Physical Therapy Interventions for an Individual with Lyme Disease

A Capstone Project for PTY 769
Presented to the Faculty of the Department of Physical Therapy
Sage Graduate School

In Partial Fulfillment
of the Requirements for the Degree of
Doctor of Physical Therapy

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May, 2010

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ABSTRACT

PURPOSE- The purpose of this case report was to describe outcomes of physical therapy intervention in the treatment of musculoskeletal signs and symptoms produced by the secondary effects of Lyme disease. CASE DESCRIPTION- A 37 year old male with a diagnosis of Lyme disease was referred to physical therapy for evaluation and treatment of the secondary effects of the disease, including pain and muscle weakness. The impairments with which he presented included limited endurance, pain, decreased strength throughout, decreased standing balance and an impaired gait pattern. Functional limitations included difficulty with stair negotiation and sit to stand transfers, and inability to work. METHODS- The participant was given a home exercise program and participated in aquatic and land-based therapeutic activities. He began aquatic physical therapy sessions twice a week for two weeks followed by land-based physical therapy sessions twice a week for 18 treatments over a span of 12 weeks. He was also educated on a number of different topics relevant to his care. OUTCOMES- He rated his pain as a 5/10 at initial evaluation and 4/10 at discharge. Manual muscle testing improved by ½ to 1 muscle grade throughout. At discharge he was able to hold each position on the modified CTSIB for at least 30 seconds. Improvements in aerobic endurance were observed as he was able to increase time spent on a recumbent bicycle from 2 minutes to 8 minutes. Transfers and ability to negotiate stairs improved as did the participant's reported quality of life. He had not achieved employment at the end of treatment. DISCUSSION- It appears that increased physical activity helped the participant achieve greater function as well as an improved quality of life. Pain did not dissipate and flare-ups did not disappear so it was difficult to quantify success of physical therapy treatment based on the outcome measures utilized.

INTRODUCTION

Currently, Lyme disease is the most common arthropod-borne illness in the United States as there have been over 150,000 cases reported to the Centers for Disease Control (CDC) since 1982.[1] In 2008, state health departments reported 28,921 confirmed cases and 6,277 probable cases of Lyme disease. When compared to the number of confirmed cases reported in 2007, this represents a 5% increase. The prevalence of Lyme disease in a geographic area correlates to the number of ticks present in that area and how often the ticks are infected with the bacteria. New York State has the highest number of cases in the United States with 5,741 confirmed and 2,053 probable cases.[1] There are certain areas in the state of New York where over half the ticks are infected. Although people of all ages and gender are susceptible to tick bites, Lyme disease is most commonly found in boys between the ages of 5-19 and people over the age of 30.[1] People with Lyme disease are most likely to develop the illness in the months of June, July, or August and least likely to develop the illness from December through March.[1]

Lyme disease is a bacterial illness known to be caused by *Borrelia burgdorferi*.[2] This bacterium resides in the stomachs of ticks often found on deer. Lyme disease is spread to humans when ticks bite the skin allowing the infection to enter the body. This is the only method of transmission for Lyme disease as it cannot be passed from individual to individual. Lyme disease is known to cause health problems in humans that can involve multiple systems. It affects these different areas to varying degrees of severity as the disease progresses. There are three phases the medical community uses to describe Lyme disease: early localized disease (affecting the skin), early disseminated disease (affecting the heart and nervous system), and late or chronic disease (affecting the nervous system as well as causing arthritis).[2-3]

Diagnosis of infection by *B. burgdorferi* can be difficult and timely. Lyme disease has been found to be frequently curable if it is diagnosed and treated early with a course of antibiotics. In some instances, Lyme disease can have permanent effects on the body. Often, people are unable to recall being bitten by a tick and one in four people do not develop the tell-tale "Bull's-eye" rash (erythema migrans). In the early stage of Lyme disease, symptoms can include fatigue, muscle and joint stiffness, swollen lymph nodes, and headache. These symptoms are vague and accompany a number of various other pathologies as well. The later phases of Lyme disease can include arthritis, and neurological disorders such as disorientation, confusion, dizziness, short-term memory loss, inability to concentrate, and numbness in the extremities.[4]

