding instructor and a therapist. If the therapist is not familiar with horses, then the therapist definitely needs the assistance of the riding instructor for a wealth of good horsemanship skills. This includes but is not limited to: gaits of the horse, proper horse selection, types of tack and proper fit of equipment, signs of unsoundness or unhappiness in the horse, and overall safety during the riding sessions. The physical therapist can then assist the instructor with the specific needs of each client according to their diagnosis or initial evaluation including: strategies to mount/dismount the horse, progressive challenges to trunk control, balance, and appropriate upper and lower extremity activities while riding. The therapist is also responsible for facilitation of desired functional movements and postures once the rider has dismounted.[8]

Contraindications to Hippotherapy and Therapeutic Riding

As with all types of therapeutic interventions, there are some contraindications for hippotherapy and therapeutic riding. An article written by Heine in 1997 outlines the major contraindications as patients with: acute fractures, impaired skin integrity or wounds on weight bearing surfaces, hip subluxation, complete quadriplegia, combativeness, epilepsy with uncontrolled seizures, severe progressive neuromuscular disorders with inability to sit erect, and osteogenesis imperfecta.[9] Pediatric patients with Down's syndrome should be screened for atlanto-axial instability with medical imaging prior to any type of therapy as this is another contraindication to riding.[10]

A thorough physical evaluation is crucial prior to beginning a hippotherapy or therapeutic riding program. The therapist will first screen for all of the above

contraindications. Then the therapist will determine the client's range of motion, muscle strength and functional goals. This information in conjunction with the client's body size and shape will assist the therapist to determine the proper horse, type of tack and specific therapy to be provided during riding as well as following the completion of the riding sessions.

Selection of the Equine Therapist/Therapeutic Riding Horse

In a previous thesis on hippotherapy by Graham and Manzi from The Sage Colleges in 1998, several important qualifications were outlined for horses employed in therapeutic activities. They cited the qualifications were from a book written by Jan Spink in 1993. This text, "Developmental Riding Therapy", is currently out of print. Due to the importance of safety for all in horse activities, the qualities of a good therapy horse will be repeated here. All horses used in hippotherapy and therapeutic riding should have all of the following qualifications. The most important requirement is that the horse overcomes his or her natural flight or fight instinct. This is to ensure that the horse does not make any sudden moves which could unsettle patients/clients with limited physical skills and reaction times. The second qualification of the therapy horse is to show interest in patients/clients approaching them on the ground by lowering their head and allowing their head and necks to be touched and stroked. The therapy horse must remain focused during the entire therapy session without nodding off to sleep and use careful foot placement to avoid tripping. The therapy horse must selectively attend to signals from the therapist, instructor or person leading the horse while ignoring any extraneous input from the rider on board.[11,12] For instance, a good therapy horse will walk on when the client uses his or her voice to tell the horse to walk, yet will not rush off if the client

inadvertently kicks the horses sides while standing up in the stirrups to practice their balance.

The American Hippotherapy Association, Inc. website is in agreement with the above qualifications. AHA, Inc. also adds that therapy horses must be pre-tested in a variety of conditions with experienced trainers prior to their initial therapy work. This is to ensure the horses will provide a positive learning experience for the riders.[6]

Rationale for Case Report

Why is the horse an ideal method to assist with physical therapy? The horse is strong enough to allow a person to sit on him/her in order to ride and feel the movement the horse creates. The horse is also in continual motion in three dimensions which cannot be replicated on a therapy ball or bolster in a standard physical therapy environment.[9] The horses' movements directly affect the rider's pelvis and trunk[13] since the human pelvis is propelled by the motion of the horse's hind legs. As each hind leg of the horse comes forward, the rider's trunk is rotated and flexed laterally while the pelvis rotates and moves anterior/posterior.[11,12] The special importance of the three-dimensional movement of the horse is that it is reciprocal in nature, meaning the right and left sides of the body move equal and opposite of each other. This activity closely resembles the reciprocal pelvic movement humans have during ambulation.[14]

This is why it is important to understand the basic gaits of the horse (walk, trot and canter) and how they differ between each horse in tempo, stride length and cadence. Patients/clients are individuals with varying shapes and sizes which often require different size and shaped horses so that the person's body weight can be carried appropriately. Also the amount of movement due to the freedom and mobility of each

horse's back can vary greatly, even between two horses with the same physical stature. The horse can be exponentially more effective than a big therapy ball, since the horse is constantly moving in several directions at the same time in a 4, 3 or 2 beat rhythm. Most important to the therapist, the rhythm is repeated constantly yet the tempo can be varied by asking the horse to move faster or slower. This creates more or less movement in order to tailor the amplitudes to the rider's needs or current ability.

A horse's walk is a four-beat gait and is also the slowest gait.[15] The horse's walk is used most frequently in hippotherapy and therapeutic riding. Although the walk is slow in pace, there is anterior/posterior movement, lateral movement and rotation all happening simultaneously due to the horses' quadruped orientation. Therapy balls and swings cannot re-create all of this motion at once. Nor can they maintain consistent rhythms or reciprocal movements. The horse's back allows the rider to practice moving the upper extremity while stabilizing the entire body with the trunk and lower extremity.

More advanced movements can be added such as scissor kicks where the client actively swings their legs back and forth while balancing with the trunk and upper body while the horse is moving forward. These types of movements requiring increased coordination allow for fractionization of the cortical spinal tracts.[16] Fractionization is the heightened ability a person develops to move their body parts independently and coordinate different movements all at the same time. For example, in a basic riding posture, the ankles should be dorsiflexed (toes up/heels down), toes pointing straight forward, knees slightly flexed, contact of the inner thigh and knees along side of the horse, pelvis in neutral position, hips flexed, abducted and externally rotated, trunk engaged, abdominals working, chest lifted, shoulders aligned over hips, head in slight

craniocervical flexion, neck retracted keeping the ears over the shoulders, elbows flexed to about 90 degrees, and hands soft but closed on the reins.[17] Maintaining this position with the entire body amidst all the perturbations from the horse can be quite challenging.

Literature Review: Hippotherapy and Therapeutic Riding

The current research literature was reviewed in order to prepare this case report. There is a limited body of evidence available regarding hippotherapy and therapeutic riding. There may be many reasons why hippotherapy is a difficult topic to research. One reason is the lack of standardized objective outcome measurements to determine the improvements made during a course of therapy. A thesis from previous physical therapy students at Sage Graduate School in 2000 conducted a survey of the documentation and objective measurements used by therapists in various facilities.[8] None of the facilities surveyed had similar standardized procedures to determine outcomes. Instead, facilities relied heavily on progress notes, subjective reports from parents, and carryover to functional activities.

Other studies lack a robust research design and do not have an adequate number of subjects with comparative control groups. This leads to questionable reliability and validity of the studies, even if positive results are discovered. A hippotherapy research proposal from Sage Physical Therapy students was developed in 1998. The authors mentioned challenges to this type of research also include the impact of weather, transportation and illness of both subjects and horses which can hamper research efforts.[11] Many of the hippotherapy and therapeutic riding studies reviewed have once weekly intervention designs which could be due to the travel, availability, and staff coordination needed to complete these therapy programs.

Pediatric Studies

Most of the quality research published concerning hippotherapy and therapeutic riding is for the younger ages with permanent neurological disorders such as cerebral palsy (CP). Hippotherapy and therapeutic riding have shown promising improvements in walking, running and jumping as evidenced by outcome measurement tools such as the Gross Motor Functional Measurement (GMFM). In 2002, The Center for Sports Therapy Research conducted a study examining the effects of recreational horseback riding therapy (HBRT) with 17 children with varying types of cerebral palsy. Each child served as their own control and the mean Gross Motor Function Classification System (GMFCS) score for the group was 2.7 (ranges: 1 (least involved) through 5 (most involved). Horseback riding therapy sessions were one hour a week for 3 terms of 6 weeks, totaling 18 weeks of riding. Each child's GMFM scores were determined every 6 weeks: prior to the start of riding, onset of HBRT, at 6 week intervals throughout the therapy, and 6 weeks after HBRT was completed. Scores on the GMFM did not change during the period prior to riding, yet the total score increased 7.6% ($p<0.04$) after 18 weeks. The total scores returned to control levels by the end of the 6 weeks with no riding. The GMFM is broken down into various dimensions and Dimension E scores the child's ability in walking, running and jumping. The Dimension E scores improved 8.7% after 12 weeks of riding ($p<0.02$), and 8.5% after 18 weeks of riding ($p<0.03$) and stayed slightly improved at 1.8% at the 6 week follow-up period ($p<0.03$).[18]

The results from this study suggest that therapeutic riding may increase gross motor function and ability in tasks such as walking, running and jumping in children with CP. The authors added that larger studies would need to be conducted as well as with children

having more severe disabilities. A small study was then conducted with children with more severe disabilities by Hamill et al in 2007. These researchers explored the benefits of a once weekly 10-week hippotherapy program for children with cerebral palsy (n=3). Using the Gross Motor Function Classification System (GMFCS), the children were rated a level V. This level is the most involved, meaning the children cannot independently maintain an upright sitting posture. None of these children made any improvements on the standardized testing, yet parental reports revealed positive improvements in head control and range of motion.[19]

A study conducted by Benda et al in 2003 investigated the effects on muscle symmetry in children with cerebral palsy while astride a walking horse (n=7) or sitting astride a stationary barrel (n=8). Surface electrodes were placed on the bilateral posterior thoracic and lumbar areas as well as abductor and adductor muscles of each thigh. After 8 minutes of hippotherapy, significant improvements in muscle symmetry (64.6% with SD = 28.3) were found as compared to minimal improvements in symmetry (12.8% with SD = 88.8) for the group of children sitting astride the barrel (p= 0.051). The 8 minute mark was chosen due to clinical impressions of positive changes in patients receiving hippotherapy seen as early as the first 5-10 minutes on the horse. The important point of this study is that the sitting posture and passive stretching over a wide surface did not create significant changes in muscle symmetry. The investigators concluded the improvements in symmetry were due to the three dimensional movement of the horse. This short-term pilot study could not address whether or not the improvements could be maintained. Therefore, the authors suggested a follow-up randomized control trial with a 12-week hippotherapy program.[20]

Muscle Tone Studies

Research has been conducted in patients/clients with similar neurological impairments from other diagnoses such as spinal cord injury. In 2003, Lechner et al published positive results of hippotherapy in the reduction of spasticity in lower extremity muscles in patients sustaining a spinal cord injury (n=32). Muscle tone values graded using the Ashworth Scale were significantly lower after hippotherapy ($p<0.001$). The authors suggested the spasticity could have been decreased by the rhythmical combination of flexion/extension/rotation of the trunk and the combined hip position of flexion/abduction/external rotation when sitting astride a horse.[21]

To further the debate between the horse and other moving/non-living objects, researchers added new control groups such as patients sitting on wooden rocking horses. Continuing his research from 2003, Lechner et al in 2007 looked at the effects of hippotherapy on spasticity and mental well-being in persons with spinal cord injury (n=12). Participants were placed in 4 different conditions: hippotherapy, sitting astride a barrel, sitting on a rocking seat, and no intervention. Short-term muscle tone assessments were made using the Ashworth scale. Hippotherapy was more effective in temporarily decreasing spasticity (median differences in Ashworth scale sum scores ranged between -8.0 before hippotherapy and +0.5 after hippotherapy) than sitting astride a barrel or on a rocking seat. Also a short-term effect on mental well-being was noted only with the hippotherapy intervention ($p=.048$).[22]

Gait Studies

A 1998 study in Developmental Medicine & Child Neurology by McGibbon et al investigated the effects of an 8-week course of twice-weekly hippotherapy sessions on 5

children with spastic cerebral palsy. At completion of the course, all of the children had decreases in amount of energy spent during walking ($p<0.05$) and improved scores in walking, running and jumping on the GMFM Dimension E ($p<0.05$). These changes were statistically significant while a trend toward increased stride length and decreased cadence (number of steps per second) was observed.[23]

Adult Studies

More research needs to be conducted on the effects of hippotherapy for the adult population. One study examined the effects of hippotherapy on postural stability in adults with multiple sclerosis (MS). In 2007, investigators Silkwood-Sherer and Warmbier tracked 15 adults with postural instability from MS. Nine subjects were receiving weekly hippotherapy sessions for 14 weeks. At the end of the 14 weeks, subjects receiving hippotherapy had statistically significant improvements on the Berg Balance Scale ($p=0.012$) and the Tinetti Performance Oriented Mobility Assessment ($p=0.006$) as compared to the control group. These results show hippotherapy may be an effective intervention for adults with balance disorders.[24]

Summary of Literature Review: Hippotherapy and Therapeutic Riding

Hippotherapy and therapeutic riding can be a very unique experience for a patient/client due to the combination of 3-dimentional movement, elongated sitting position (vs. chair seat), sensory stimulation and psycho-social impact.[25] However, large-scale systematic reviews of the available literature are currently not able to recommend hippotherapy as a positive medical treatment strategy with complete confidence.[26] A systematic review of 9 studies was conducted by Snider et al in 2007. Three articles were randomized control trials (RCTs), 4 were quasi-experimental studies and 2 were

descriptive studies. PEDro scoring and the Newcastle Ottawa Quality Assessment Scale were used to assess the quality of the studies. PICO questions (Population, Intervention, Comparison and Outcomes) helped to specify clinical questions and received levels of evidence. The investigators reported that there is level 2a evidence showing hippotherapy is an effective intervention to improve muscle symmetry in the trunk and hip and improve gross motor function. This was in comparison to traditional therapy or time spent on a waiting list.[26] Level 2a evidence means that there is one or more fair quality RCTs while other studies have either inconsistent evidence or the quality of the study is limited.[27]

Another systematic review conducted by Sterba in 2007 found 11 research articles on therapeutic riding (n=6) and hippotherapy (n=5). Therapeutic riding was found to improve gross motor function in 5 of the 6 studies with the remaining study being inconclusive. Hippotherapy was shown to increase gross motor function in all 5 of the 5 studies reviewed. The author of this review found hippotherapy and therapeutic riding to be equally efficacious and stated both are "medically indicated as therapy for gross motor rehabilitation in children with cerebral palsy."[14]

Continued Therapy Immediately Upon Completion of Riding Sessions

Over the past several years, I have volunteered at three hippotherapy centers assisting physical and occupational therapists during and after riding sessions. These facilities are: Saratoga Therapeutic Equestrian Program in Saratoga, NY (Karen White, PT, stepatnfec@yahoo.com), Vinceremos Therapeutic Riding Center in Loxahatchee, FL (Heidi Spirazza, OT, HPC, info@vinceremos.com) and Every Body Counts Physical Therapy in East Berne, NY (Kimberly Silvernail, PT, Silvernail@cfdsny.org). The therapists at these centers have taught me the importance of continuing physical therapy

once the client has dismounted to focus on achievement of the individual's functional goals. And if the horse's walk truly facilitates a normal gait pattern in a person, then the perfect time for gait training is as soon as the patient dismounts. Therefore, from clinical observation and experience, the client in this case study was provided with a method to practice her walking as soon as she completed each riding session.