Shadick et al[5] found that people with a history of Lyme disease have more musculoskeletal impairments when compared to those without a history of the disease. Arthritis resulting from Lyme disease mimics many other forms of inflammatory arthritis and can become chronic. It most commonly affects the knees and begins with swelling, stiffness, and pain. Other secondary effects of Lyme disease that can occur in the late stages are anxiety and depression.[6] Depression is the most common psychiatric manifestation. Although depression is common in any chronic illness, it is more prevalent with people infected with Lyme.[7] Intermittent bouts of arthritis appear in approximately 60% of individuals with untreated Lyme disease after several months in the form of severe joint pain and swelling. Roughly 5% of untreated individuals have the potential to develop chronic neurological complaints months to years after infection. Symptoms may include but are not limited to shooting pains, numbness, or tingling in the distal extremities, and problems with concentration and short term memory.[1]

A small number of people with Lyme disease have symptoms lasting months to years following antibiotic treatment. Symptoms can include myalgias and arthralgias, arthritis,

cognitive defects, sleep disturbances, and fatigue. The origin of these symptoms is as of yet unidentified. Some evidence has been found that they could occur as the result of an autoimmune response in which an individual's immune system continues to fight infection that has been cleared through medical testing.[1]

Current treatment of Lyme disease includes oral antibiotics in the early stage. If the disease has progressed, intravenous antibiotics are often recommended.[8] According to the American Lyme Disease Foundation,[2] there is currently no scientific evidence that any other treatment approaches, such as repeated or lengthy courses of therapy or increased doses or combinations of antibiotics are any more effective than the standard treatment regimen mentioned above.

There is currently no research on the effectiveness of physical therapy (PT) interventions for musculoskeletal impairments secondary to chronic Lyme disease nor are there any resources promoting the use of physical therapy specifically for the treatment of musculoskeletal impairments secondary to advanced Lyme disease. However, it is within the realm of physical therapy to treat musculoskeletal impairments.[9] The effectiveness of physical therapy in the treatment of musculoskeletal disorders relies on the findings of the initial examination and is determined when outcomes show that chosen interventions are appropriate for the clinical problem at hand. The Disablement Model provides the theoretical basis for a physical therapist's role in treating the impairments and functional limitations correlated with musculoskeletal disorders.[10] Many studies support the use of aquatic therapy,[11-12] balance training,[13-14] therapeutic exercise,[12,15-16] aerobic exercise,[15] and patient education programs[5,17] in treating those with musculoskeletal impairments.

In a study completed by Wyatt et al[12] the differences between an aquatic exercise program and a land-based exercise program were investigated and compared to determine if increases in functional levels for people with knee osteoarthritis (OA) differed. Forty-six participants took part in the research. Pre- and post-test measurements included knee range of motion (ROM), thigh girth, subjective pain and a timed 1-mile walk. Both groups showed significant increases in all measurements and no significant differences between groups were found. However, the aquatic exercise group had significantly lower subjective pain levels when compared to the land-based exercise group.[12] Minor et al[15] found that people with lower extremity OA showed significant improvement in aerobic capacity, 50-foot walking time, depression, anxiety, and physical activity following a 12 week aerobic aquatic program when compared to a control group performing only ROM activities. In addition, aquatic programs have been shown to improve functional status and reduce pain.[18]

People with OA of the knees, have significant losses of proprioception and kinesthesia sensation when compared to control subjects. In a study designed to investigate short-term clinical effects of kinesthesia and balance training in people with knee OA, significant improvements were seen following exercise when compared to baseline scores using the Western Ontario and MacMaster Osteoarthritis Index (WOMAC), SF-36, number of times performing activities of daily living (ADLs), isokinetic quadriceps strength, and proprioceptive sensation levels. The researchers determined that the results of this study are clinically applicable and it is within the realm of possibility to increase the functional abilities of these people.[13]

Minor et al[15] found that therapeutic exercise is an effective therapy in successful management of OA and is critical in reducing impairments, improving function, and preventing further disability. There are several benefits resulting from flexibility, muscular conditioning,

and aerobic exercises. Deyle et al[16] found that a combination of manual physical therapy and exercise resulted in functional benefits for individuals with OA of the knee. In this study, 83 participants with OA of the knee were randomly assigned to a treatment and control group. The treatment group demonstrated significant improvements in the 6-minute walk and the WOMAC scores at 4 and 8 weeks but this did not hold true in the placebo group.[16] Participants with OA of the knee who were in the treatment group experienced improvements in pain, stiffness and functional ability as well as distance walked in the 6-minute walk test. The study found the beneficial effects of treatment persisted up to 1 year following the conclusion of clinical treatment.