In some of our classes and laboratories at Sage Graduate School (The Sage Colleges, Doctor of Physical Therapy Program, Troy, NY), we learned about visual and auditory cues and how these can help people improve their gait. For instance, visual cues can help patients with Parkinson's disease (PD) who have trouble initiating their gait. The visual cues such as lines across the floor or a checkered floor pattern help them jump start their gait and transform their shuffling steps into longer, more natural strides. Visual and auditory cues are also widely used in horse-back riding, usually to help the horse keep a consistent stride length and maintain a consistent tempo. Ground poles (cavaletti) are visual cues to the horse for step height and stride length when they are placed at specific heights and distances. Metronomes are often used for auditory cues to help horse and rider maintain a consistent tempo. Metronomes can be set to match the rhythm of the horse's gait (4, 3, or 2 beat gait) or the tempo can be adjusted to influence the gait in a certain manner.[28]

Literature Review: Rhythmic Auditory Stimulation

Auditory cuing with a metronome is technically called Rhythmic Auditory Stimulation (RAS). This method has been thoroughly researched and capitalizes on the rhythm of music or basic sounds to help a person stimulate, maintain or influence their gait pattern. Thaut et al in 2007 compared gait parameters in patients post hemiparetic

stroke who participated in gait training using RAS (n=43) versus patients receiving gait training via Neurodevelopmental Theory (NDT)/Bobath techniques (n=35). The study was over a three-week period. Patients receiving gait training with RAS significantly improved their gait velocity (p=.006), stride length (p=.0001), cadence (p=.0001) and stride symmetry (p=.0049) as compared to the NDT/Bobath group. The authors concluded that rhythmic auditory stimulation is an effective intervention to improve gait training in hemiparetic stroke rehabilitation.[29]

Once research began showing the entrainment effects auditory cues can have on gait, researchers began to investigate whether gait could be modified by adjusting the rhythm of the auditory cues. In 2003, Howe et al questioned whether this was possible in the gait of patients in the early stages of Parkinson's disease. The study subjects (n=11) performed a series of fifteen 9-meter walks under non-cued and four auditory cued situations (85, 92.5 107.5 and 115% of their average cadence at each subjects normal walking pace). The results showed that adjusting the cues affected their gait, with mean velocity and cadence significantly increasing ($p \leq 0.01$) at the cue rates of 115 and 107.5%., and decreased during the slow, 85% cue rate. The average stride lengths of the subjects were unaffected by any of the cue rates. The researchers concluded that these two aspects of gait, velocity and cadence, could be modified with auditory cues and may provide a potential treatment strategy for improving gait in patients with Parkinson's disease.[30]

Purpose of the Case Report

This case report will focus on the physical improvements one can gain from horse-back riding in the realm of therapeutic riding. The client's lessons were taught by a

dressage riding instructor without the assistance of a licensed physical therapist. The instructor's background in dressage focuses specifically on teaching riders to follow the movements of the horse while retaining good posture and balance in an upright, elongated seated position. First riders learn to follow the horse's movement without disrupting their balance. Then, the instructor teaches them how to influence the horse's movement and direction with their hips and pelvis, creating longer or shorter, slower or more forward strides of the horse. Riding sessions progress to increasingly more challenging patterns: from straight lines, to large circles, to smaller circles, to weaving through cones. These patterns create more perturbations and thus a greater challenge to the rider to maintain their balance.

The client in this case report has prior riding experience and did not require continuous hands on facilitation or guarding during the riding sessions. The client had recently begun riding again prior to the start of the research project. Due to the distinct capabilities of her riding instructor, the client was already making improvements in her gait and decreasing her reliance of her straight cane. Thus it became apparent that any further changes should be documented in a case report to add to the body of research literature. The client would continue to benefit from remaining in a therapeutic riding setting as the proposed research intervention with the addition of RAS for gait training to follow each riding session.

The goal here was to focus on allowing her horse's walk to improve the mobility in her lumbar spine and lower extremities while providing reciprocal movement to stimulate a more symmetrical gait pattern. Once facilitated by the riding, an improved gait pattern would be reinforced by having the client practice her walking as soon as she got off her

horse. Formal gait training could not be conducted with the client in this case report. This was due to my current student status and decreased availability of a licensed therapist to observe me at the rural location of the case study. Therefore, the client was given an independent walking program with a metronome for auditory cuing. The metronome was chosen to replace the physical therapists verbal cues and was supported by the positive research reports regarding RAS discussed above. This allowed the client to work on her functional goal of improved walking as soon as she dismounted. According to current clinical practices, this is suggested to be the best way to maximize outcomes when incorporating riding as a therapeutic intervention.

For this case report, an adult volunteer was chosen from the orthopedic population with lumbar spine pathology and gait impairments to determine the changes in her gait and balance due to therapeutic riding. This case report is unique since there is limited information available on the effects of therapeutic riding in the orthopedic as well as the adult populations. Also, since a normal gait pattern seems to be facilitated during riding, research on the effects on gait would be most beneficial to the body of evidence currently available. Case reports are usually the first step in the research process. Then the current gap in research literature available will need to be fulfilled with reliable and valid randomized control trials with larger populations of varying ages and diagnoses. The purpose of this case report is to add information such as the effects of therapeutic riding and RAS in the adult population and how this affects the balance and gait of a single subject from an orthopedic population. This case report will also examine the effect of a more intense, three times per week, intervention design as compared to previous research in this area which traditionally uses a once a week design.

This research project was approved by the Institutional Review Board at The Sage Colleges in Troy, NY via a formal review on October 16, 2008. The client was previously known to the student researcher. Upon approval, she was invited to participate and educated on potential benefits and risks of the study.

CASE DESCRIPTION

Client history

The client who participated in this case report is a 59 year old Caucasian female, who is 5'7" in height and 155 lbs in weight. She is a long-term horse owner, recently retired and active in her housework and gardening. The client's medical history was reviewed during her initial examination at the beginning of this case study. Supporting documentation of medical imaging results, physical therapy evaluation and progress notes were provided by the client with her informed consent. In January 2005, the client began bowling once a week and started feeling numbness/tingling in her toes. Then while doing spring cleaning in April 2005, she reported instant low back pain after picking up a mattress. She had sustained a prior injury to her back at about age 30 when falling down a set of stairs and landing on her bottom. She received treatment for her back pain from a chiropractor from May – August, 2005. The chiropractor's treatment consisted of heat and electrical stimulation to her low back for 12 sessions without spinal manipulation. The client also reported osteoarthritis and stiffness in cold weather. She stated she has high cholesterol and takes Zetia to help control the levels. The client's past medical history reveals good health in all other systems. She discussed taking Advil or Tylenol for low back pain or other musculoskeletal pains as needed.

In June 2005 the client began having episodes of falls, about 5 total for the month. Her symptoms were not improving and she was sent for diagnostic testing. Plain films of her lower spine revealed a grade I spondylolisthesis of the L4 vertebra at the L4-L5 level. A grade I spondylolisthesis is a mild (less than 25%) forward slippage of one vertebra in relation to the other vertebrae in the spinal column. This condition is more common in females than males and tends to be associated with trauma and lumbar-sacral instability.[31]

Magnetic resonance imaging done in July 2005 showed moderate to severe spinal stenosis at the L4-L5 level and lesser degrees of central and foraminal stenosis at multiple upper lumbar levels due to disc bulges and ligamentum flavum thickening. Symptoms of spinal stenosis from the compression of these structures include: pseudoclaudication (difficulty walking), paresthesia (numbness/tingling), muscle weakness, local or radiating pain, and loss of bladder or bowel control.[32] The client in this case study had symptoms of spinal stenosis which included pseudoclaudication, paresthesias in her toes of both feet, lower extremity muscle weakness and low back pain.