In a study completed by Jette,[9] treatment choices for people with knee impairments were characterized by use of all types of exercises and frequent use of cold modalities. Strengthening, flexibility, and various exercises were used in many of the initial stages of therapy and endurance exercises were the focus in later stages.[9] According to the results of this study, outpatient physical therapy intervention for people with knee impairments was described by the use of modalities, exercises, and manual therapy treatments. Treatment choices varied based on impairments and were dependent upon which stage of therapy the person had reached. Although modalities were used often during treatment sessions, they were used in conjunction with exercises and manual therapy.[9]

Arthritis secondary to Lyme disease occasionally mimics OA or rheumatoid arthritis.[1-2] Therefore it is reasonable to presume the same interventions used in people with either of these conditions will likely work for someone with Lyme disease however there is currently no research to show this is true. The purpose of this case report was to describe outcomes of

physical therapy interventions in the treatment of musculoskeletal signs and symptoms produced by the secondary effects of Lyme disease.

CASE DESCRIPTION

The participant was a 37 year old male with a diagnosis of Lyme disease. He was referred to PT for evaluation and treatment of the secondary effects of the disease including pain and muscle weakness, mainly of the lower extremities. The setting in which the evaluation and treatment took place was an out-patient, orthopedic, hospital-run clinic. He had received PT two months prior but stopped going before termination of care due to an injury to the left leg secondary to a fall from his bicycle. Following his leg injury during the first episode of PT, radiographs were taken of the left lower extremity and found to be negative. This participant had a history of depression, cutting, and suicidal tendencies. At the time of the initial evaluation, he was seeing a psychiatrist once a month and a therapist once a week. He noted that he had been to behavioral health hospitals twice in the last three years. He stated that seeing his psychiatrist and therapist had been helpful for him and he believed it was keeping him alive. At the time of the initial interview, the participant reported that he felt he was making progress with the issues that were psychological in nature. He was also receiving occupational therapy for limitations in his hands and a possible fitting for an adaptive eating device.

His medications included Abilify which was prescribed to him by his psychiatrist. Other medications included vicoprofen, oxycontin, ibuprofen, Celexa, Ambien, Phenergan suppository and Phenergan. The participant reported that in the past he had experienced genitourinary issues as a result of medication side effects. According to the American Physical Therapy Association's Guide to Physical Therapist Practice there is no Preferred Practice Pattern for musculoskeletal impairments secondary to Lyme disease.[19] The Preferred Practice Pattern for OA, which presents

with many similarities when comparing musculoskeletal symptoms to chronic Lyme disease is 4E: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Localized Inflammation. The appropriate ICD-9 code for Lyme disease is 088.81.

The participant reported that he did not experience symptoms from Lyme disease that affected his lifestyle until 5 years ago. He has been unable to work since that time secondary to pain and weakness. He used to reside in an area with a high prevalence of Lyme disease and ran a construction company. When his symptoms began worsening he lost his business, homes, equipment, and vehicles and had to claim bankruptcy. He could remember periods in his early twenties when he had severe pain in his knees and difficulty yielding a hammer. Five years ago he reached a point at which he was unable to hold a nail with either hand. During the initial evaluation, he reported new difficulties in which he was unable to lift a heavy weight more than a couple of times, unable to finish a meal due to issues with using utensils, problems negotiating stairs, and decreased ability to rise from low surfaces, such as a toilet seat. He noted that he was fatiguing quickly following any activity and he was having days in which negotiating stairs was impossible for him to do. This was a major issue as he lived in an upstairs apartment over a garage. The participant described the stairs to his apartment as winding with no railings. On the days when he was feeling worse he would use a cane or a pair of crutches to get down the stairs. Going up was easier for him as he was able to use his upper body to some degree by sitting on a step and pulling himself onto the subsequent step with his arms.

The participant was wearing bilateral knee braces at the time of initial evaluation and stated that he wore them daily for support. He also noted he had bilateral wrist braces at home that he would wear when the weakness became overwhelming to him. The early morning upon

first waking up and the end of the day were his worst times. He felt best in the middle of the day after he had been moving around. The participant had goals of improving overall ability, losing weight, decreasing pain, increasing strength, riding a bike, and being able to keep up with his wife. He appeared highly motivated and asked to be challenged. He was originally prescribed four weeks of aquatic therapy prior to starting land treatment and requested it be changed to two so that he could start working harder.

The participant's chief complaints included bilateral knee pain that he reported as a 5/10 on the Visual Analogue Scale (VAS).[20-21] He described his pain as chronic, aching, and dull that at times became stabbing and sharp. He noted that often his left knee was more severe than his right. The participant also reported generalized pain, especially in his back, that he rated 4/10 on the VAS.[20-22] He used a home TENS unit that had been given to him by a physician 5 years ago. This provided mild, short term relief during periods of severe pain however the effects did not last.

Examination

During the system's review, the participant was found to have no integumentary or cardiovascular issues. His neuromuscular system was found to be intact with no report of paresthesias or anesthesias. Light touch sensation testing as described by Rolke et al[23] over the dermatomes of the lower extremities was intact and muscle tone was deemed normal. Coordination and reflexes were not assessed. ROM was found to be within normal limits (WNL). Impairments in muscle strength were noted throughout bilateral upper extremities and lower extremities expect at the ankle. See Table 1 for specific values.

Unsupported sitting balance was unimpaired. Upon evaluation of standing balance, it was revealed that the participant relied more heavily on his right side, especially when he was

challenged. He was tested standing naturally with eyes opened and eyes closed, standing tandem with eyes open and eyes closed, and standing on foam with eyes opened and eyes closed. He was unable to maintain any of these positions for more than 10 seconds. He also demonstrated difficulty when performing sit to stand transfers from a low surface and reported that this carried over into his daily life in that he required the use of bilateral upper extremity assistance to rise from his toilet seat at home. Upon inspection of normal paced gait, the participant was found to rely more heavily on his right side, as he did during balance assessment. He demonstrated no trunk rotation, decreased arm swing on the left, absent arm swing on the right, and held his torso rigidly. Right step length was slightly decreased as was left stance time. Stair negotiation was not assessed at the time of initial evaluation however, the participant reported that he used a cane to assist with negotiation of stairs at home. He stated that descent was more difficult and if he had not taken his pain medications for the day then it was impossible for him to go down the stairs.

Outcome Measures

The VAS was used to monitor the participant's pain from treatment to treatment and was documented at every session. The participant was asked to rate his pain on a scale of zero to ten with zero being no pain at all and ten being the most unbearable pain he had ever experienced. His pain was documented at every session. The Visual Analog Scale has been found to be a reliable and valid measure by Jenson et al,[20] Carlsson et al,[21] and Price et al.[22] In an article by Williamson and Hoggart[30] it was reported that when a VAS is repeated within a brief time period, 90% of scores are close together. The repeatability of the VAS is good as was determined by correlation coefficients ranging from 0.97 to 0.99. The VAS also has greater sensitivity to change than do the Numerical Rating Scale and the Verbal Rating Scale. The VAS also scored highest out of the three tests when validity was examined.[30-33]

Muscle strength was assessed using manual muscle testing (MMT) techniques as described by Kendall and Kendall.[24-29] According to Cuthbert and Goodheart[24] MMT is the most frequently used means for recording impairments in muscle strength. In a literature review assembled by Cuthbert and Goodheart,[24] over 100 studies related to MMT and the applied kinesiology technique utilized by chiropractors that uses MMT were reviewed. The literature review included studies that investigated the clinical efficiency of MMT in the diagnosis of patients presenting with symptoms.

In physical therapy research, the "break test" is the most commonly used procedure for performing MMT. Cuthbert and Goodheart[24] provide the operational definition for the use of MMT as described by the International College of Applied Kinesiology. This method of MMT was originally developed from the work of Kendall and Kendall.[25] The individual is instructed to contract the muscle to be tested in a position that isolates the muscle. The examiner then resists the pressure until they detect no increase in force against their hand. Next, an additional small force is exerted against the pressure being provided by the person. Strong muscles are those that can adapt to the additional force applied by the examiner and maintain contraction without weakening. Weak muscles are unable to adapt to a small increase in pressure.[24-29] The grading system is based on muscle performance as it relates to the amount of manual resistance being applied by the examiner. Scores are given on a scale from 0-5 where zero is the equivalent of no contraction and a score of one is when the contraction can be felt but there is no corresponding movement. A score of two means that movement is possible in gravity-eliminated positions. Three means that the participant can move through the full range of motion against gravity but without any resistance from the examiner. A score of four translates to movement is possible against some resistance from the examiner and a score of five indicates normal strength.[24-29]

Some practitioners use subscales as well including plus and minus for contractions scoring less than a whole value along the scale.

As mentioned above manual muscle testing was used to evaluate strength during the initial evaluation and during subsequent reevaluations to determine progress. Manual muscle testing was performed by using the "break test" (described above) in which the participant was instructed to hold against manual resistance.[24-29] Manual muscle testing has been shown to be reliable and valid form of measurement by many researchers,[24-29] but it can vary between practitioners.