Treatment for spinal stenosis is conservative at first and includes rest, steroid (epidural) injections, medications and exercise. Physical therapy is indicated for patients with spinal stenosis for pain relief, muscle strengthening, gait training and therapeutic exercises. If the conservative treatment is unsuccessful and the symptoms become debilitating for a patient, surgical intervention may be required. Often a portion of the vertebral body is removed (laminectomy) to widen the spinal canal and remove the pressure off of the nerves and vasculature to improve function. Then a fusion is normally performed with cage-type hardware to bind the involved vertebrae to the next level to maintain the stability of the vertebral column.[32]

The client was referred to physical therapy in July 2005 for conservative treatment for her symptoms of low back pain and left lower extremity weakness. The physician referral included range of motion, strengthening exercises and the use of the McKenzie Method for her treatment. The client reported her reasons for seeking care were due to her decreased balance during walking and recent falls. The client's desired outcome from physical therapy was primarily to improve her walking. She reported having to give up horseback riding and was not sure if she would be able to return to riding again in the future. The evaluation noted that the client presented with an ataxic gait which is defined as a staggering type of walk with postural imbalance and decreased coordination of movements.[33] The evaluation also documented the client ambulated (walked) with a straight cane due to the prior falling episodes, had weak trunk musculature, low back pain greatest in her left side, with her left lower extremity being weaker than her right and decreased flexibility in her hamstrings (straight leg raise 50-60 degrees for both legs).

The client began physical therapy three times a week for four weeks. The initial treatment consisted of lumbar stabilization and William's flexion exercises. Wall squats, bilateral arm ergometry, cardiofit and recumbent bicycling activities were added to her program, according to the client's daily progress notes. Electrical stimulation with moist heat was applied to the client's low back on days she reported increased pain. Gait training and balance exercises on a dynadisc (unstable round shaped surface) were emphasized towards the end of the course of treatment. During the client's time at the physical therapy clinic, the therapist suggested a neoprene back brace with Velcro straps. The client began wearing the brace and reported it provided her with extra trunk stability.

During the course of treatment, the client reported new symptoms of numbness and tingling into her fingers on both hands. She also reported dropping small objects such as her car keys. Her upper extremity coordination was found to be within normal limits as demonstrated by her ability to touch finger to finger patterns accurately. At the conclusion of the four weeks of traditional PT, the client was discharged when she had completed the total number of visits allowed by her insurance company. The physical therapist sent a written report to a neurologist to introduce the doctor to the client's current status. The therapist stated his concerns for the client's ataxic gait and felt this may or may not be related to the lumbar condition. The therapist reported the gait training and therapeutic exercises only provided a mild improvement to her gait. Her lower extremity strength had improved and was more symmetrical between the left and right sides. Yet the therapist felt her strength was still low in overall output for her age and activity level. He suggested the client may need to be further examined by the neurologist to rule out any other sources contributing to her current gait pattern, need for a cane, history of falls and decreased sensation in both hands.

In September of 2005, the client was seen by a neurologist and magnetic resonance images (MRI) were taken of her cervical spine. The impression of the images stated there was central canal stenosis, greatest at the C5-C6 and C6-C7 levels. Foraminal stenosis was also present, with the greatest amount in C5-C6 and C6-C7 levels. Mild central canal stenosis was present at C3-C4 and C4-C5 and mild foraminal stenosis at the C3-C4 level. The client was diagnosed with cervical spondylosis, which is a condition of the spine characterized by fixation or stiffness of the vertebral joints.[34] The client received an anterior spinal fusion covering five levels from C3-C7 in November of 2005. The cage-

type instrumentation used in the fusion is designed to increase stability of the vertebral column, which in turn limits the range of motion of the involved segments. During this time, the client also had a series of 3 epidurals to her low back for temporary pain relief. She received one isolated epidural shot in February of 2007 for low back pain and has not had another one since then.

I met the client in this case report in the spring of 2007 when she brought her horse to live at the same boarding facility where my horse was located. She said she had to stop riding and start boarding her horse since she was unable to care for him at home with her ongoing back and neck problems since January 2005. We tried different ways to lead her horse around the farm so she could still ambulate with her cane. We experimented with leading her horse from the off-side (the right side or non-traditional side) so she could walk on the packed down section of the outer track around the arena and make her horse walk in the deeper footing. Sometimes I would flatten out the inside track with a rake to make it easier for her to walk on, as we tried leading her horse from the usual left side. Her horse was being exercised at the farm to improve his own health and ability to carry a rider after some lameness (soreness) issues and time off. When her horse was fit to carry a rider again in the fall of 2007, she got back in the saddle to ride him for a few minutes. We used a series of stairs so she could walk up closer in height to her horses back and three people assisted her to get on. She was so happy to be able to ride after these past few years of health issues for both her and her horse, and was full of excitement and tears of joy when she finished.

The client started riding short intervals regularly with our dressage instructor at the horse farm in the summer of 2008. During that time she seemed more balanced on her

feet and was not using her cane as often. She began marching around the softer footing in the arena without needing it dragged or flattened out, showing signs of increased balance and improved foot clearance. A 12-week clinical experience at a local out-patient orthopedic clinic that summer provided me consistent exposure to many types of functional tests for gait. Writing this case report was a good method to combine what I was learning at the horse farm and physical therapy clinic and document her improvements with functional tests.

EXAMINATION

The client's vital signs were taken at the start of the initial examination which was conducted on October 18, 2008. Her vital signs were stable with the following measurements: respiratory rate = 17 breaths per minute, heart rate = 71 beats per minute, and blood pressure = 130/70 mmHg. The results of the initial examination of the client's range of motion, muscle strength and functional tests are listed in the tables found at the end of the paper. Table 1 contains the range of motion measurements for the joints of the bilateral lower extremities. Table 2 contains the manual muscle strength values for the joints of the bilateral lower extremities. Table 3 contains the initial examination results of the functional tests of gait, agility, strength and balance.

Range of motion measurements were done using a goniometer in each respective position noted in parentheses next to the motion indicated in Table 1. The intrarater reliability of goniometry has been generally accepted as sufficient for documenting the range of motion of joints in the human body. In 2008, Glanzman, Swenson and Kim defined the interclass correlations (ICCs) for goniometry of hip extension in 25 children with cerebral palsy to range from 0.97 to 0.98 and from 0.96 to 0.98 for 1 and 2-person

goniometry, respectively.[35] Upon initial examination, the client had decreased active range of motion in bilateral hip flexion, extension, abduction and external rotation, with the right leg being slightly more limited in all directions as compared to the left leg. The client's active range of motion for knee flexion and extension was within normal limits for both right and left sides. The client had decreased active range of motion for bilateral ankle dorsiflexion.

Manual muscle testing (MMT) measurements were recorded in various positions against gravity. The client's strength was greatest in bilateral hip flexion, knee extension and ankle plantarflexion, however the manual muscle testing grades for all these areas was still decreased at 4/5. This grade of 4/5 means the client was unable to sustain a 5 second resistance to these areas in an isometric position against gravity. The client was weakest in bilateral hip extension, left hip adduction and left ankle dorsiflexion, and scored a 2/5 for these areas. This grade of 2/5 means the client was unable to perform the full range of motion for bilateral hip extension, left hip adduction and left ankle dorsiflexion when attempting these movements against gravity. The client had decreased strength in the remaining areas of her lower extremities in bilateral hip abduction, right hip adduction, bilateral knee flexion and right ankle dorsiflexion. Scores for these areas ranged between 3/5, where the client could complete the full range of motion, to 4/5 where the client could sustain a mild resistance in the mid range of the motion.

There is much controversy surrounding the reliability and validity of MMT due to the need for objective outcome measures in physical therapy clinics worldwide. A literature review conducted by Cuthbert and Goodheart in 2007 found over 100 studies using MMT to evaluate patients and this type of testing has historically been a clinically

useful tool to determine muscle imbalances. However, the authors reported the ultimate validity of manual muscle testing remains to be proven and will require sophisticated research with rigorous statistical analysis.[36] Florence Kendall's 2005 5th edition textbook, Muscles: Testing and Function with Posture and Pain, reports on the objectivity of muscle testing. On page 7, the text reminds therapists that our hands are "the most sensitive, fine-tuned instruments available." "All the while, this instrument we call the hand is hooked up to the most marvelous computer ever created – the human mind – which can store valuable and useful information on the basis of which judgments about evaluation and treatment can be made. Such information contains objective data that are obtained without sacrificing the art and science of manual muscle testing to the demand for objectivity."[37]

The first functional test conducted during the initial examination was The Gait Speed Test. The Gait Speed Test was described by Steffen and Hacker in the Physical Therapy journal in 2002. The Gait Speed Test is used as a measure of overall walking performance and times the participant walking a 6 meter distance for a total of 4 trials, 2 trials at a comfortable pace and 2 trials at a fast pace. The higher the speed in meters per second (m/s) the patient is able to walk, the more independent the patient is considered to be. Older adults with gait speeds of less than 1 m/s are considered at risk of developing adverse health issues. Patients in the research study with no know impairments had average gait speeds of 0.6 – 1.4 m/s for the comfortable speed and 0.84 – 2.1 m/s for the fast walking speeds. The reliability of the Gait Speed Test is considered high for normal individuals with ICC = .94 for the comfortable walking speed and ICC = .97 for the fast walking speed.[38] During the initial examination, the client had a comfortable gait speed

of 1.22 m/s and a fast gait speed of 1.69 m/s. Therefore the client does not fall into the category for being at risk of increased health conditions due to decreased mobility.

The second test conducted during the initial examination was The Dynamic Gait Index. The Dynamic Gait Index (DGI) was designed to assess dynamic postural stability in older adults who may be at risk for falling. The test grades the patient's ability to change gait speeds, maintain balance while turning the head side to side and up and down, step around and over objects, make turns and ascend/descend stairs. The DGI is scored with a maximum of 24 points on an ordinal scale. Scores of 19 or less indicate the patient is at risk for falls, scores of 19-21 reveal a patient has a balance dysfunction, and scores of 22-24 designate the patient as a safe ambulator. Intrarater reliability of the DGI is 0.96, interrater reliability is 0.96 and test-retest reliability is 0.98.[39] The client scored a 16/24 on the DGI during the initial examination, placing her in the risk for falls category.

The DGI may also be a sensitive tool to use to identify patients with vestibular disorders. Research by Herman et al in 2009 found the DGI to be an appropriate test to accurately assess function of older healthy adults since it examines patients walking during challenging tasks. The investigation compared the DGI with other tests in 278 healthy elderly participants. Those participants with a history of falling performed worse on the DGI as compared to those without ever falling ($p = 0.029$).[40]

The next test administered during the initial examination was The Four Square Step Test. The Four Square Step Test (FSST) is used to predict patients at risk for falls and is also a measure of agility. Patients must step over 1" PVC pipes into a series of squares and are timed on how fast they can go forward, backward, left and right. A time greater than 15 seconds is associated with people at risk for falling. The client had an

average score of 16.48 seconds during the test, placing her in the risk for falls category. In 2008, Blennerhassett and Jayalath examined patients who had a stroke (n=37) with the FSST and determined the test was sensitive to improvements the patients made during rehabilitation ($p<0.001$). The five participants who reported falls during the study also had low scores on the FSST with marked difficulty clearing their feet over the 1" pipes used with the test.[41]

Another functional test used during the initial examination was The Chair Stand Test. The Chair Stand Test is a test of overall lower extremity strength and endurance which measures how many times a person can stand up from a specific seated height (17 inches) in 30 seconds. This test was designed as a functional fitness test for older adults in 1999 by Rikli and Jones. The authors published test/retest reliability for females as 0.92 with 61% sensitivity and 59% specificity.[42] The client was able to complete 9 standing efforts during the 30 second time period. As compared to other females tested, the client's 9 efforts placed her in the 10^{th} percentile, showing significant decreased strength and endurance of her lower extremities as compared to other females tested in her age category.

A single leg stance test was also used during the evaluation to assess the client's static standing balance on each leg. The generally accepted normal value is an ability to stand on each leg unsupported (without a hand hold) for 30 seconds. The client was able to stand 6.7 seconds on her left leg and 12.5 seconds on her right leg, showing she has decreased balance for both sides. In 2005, Sherrington and Lord looked at the test-retest reliability of balance measures in older people after having a hip fracture (n=30). The single leg stance test was not found to be a reliable measure of balance. The functional

reach test did have high test-retest reliability with an ICC = 0.89.[43] Therefore the client's results during her performance on the single leg stance testing should be viewed with caution, although her past medical history includes several episodes of decreased balance leading to several falls.

EVALUATION

The initial evaluation of the client in this case study revealed decreased strength and ROM of bilateral lower extremities, decreased endurance, agility, balance and impaired gait. Visual inspection of the client's gait showed decreased stride symmetry and circumduction with the right lower extremity. The client's score on the DGI of 16/24 revealed she was at risk for falls. The client's time on the FSST of 16.48 seconds was longer than the cut-off time of 15 seconds, revealing the client was at risk for falls.

Diagnosis:

The multi-level spinal stenosis in the client's lumbar spine could be responsible for her symptoms of parathesias in bilateral toes, weakness in bilateral lower extremities and ataxic gait. The nerves and blood vessels become compressed with less space in the spinal canals. Each person's unique symptoms are related to the specific structures and locations involved. The client's decreased strength and balance can contribute to her difficulty with foot clearance over flat and uneven ground. This can lead to a potential trip or fall, which is in agreement with the client's past medical history.

The multi-level cervical fusions in the client's neck limit her range of motion in head and neck movements. Therefore, she has a decreased ability to turn her head to look for assistance with her balance, plan stepping maneuvers or look for a hand hold to avoid a fall.

The physical therapy diagnoses for the client according to the Guide to Physical Therapy Practice are:

Practice Pattern 4F: Impaired joint mobility, motor function, muscle performance, range of motion and reflex integrity associated with spinal disorders.

Practice Pattern 5A: Primary prevention/risk reduction for loss of balance and falling.[44]

Prognosis:

The prognosis was positive for the client in this case report for the following reasons: she was a highly motivated individual with lack of other co-morbidities, she was able to commit the time and be consistent with the interventions, and she was to be riding her own horse, benefiting her horse as well. The prognosis was also positive due to the fact that the client had recently begun riding prior to the start of this research project and had already experienced some objective and subjective improvements.