Unilateral stance balance testing was used to determine the presence of postural control. The participant stood on one leg and was timed in seconds. The findings from a study done by Harrison et al[34] suggest that single-leg standing balance can be reliably evaluated by physical therapists, but no values on reliability and validity of this test were found in the research. The single-leg stance test is a measure considered to assess balance in a static position using time as the measurement. It is widely held that better balance allows for longer time standing on one leg. There is a lack of evidence available regarding how balance during unilateral stance changes over time.[35]

The specific balance measure utilized in this case report is similar to a modified Clinical Test of Sensory Integration on Balance (mCTSIB). This test measures the way that vision, vestibular and somatosensation interact to allow people to maintain balance against forces of gravity. The test was developed by Shumway-Cook and Horak.[36-37] The participant was instructed to stand up straight without moving, looking straight ahead as long as possible or until the trial was over. The participant performed this test with no shoes on, as protocol states the test should be performed. The first condition of this test consisted of the participant standing on the

floor with his arms folded across his chest with his hands touching opposite shoulders. His feet were shoulder width apart. He was told to hold this position for thirty seconds. Condition two had only one difference from condition one. For the second condition the participant had his eyes closed. The third condition consisted of one difference from condition one as well. The participant's feet were together with his ankle bones touching. Condition four was the same as condition three with the participant's eyes closed. The fifth condition was the same as condition one except that the participant was asked to stand on a four inch thick foam cushion. The sixth condition was the same as the fifth condition but with the participant's eyes closed.

Aerobic endurance was measured by the amount of time, measured in minutes, the participant was able to spend on a recumbent bicycle. Much information on function was collected via self-report through question and answer sessions with the participant over the course of his treatments. Most of the information the individual provided had to do with his quality of life, general state of well-being, what he was and was not able to do easier at home and what types of activities affected the onset of increasing symptom intensity. There were no research articles found supporting self-report measures on function as reliable and valid. For this reason, although it was used as an outcome measure for this participant there are no reliability or validity scores available.

Evaluation

The participant's pathology was Lyme disease as diagnosed 13 years ago with clinical manifestations that appeared 5 years ago. As a result, the participant had decreased endurance for functional activities and activities of daily living and was unable to work secondary to the effects of the disease. He could not lift more than a few pounds due to his significantly decreased strength and he was unable to hold a hammer secondary to the effects of the disease in the joints

of his hands. His impairments included generalized and bilateral knee pain, decreased strength throughout, decreased standing balance and an impaired gait pattern. Based on examination findings it was reasonable to assume that the participant was presenting with an impaired gait pattern and decreased balance secondary to pain and muscle weakness in the lower extremities. He also demonstrated difficulty negotiating stairs and sit to stand transfers, especially when he rose from a low surface. These functional limitations likely resulted from the participant's decreased endurance, decreased strength in the lower extremities, debilitating pain and decreased balance.

The participant attended PT twice a week for two weeks in an aquatic setting and twice a week after that for a total of eighteen treatments over a course of twelve weeks in a land-based out-participant orthopedic setting. The potential for rehabilitation for this participant was determined to be good despite no success during the first episode of care as psychological issues may have effected treatment in a negative manner. The participant presented as highly motivated and had a good understanding of material given to him during treatment sessions as he was able to recite information correctly and demonstrate activities/exercises appropriately. He recognized that in the past he had a tendency to overexert himself. He was under the belief that the more he did the quicker he would improve. Following a discussion regarding the possibility of symptom irritation with the slightest triggers in individuals with chronic Lyme disease he acknowledged the importance of gradual progression. He was highly aware of his situation and understood the importance behind gradually building up a tolerance to increased physical activity though at times his impatience outweighed this knowledge. Barring any unexpected occurrences that slow or postpone further treatment, reasons in which this individual might not achieve the goals set forth in the allotted time would be a severe exacerbation of symptoms that last longer than usual

(2-3 days as reported by the participant), and possible setbacks with the psychiatric aspect of his care, or illness.

Long-term goals were decided in collaboration with the participant and were expected to be met at time of discharge. They included 1) participant will be able to negotiate 15, 8 inch stairs up and down independently while maintaining safety using a step-through pattern without assistance from the upper body, 2) participant will be able to transfer from sit to stand when rising off the toilet seat independently without use of upper extremity assistance, 3) the participant will have increased strength throughout his lower extremities to 5/5 manual muscle test grade, 4) the participant will be able to perform functional activities and activities of daily living independently with no restrictions or limitations, and 5) the participant will have the ability to achieve gainful employment with no physical restrictions or limitations within the requirements of the job found. Additional goals include 1) he will be able to walk greater than 1000 feet independently to be able to go grocery shopping, 2) he will have decreased knee pain to less than 3/10 at all times, 3) he will improve his score on the CTSIB demonstrating improved standing balance, and 4) he will demonstrate increased aerobic capacity as measured by increased time spent using a recumbent bicycle.