Goals to be accomplished in 3 weeks:

1. Client will be able to ride for 15-30 minutes without pain.
2. Client will improve her Dynamic Gait Index score to a 20/24 to decrease her fall risk.
3. Client will decrease presence of circumduction pattern with right lower extremity 50% of the time during a 10 minute walk on outdoor flat surface per visual observation.

Plan of care:

The client will participate in 15-30 minute therapeutic riding sessions 3 times per week for 4 weeks. Riding sessions will focus on teaching the client proper posture in sitting and to allow her low back, hips and pelvis to follow the natural movement of her horse's walk. Some brief periods of trotting may also be used in order to build her lower extremity strength and improve her balance during the posting movement. Each riding

session will be followed by 5-15 minutes of gait training via an independent walking program with RAS immediately after riding to focus on ambulating with a proper gait pattern.

INTERVENTION

The decision to choose therapeutic riding and RAS as the proposed interventions was supported by the examination findings and the literature review. The client had already received a conservative course of treatment for her condition and made limited improvement. The client did not want to have the lumbar laminectomy procedure done unless her symptoms became more serious. However, the client was interested in exploring other interventions that may help to improve her gait and balance.

An article written about Hippotherapy in the March 2009 Today in PT magazine summarized a few studies which also supported the riding portion of the intervention for this client. Although unable to access translated versions of these articles published in German through the Sage Colleges research database, the magazine review highlighted research articles supporting hippotherapy for patients with lumbar instability,[45,46] status-post lumbar disc surgery[45,47] and that hippotherapy could assist mobility of hypomobile segments as well as improve core strength to help stabilize hypermobile vertebral segments.[45,47] Another study reported hippotherapy does not create a risk for damage to intervertebral discs from the pressure in the seated position, which was a common fear in the early years of hippotherapy.[45,48]

Therapeutic riding was hypothesized to improve the range of motion, strength and agility of her lower extremities, leading to overall improvements in her balance and gait. RAS was included to provide the client with a method to practice a proper gait pattern

and utilize all the gains which may have been facilitated during the riding sessions. RAS was hypothesized to provide repetitive practice of the proper gait pattern to improve motor control.

Therapeutic Riding Sessions

The horse used in this case study for the therapeutic riding sessions is named StrawBoss. “Boss” is a 24 year old quarter-horse gelding and belongs to the client. Prior to this case study, he was examined by a licensed veterinarian in June 2007 for soreness issues in his legs. He received changes in his shoes (equine footwear) and progressions in exercise to help him return to full strength to carry a medium weight rider. Boss has demonstrated the proper personality, temperament and movement as described previously in the requirements for therapeutic riding horses. While working with this horse to help improve his own gaits, he has proven his willingness, competence and consistent safety. There is also a strong long-term bond between Boss and the client in this case study, which made the partnership quite special.

Rhythmic Auditory Stimulation Sessions

The client’s personal goal was to improve her gait, therefore the independent gait training program was designed. This consisted of ambulation along the uneven dirt surface of the indoor riding arena using a metronome for RAS. The metronome was set at the client’s baseline gait speed to focus on improving her foot clearance for a more symmetrical stride length to improve her balance. This was done for safety reasons since this was an independent walking program and also to focus more on gait symmetry rather than just increasing gait velocity. The metronome was set to a 2-beat pattern to match the human 2-beat walking gait. The metronome may generate symmetrical stride lengths

between right and left legs due to the even tempo facilitating heel strike to occur within the same time frame for both right and left legs. This way the auditory cues (beeps) sounded in unison with each heel strike through the phase of gait. RAS sessions were completed immediately after the therapeutic riding sessions. This simulates current hippotherapy clinical practice where functional goals are focused on as soon as the patient dismounts from the horse.

The completed schedule of therapeutic riding and RAS interventions can be found in Table 4. The frequency of the interventions was 3 sessions per week and the duration of the intervention was 4 weeks. The average therapeutic riding time was 21 minutes per session. The RAS intervention was conducted for 10 minutes after each riding session, however there were 2 days out of the total 12 sessions where the client did not complete the RAS intervention. The research project was terminated at the end of the fourth week due to the increasingly cold weather in Upstate, NY. The post-test date was chosen to be the 16th of November as this day was similar in temperature to the date of the initial examination.

OUTCOMES

The results of the initial and final examination are listed together in the tables in the appendices. Please refer to Tables 5-7 for a summary of the outcome measures. Additional columns were provided to show changes in range of motion, strength and functional tests the client made during the course of the 4-week intervention.

During the final examination, the client demonstrated improvements in lower extremity range of motion in a majority of joints. Table 5 contains the outcomes for range of motion measurements for bilateral lower extremities as well as the change measured

between initial and final values. The largest gains were seen in right hip flexion (gain of 14 degrees), right hip abduction (gain of 12 degrees) and right hip extension (gain of 9 degrees). The client had increased knee flexion range of motion with an 8 degree gain in the left knee and a 4 degree gain in the right knee, so that the range for each side was almost identical. The client had a gain of 6 degrees of left hip flexion, 3 degrees of left hip abduction and 5 degrees of left ankle dorsiflexion. The client had decreased left hip extension (loss of 2 degrees) and no changes recorded for right hip external rotation passive range of motion and right ankle dorsiflexion. The client did not have any changes in bilateral knee extension range of motion which remained at a normal value (0 degrees) from initial to final examination.

Table 6 contains the outcomes for manual muscle strength for bilateral lower extremities. The client demonstrated increased strength in bilateral hip abduction, both sides increased by 1 MMT grade with the left hip abduction achieving the highest score of 5/5. The client had increased bilateral hip adduction strength, as measured by a gain of 2 MMT grades with the right hip adduction earning the full 5/5 normal value. The client had increased strength in bilateral ankle dorsiflexion, with the left ankle gaining 2 MMT grades and the right ankle gaining 1 MMT grade. The client increased her left ankle plantarflexion strength by 1 MMT grade, achieving a 5/5 for full strength. No changes in strength were recorded for bilateral hip flexion and extension, nor right knee flexion, right knee extension or right ankle plantarflexion.

Table 7 contains the outcomes for the functional gait, agility, strength and balance testing. The final results of the Gait Speed test were a 0.05 m/s increase in the client's comfortable gait speed and a decrease in the client's fast speed by 0.06 m/s. The

participant in this case study remained in the average ranges as published by Steffen and Hacker in 2002 for both her comfortable and fast walking speeds. The client did not make a significant change in her speed during the intervention period; however her comfortable and fast speeds were above 1.0 m/s which demonstrated she is not at risk for adverse health effects.[38]

The final results of the Dynamic Gait Index were positive. The client improved her scores on the DGI from 16/24 (indicating she was at risk for falls) to 20/24. The score of 20/24 categorizes the client with only a balance dysfunction, and not remaining at risk for falls.[39] This test reveals that the intervention period was successful in reducing the participants risk for falls.

During the Four-Square Step Test, the client scored an initial average of 16.48 seconds, placing her in the fall risk category. When re-tested during the final examination, she improved her average time to 10.7 seconds. The client was not at risk for falls during the final examination according to her ability to score well under the cut-off time of 15 seconds.[41] With a time of 5.78 seconds faster, she showed increased agility and decreased her risk of falls by 27%.

In the Chair Stand Test, the client increased her score from 9 sit to stand efforts on the initial day to 12 sit to stand efforts on the final day. An average of 3 additional efforts in 30 seconds showed a 25% improvement over the course of the research period. Using the percentile ranks published by the authors, the client went from the 10th percentile to the 30th percentile for females in the age group of 60-64.[42] The clients improvements in percentile ranking appears to correlate with the reported manual muscle testing

measurements, showing strength improvements yet still requiring increased strength to approach average levels compared to peers of a similar age.