Plan of Care

After the initial evaluation, the participant was deemed a good candidate for PT with no observed contraindications to physical activity. He was given a home exercise program including various exercises meant to begin treatment of impairments found during the examination. Immediately following initial evaluation he was given a prescription for aquatic physical therapy in an attempt to reduce pain while initiating strength and balance activities. He had two weeks of aquatic physical therapy at the end of which a reassessment occurred and land-based intervention

began. During aquatic therapy he complained of dizziness and headaches that intensified as the session progressed. He also noted nausea and a sense of feeling light-headed. Initial aquatic and subsequent land-based treatments consisted of exercises meant to improve posture and flexibility, institute better trunk control and strengthen the lower extremities. The exercises were prescribed to be done at low intensity, once a day, with minimum repetitions of each in order to establish a baseline to determine how he would react to increased physical activity. At subsequent treatment sessions the participant's exercises were progressed by increasing the number of repetitions, adding weight or lengthening duration. For a complete list of interventions used refer to Table 4. As the participant's symptoms were musculoskeletal in nature secondary to chronic Lyme disease, the rationale for treatment was similar to that for an individual with a lower extremity musculoskeletal dysfunction that was similar to the diagnosis and in which the clinical instructor had experienced success in treating in the past, such as osteoarthritis of the knee.

The participant was educated consistently throughout the course of treatment about the importance of and rationale behind each of the activities he was asked to performed. He was also taught about the progression of exercise and that doing more does not necessarily mean quicker return to previous function and often can have deleterious effects. Much time was spent discussing the differences between quality and effort put into the activities versus quantity of repetitions. The home exercise given to the participant was based on what was being done in the clinic and was advanced as deemed appropriate based on his progress and comprehension. The participant was asked to verbally repeat instructions for the home exercises as well as demonstrate each one prior to having them assigned to his program.

Over the course of treatment the individual missed five treatment sessions. He cancelled four appointments due to illness or periods of exacerbated symptoms and did not show up to one for reasons unknown.

OUTCOMES

Over the course of receiving physical therapy, the participant in this case study made improvements in muscle strength, balance, endurance, function and quality of life. He stated that he felt he was making good progress towards his goals of becoming more active and keeping up with his wife. Based on measurements of pain using the Visual Analog Scale, the participant showed little to no improvement and actually exhibited increased pain in several of the last sessions observed.

Manual muscle testing showed improvement throughout the lower extremities. He improved approximately ½ to 1 muscle grade per every muscle measured. For specific measurements see Table 5. The participant reported that he felt his lower extremities were gaining significant strength because he was able to decrease the amount of time that he wore his bilateral knee braces throughout the day. He stated that it was easier for him to rise from the toilet and that he found himself less frequently using his arms to pull himself up.

He noted that his balance had improved greatly and could provide evidence of this by performing all of his exercises pertaining to balance with little to no difficulty. At the discharge evaluation the participant's balance was retested using the same methods and was found to be unimpaired as he was able to hold all positions required for testing for greater than thirty seconds on the mCTSIB. In addition to improving on this test the participant reported that he could more easily descend stairs and felt increased safety as he did so.

The participant's gait impairments were found to be directly related to the level of pain reported that day. His gait pattern improved on days when his pain was low and worsened on

days when a higher pain level was documented. The participant noted that he was negotiating stairs, both up and down, with increased ease. This was observed during a therapy session in which he demonstrated his ability to do so multiple times with no complaints of worsened symptoms. It should be taken into account however, that the setting was extremely different from the participant's stairs at home.

The participant was able to improve his aerobic endurance as shown by extended time periods on the stationary bike and felt that he was close to achieving his goal of riding a bicycle. At the conclusion of treatment the participant noted mild fatigue, mild shortness of breath and minimally increased knee pain were reported. The participant's aerobic capacity at onset of treatment was such that he would not have been able to tolerate 8 minutes worth of recumbent cycling without experiencing symptoms. The participant began cycling against no resistance, at a self-selected intensity for a time period of 2 minutes. By the middle of land-based treatment sessions he was able to increase his time spent cycling against no resistance, at a higher level of self-selected intensity to 8 minutes. Recumbent biking was stopped midway through the episode of care secondary to short treatment sessions and necessity to include other aspects of therapy. The participant reported feelings of excitement and expressed his belief that he would be able to ride a bicycle outdoors without limitations.

The participant noted an overall improvement in his quality of life through accounts of ability to do activities that would not have been considered prior to the onset of physical therapy. He was able to spend more time with friends, perform duties related to lawn and home care, and walk for pleasure as well as exercise. Approximately one month prior to discharge the individual began reporting a better mood in addition to feeling better physically. He noted that he had begun measuring his walks by distance rather than time and had worked up to one mile on

uneven surfaces with no exacerbation of symptoms. The individual noted also that at times of increased pain, he had taken to using a walking stick on his stairs at home and this seemed to help take some of the pressure off of his lower extremities which in turn resulted in decreased pain. He stated that stairs were most difficult for him when he first woke in the morning and felt stiffness in his joints.

ADLs were focused on when he attended occupational therapy. He reported that he had difficulty with many of the same tasks as he had prior to treatment whenever he had flare-ups or increased intensity of symptoms. At the culmination of treatment he had not yet gained employment but reported that he had not been actively searching for a job.

He had gained a substantial amount of knowledge on methods to control his pain, manners in which to approach exercise on any one of the broad spectrum of days he might have, and when to stop on occasions when physical exertion should not be overdone. He came to the recognition that doing more exercise would not necessarily result in a more rapid improvement in function. He came to recognize the process and the purpose behind the activities he was being asked to perform. The participant was quoted as having said "This is the best I have felt in a long time."

DISCUSSION

The participant in this case study made improvements in muscle strength, balance, and endurance. He showed inconsistent improvements in pain although he verbally reported significant improvements in function and quality of life. As the individual progressed throughout the physical therapy process he noted that most of the exercises originally assigned to him began to feel very easy to him while a few others remained challenging. At reassessment the participant reported frequent half hour walks around his neighborhood which he stated he had been unable

to do prior to starting physical therapy. The participant stated that the first time he tried this walk he felt out of breath but since he had felt good and felt as though he was no longer having flare-ups secondary to increased activity.

The participant reported several flare-ups of symptoms that occurred following days when he felt great and decided to do something active. An example of this is when he helped a friend mow a large and uneven lawn. He stated that he noted pain immediately but kept going anyways. He was unable to partake in his home exercise program for a week following this incident. After this event, he acknowledged that stair negotiation once again became more difficult for him, but it was still not as difficult as prior to having started physical therapy.

It is likely that the participant made improvements in muscle strength, balance and endurance because he partook in an organized, customized exercise program designed to improve impairments specific to him. Also, exercise programs have been shown in the literature to be effective in successful management of OA by reducing impairments, improving function, and preventing further disability.[15] As mentioned in the introduction, Deyle et al[16] found that combining manual physical therapy with exercise results in functional benefits for individuals with OA of the knee. The participant in this case report presented most often with bilateral knee pain ranging from mild to severe. In a study done by Deyle et al[16] it was shown that the treatment group which received manual physical therapy and exercise demonstrated improvements in pain, stiffness and functional ability. Jette[9] described strengthening, flexibility and various exercises used during all stages of therapy which were effective interventions for participants with knee impairments.

Following the initial evaluation, it was thought that the participant's gait, transfers, difficulty with stair negotiation and balance were affected secondary to pain and decreased strength. When the participant's strength was shown to improve via manual muscle test scores, he also demonstrated improvements in standing balance, transfers, and stair negotiation, and exhibited a more effective gait pattern.

Over the course of physical therapy sessions the participant continued to report pain scores across the Visual Analogue Scale that did not consistently increase or decrease. He stated after being asked about pain that he had good days and bad days but that even on some of the bad days he felt he was able to participate in more activities than he had prior to starting his home exercise program. A few treatments following reassessment, he noted that he was having an easier time descending stairs at his home and that he felt safer using a technique that was taught to him during physical therapy in which he stepped down on the ball of his foot and rolled his toes over the edge of the step. The individual began inconsistently reporting less pain following treatment sessions in which exercise was increased. The individual noted that he had been weaning himself off of his prescribed pain medications and found that he had to stop doing this as without the medication, his pain seemed to increase following physical activity, particularly after strenuous bouts of physical therapy in which the participant reported feeling good in the beginning but worse at the end of the day.

It is likely that the individual's pain did not fully resolve and presented as increased or decreased in an inconsistent manner secondary to frequent flare-ups caused by the participant increasing his activity in direct proportion to feeling better physically and mentally. Also, according to the CDC,[1] it is common for people with infection to have intermittent bouts of arthritis with severe joint pain and swelling. Chronic complaints can occur years after the initial

infection which can include many of the reports given by the participant in this case. As the exact cause behind these symptoms is unknown there were occasions when amount of medication did not seem to be a factor and pain levels were documented as high secondary to increased duration or intensity of activity the previous day it is reasonable to assume that this participant may have bouts of pain, stiffness and fatigue for many years to come.