The client demonstrated a 2 second increase on the left single leg stance and an 8 second decrease on the right single leg stance. The Single Leg Stance Test has not been shown to be a reliable measure of balance according to research by Sherrington and Lord. A better measurement that should have been used in this case study is the Functional Reach Test which has better reliability as described previously.[43] Therefore the client's results during her performance on the single leg stance testing were not consistent with all the other measurements and tests and therefore should be viewed with caution.

In summary, the interventions yielded improvements in the client's bilateral lower extremity range of motion, strength and agility which contributed to overall improvements in gait and balance. The client decreased her reliance of the straight cane assistive device due to improved confidence and foot clearance over uneven terrain and did not have any loss of balance leading to a fall during the course of the intervention. Subjective outcomes included decreased pain, decreased assistance required to mount/dismount her horse, improved sitting and standing tolerance prior to onset of pain, and improved ability to maintain her balance and avoid falls during challenges from cats and dogs running in front of her at home.

DISCUSSION

The twelve intervention sessions of therapeutic riding followed by ten sessions of rhythmic auditory stimulation yielded improvements in the Average Gait Speed, the Dynamic Gait Index, the Four-Square Step Test, and the Chair Stand Test. No improvements were noted in the Fast Gait Speed or Single Leg Stance Tests.

Improvements in active range of motion were seen in bilateral hip flexion, hip abduction and knee flexion as well as left ankle dorsiflexion. Improvements in lower extremity strength were seen in bilateral hip abduction, hip adduction and ankle dorsiflexion.

Since the client in this case study was from the orthopedic population, the outcome measures were selected for her level of ability and make it difficult to compare her outcomes with those of previous research. The neurological impairments of the patients in previous research discussed selected outcome measures appropriate for that population such as the Modified Ashworth Scale for impaired muscle tone, electromyography studies to examine muscle symmetry, and the GMFM for pediatric gross motor classifications.[20,22,23]

The increased strength seen in the client's bilateral hip abduction and adduction as well as bilateral ankle dorsiflexion were interesting since the riding position provides a unique method to strengthen these areas. The decrease seen in the client's fast gait speed during the final examination could be attributed to the gait training effects of the RAS. During the 10 sessions of RAS, the client walked at a consistent velocity for 10 minutes which was closer in speed to her comfortable pace rather than her fast pace. As mentioned previously in the work by Howe et al in 2003, a patient's gait velocity can be increased or decreased according to the cue rate of the metronome. This may explain why a decrease in the fast gait speed test was noted.

The positive improvements were relatively in agreement with the literature review in a general sense that patients and clients benefit from hippotherapy and therapeutic riding interventions, as compared to not improving or declining in status.[14,18,20-26] Although this research was with a new type of diagnosis (orthopedic) and used different outcome

measures, the client improved her condition. Rather than stay the same or have deficits from the interventions, the client showed positive improvements. The findings in this case study may be in agreement with the articles in German reviewed in the continuing education highlight on hippotherapy in the magazine Today in PT. The research completed by the German authors were publishing positive effects of hippotherapy for orthopedic conditions of the lumbar spine including instability and hypomobility, although not specifically spinal stenosis.[45-48]

A majority of the hippotherapy and therapeutic riding research studies reviewed used once a week riding session study designs.[18-20,24] This case report was fortunate to have a three session per week study design. This was due to the availability of the therapeutic riding instructor, therapy horse and ability of the client to commit to the frequency of the interventions. Most traditional physical therapy programs are 30 minute sessions 2-3 times per week. With an average of 21 minutes of therapeutic riding and 10 minutes of gait training for 3 sessions per week over a period of 4 weeks, the interventions in this case report more accurately resemble the intensity, frequency and duration of therapy a client would receive in a typical physical therapy plan of care. The improvements seen in this 4 week time frame with similar frequency of therapy as traditional PT is of interest as compared to extended durations of hippotherapy and therapeutic riding in previous research.[18,23,24]

Alternative explanation of findings

The established relationship between horse and owner/client could have contributed to the positive results of this case study. The client has owned this horse for a majority of his 24 years of life, had ridden him through the years, and also took care of him at her

home farm. Her riding stopped due to her back and neck impairments in 2005 and she had given up the idea of being able to rider her horse ever again. To complicate matters, her horse also went through a time period of soreness issues with his legs and time and efforts were in place to get him back to sound health again. Therefore, the positive aspects of this lifelong partnership becoming reunited in terms of riding again could have assisted the positive outcomes during the 4 week duration of the intervention.

Implications of this case report

More high quality research is needed to improve our knowledge of hippotherapy and therapeutic riding in terms of its medical efficacy and rehabilitation potential. Also the major governing bodies (NAHRA, AHA, Inc., APTA) promote hippotherapy and therapeutic riding as interventions for patients with autism spectrum disorders, traumatic brain injury, stroke, cerebral palsy and sensory integration disorders. What about patients in the orthopedic population with low back pain and lumbar spine related disorders? Low back pain and spine related problems consist of a large percentage of medical care, health insurance costs and financial loss to patients/clients due to decreased work capacity. This case report is one of few in the United States regarding therapeutic riding as a successful intervention for clients with impairments of orthopedic nature. Therefore the implications of this case report support the need for continued research in this area. Several studies have been conducted in Germany in the past ten years in this area and the ability to translate these articles to assist further research in this area is of great importance.[45-48]

Suggestions for future research

Future use of computerized gait analysis software with high speed video recordings will help improve the research regarding hippotherapy and therapeutic riding and its

effects on gait. The Institute for Human Performance, Rehabilitation and Biomedical Research at the State University of New York's Upstate Medical University has started using computerized gait analysis to assist with research on hippotherapy.[6] Researchers believe the advanced gait analysis software will provide a better understanding of what components of gait are most affected or improved with hippotherapy. Two studies investigating the kinematic parameters of gait in children with cerebral palsy after hippotherapy programs are currently being conducted. Gait studies incorporating comparisons of biomechanics prior to and upon completion of hippotherapy sessions will be very beneficial to the current body of research.

Randomized control trials with standardized outcomes should be incorporated into the studies and enough participants recruited for studies to have higher power to become candidates in the systematic reviews.[8,11,26] Yet, the body of evidenced-base research for hippotherapy and therapeutic riding is steadily continuing to grow. Positive results in studies of high reliability and validity is required for this therapeutic strategy to be further accepted into the medical model and foster improvements in reimbursement.[6]

There are many questions that remain unanswered regarding hippotherapy and therapeutic riding. For example, what is the optimum frequency (sessions per week), duration (total weeks) and intensity (minutes per session) for this type of intervention? Are improvements increased when hippotherapy is followed by continued treatment as soon as patient/client dismounts? Is hippotherapy and therapeutic riding more effective for certain types of impairments over others, such as muscle tone or balance or gait? How does hippotherapy and therapeutic riding compare to body weight supported treadmill training in regards to improvements in gait?

This case study will add to the limited research data for adults participating in therapeutic riding. This client was discharged from a standard physical therapy clinic since she had a functional gait with a straight cane at the start of this program. However, she still desired to further improve her gait and return to riding and other functional activities. The client is now walking without the straight cane and reported she was able to walk on uneven surfaces at the county fair for 1 hour without pain during or after the fair.

Limitations of the study

The Gait Speed Test may not have been an appropriate test for the client in this case study. This test is geared for patients with significant disabilities who walk less than 1m/s.[38] The Gait Speed Test is clinically indicated for patients who have ambulation as a goal, therefore this test may have been at too low of a level for the client in this case study. The Gait Speed Test was used primarily to define the clients gait speed. The video review of the test assisted in setting the metronome to the appropriate rhythm for the client.

The Single Leg Stance Test was not found in the research literature to be a reliable measure of balance.[43] According to work by Sherrington and Lord in 2005, the Functional Reach Test would be a better measure of standing balance. The Berg Balance Test could also have been used as in the article by Silkwood-Sherer and Warmbier in 2007 when they examined the effects of hippotherapy on postural stability in adults with Multiple Sclerosis.

Future researchers would be advised to complete IRB proceedings in the early spring since weather plays such a large factor in therapeutic riding and all other outdoor related activities in the Northeast.

CONCLUSION

The horse is an ideal method to assist with physical therapy due to its continual motion in 3-dimensions which cannot be replicated on a therapy ball or bolster in a standard physical therapy environment.[25] Clients may benefit from the increased frequency of therapeutic riding sessions as in this case study as compared to once per week sessions implemented in previous research. Therapeutic riding in combination with RAS may be a successful intervention strategy for clients with gait and balance impairments of orthopedic nature. The client in this case study reduced her risk for falls upon completion of the intervention period. This is an important accomplishment because decreasing a client's risk for falls reduces the client's future need of high-cost medical services and can improve their quality of life.

Most of the research published on therapeutic riding is regarding children with permanent neurological disorders. Continued high quality research will determine the efficacy of this treatment strategy for a broader range of ages, diagnoses, impairments and functional limitations. The translations of previous work of German researchers will help define the future research in the realm of therapeutic riding as an intervention strategy for patients with impairments of an orthopedic nature.

The future of physical therapy needs to expand beyond the clinic into the outdoor environments to develop additional successful interventions. Physical therapy services

should be extended to those patients that would be routinely discharged for insurance reasons if they are considered independent yet still have functional goals to be attained. These people can significantly benefit from continued progressions and deserve an opportunity to continue their therapy. This will also reduce the future need for more serious medical services such as reducing patient/client risk for falls. Also children and adults with permanent disabilities will be involved with physical therapy for a lifetime. Many parents, children and adult clients would like the opportunity to participate in sports and expand beyond conventional therapy in clinic settings.

Therapeutic riding followed by an independent walking program incorporating rhythmic auditory stimulation with a metronome appears to be a successful intervention to facilitate improvements in balance and gait for the participant in this case report. There are many factors that are involved in creating a successful therapeutic riding environment, yet this type of intervention should be considered for patients with gait impairments who have ceased to improve in a typical physical therapy environment.

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Table 1. Initial Range of Motion Measurements for Bilateral Lower Extremities

Lower Extremity (position)	**Left** Active Range of Motion	**Right** Active Range of Motion
Hip Flexion AROM (supine)	5-101°	10-90°
Hip Extension AROM (prone)	minus 5	minus 10
Hip Abduction AROM (supine)	0-37°	0-26°
Hip External Rotation PROM (supine)	0-37°	0-36°
Knee Flexion AROM (supine)	0-131°	0-136°
Knee Extension AROM (supine)	0°	0°
Ankle Dorsiflexion AROM (sitting)	0-5°	0-5°

Table 2. Initial Manual Muscle Strength Measurements Bilateral Lower Extremities

Lower Extremity (position)	Left Strength (out of 5)	Right Strength (out of 5)
Hip Flexion (sitting)	4	4
Hip Extension (prone)	2	2
Hip Abduction (sidelying)	4	3
Hip Adduction (sidelying)	2	3
Knee Flexion (prone)	3	4
Knee Extension (sitting)	4	4
Ankle Dorsiflexion (sitting)	2	3
Ankle Plantarflexion (standing)	4	4

Table 3. Initial Functional Gait, Agility, Strength and Balance Tests

Functional Test	Initial examination score
Comfortable Gait Speed Fast Gait Speed	1.22 m/s 1.69 m/s
Dynamic Gait Index	16/24
Four-Square Step Test	16.48 s
Chair Stand Test	9 stands
One-legged Stance Left One-legged Stance Right	6.7 s 12.5

Table 4. Completed Schedule of Therapeutic Riding and RAS Interventions

Session Number	Day of Week	Month	Date	Therapeutic Riding Time (minutes)	Gait Training (RAS with metronome time in min)
1	Monday	October	20th	20 minutes	10 minutes
2	Wednesday	October	22nd	20	10
3	Friday	October	24th	22	10
4	Monday	October	27th	15	No gait training today
5	Wednesday	October	29th	23	10
6	Friday	October	31st	23	10
7	Monday	November	3rd	13	No gait training today
8	Wednesday	November	5th	23	10
9	Friday	November	7th	23	10
10	Monday	November	10th	30	10
11	Wednesday	November	12th	20	10
12	Friday	November	14th	20	10

Table 5. Range of Motion Measurements for Bilateral Lower Extremities

ROM	Initial Left	Final Left	Change Left	Initial Right	Final Right	Change Right
Hip Flexion (supine)	5-101°	7-107°	Gain of 6º	10-90°	1-104°	Gain of 14º
Hip Extension (prone)	minus 5	minus 7	Loss of 2º	minus 10	minus 1	Gain of 9º
Hip Abduction (supine)	0-37°	0-40°	Gain of 3º	0-26°	0-38°	Gain of 12º
Hip External Rotation (PROM)	0-37°	0-38°	Gain of 1º	0-36°	0-36°	No change
Knee Flexion (supine)	0-131°	0-139°	Gain of 8º	0-136°	0-140°	Gain of 4º
Knee Extension (supine)	0°	0°	No change	0°	0°	No change
Ankle Dorsiflexion (supine)	0-5°	0-10°	Gain of 5º	0-5°	0-5°	No change

Table 6. Manual Muscle Strength Measurements for Bilateral Lower Extremities

Lower Extremities (position)	Left	Left	Change	Right	Right	Change
Hip Flexion (sitting)	4/5	4/5	None	4/5	4/5	None
Hip Extension (prone)	2	2	None	2	2	None
Hip Abduction (sidelying)	4	5	Gain of 1 MMT grade	3	4	Gain of 1 MMT grade
Hip Adduction (sidelying)	2	4	Gain of 2 MMT grades	3-	5	Gain of 2 MMT grades
Knee Flexion (prone)	3+	4	Gain of 1 MMT grade	4+	4+	No change
Knee Extension (sitting)	4	5	Gain of 1 MMT grade	4	4	No change
Ankle Dorsiflexion (sitting)	2+	4	Gain of 2 MMT grades	3-	4	Gain of 1 MMT grade
Ankle Plantarflexion (standing)	4	5	Gain of 1 MMT grade	4	4	No change

Table 7. Functional Gait, Agility, Strength and Balance Tests

Functional Tests	Initial Evaluation Date 10/18/08 Temperature 42°	Final Evaluation Date 11/16/08 Temperature 47°	Change	Results
Comfortable Gait Speed Fast Gait Speed	1.22 m/s 1.69 m/s	1.27 m/s 1.63 m/s	0.05m/s -0.06 m/s	+ -
Dynamic Gait Index	16/24 At risk for falls	20/24 Impaired balance	4	+
Four-square step test	16.48 s	10.7 s	5.78 s	+
Chair stand test	9 stands	12 stands	3 stands	+
One-legged stance Left One-legged stance Right	6.7 s 12.5	8.7 s 4.48	2.0 s -8.02	+ -