The limitations of this case report include that there is currently no research on the effectiveness of physical therapy intervention for musculoskeletal impairments secondary to chronic Lyme disease and the results from this case are somewhat inconclusive. It is difficult to tell whether the exercise which led to increased strength also led to improved function and better quality of life or if the participant was having intermittent bouts of arthritic symptoms that would have dissolved spontaneously given time. Another limitation to this report is that the participant was not consistently seen by the same therapist and during his discharge evaluation manual muscle test scores were evaluated by a different individual than during the initial evaluation and again at reassessment. It can be inferred through comparison to participant reports at the initial evaluation to those at the termination of observation that he had an improved outlook on his circumstances overall.

This case report could have been improved if specific outcome measures had been determined prior to the start of treatment and were repeated throughout the time spent working with the participant. Measures that would have been appropriate to use would have included, but not be limited to the 6-minute test, Dynamic Gait Index and Berg Balance Scale. Other outcome measures that would have improved this case report would have been including the use of functional scales such as the WOMAC and a quality of life scale as well. It would be important to include some sort of self-report measure as well rather than just state subjective data collected

via conversation with the participant. Had the participant tolerated the conditions of the pool it may have helped decrease his pain in a more consistent manner if he had continued for a few more aquatic sessions prior to beginning land-based physical. Modalities such as heat and ice to modulate pain may have been helpful as well.

Muscle strength could have been more accurately recorded by having the same examiner measure every time and by using a dynamometer rather than relying on manual muscle strength testing. Differences in perception of muscle strength between examiners vary greatly.

Physical therapists would benefit from further research into commonly used physical therapy interventions and their effectiveness for an individual with musculoskeletal symptoms resulting from chronic Lyme disease. It is likely that in the future clinicians will be seeing an increase in the number of patients with this diagnosis. It would be prudent to be prepared by knowing which interventions are appropriate and effective as well as be able to provide evidence of such by building a greater body of research.

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Table 1: Muscle Strength at Initial Evaluation

	INITIAL EVALUATION (5/29)	
Muscle Tested	Right	Left
Shoulder Flexion	4	4
Shoulder Extension	4	3+
Shoulder Abduction	4	4
Shoulder External Rotation	4	4
Shoulder Internal Rotation	4	4
Elbow Flexion	4	4
Elbow Extension	4	4
Hip Flexion	4	4
Hip Extension	4	3+
Hip Abduction	NT	NT
Hip Adduction	NT	NT
Hip External Rotation	4	4
Hip Internal Rotation	3	3
Knee Flexion	4	4
Knee Extension	4	4
Ankle Dorsiflexion	5	5
Ankle Plantarflexion	5	5
Ankle Inversion	NT	NT
Ankle Eversion	NT	NT

NT= Not tested

Table 2: Pain at Start of each Treatment Session.

Treatment Session	Pain Level (0-10)	Location
Initial Evaluation	5	Bilateral Knees
	4	Generalized
2	6	Generalized
3	6	Bilateral Rib regions
	6	Left Hand
	6	Left Knee
4	7	Bilateral Knees
5	5	Generalized
6	5	Left Knee
Reassessment	5	Left Knee
8	0	
9	7	Bilateral Knees
10	0	
11	7	Bilateral Knees
12	8	Bilateral Knees
13	8	Bilateral Knees
14	3	Bilateral Lower Legs
15	5	Bilateral Knees
16	5	Left Wrist
		Left Knee
17	8	Bilateral Knees
		Bilateral Lower Legs
Discharge	4	Generalized

Table 3: Aquatic-based Exercises by Session.

Session/Duration Exercises	2 40 min	3 30 min	4 25 min	5 38 min
Treadmill	0.7-1.0mph x 9min	0.9-1.1 mph x 7min	0.8-1.0 mph x 7min	1.0-1.2 mph x 10min
Lumbar Stabilization with water fan	3# 2min x push/pull 2min x up/down 2min x side/side	 * * *	 * * *	5# * * *
Trunk ROM	Flexion & rotation x 12 (with & without UE support)	*	*	* x 15
Vertical Stabilization	√	*	*	
Shallow UE program	B shld IR/ER x 10 B shld abd/add x 10 B shld hor abd/add x 10 Lateral push/pull x10 B shld flex/ext x 10 B elbow flex/ext x 10	* * * * * *	* * * 	
LE program		B hip flex/ext x 10 B hip abd/add x 10 B knee flex/ext x 10	* * *	
Balance				Stepping forward & back/side to side/side & back with hands on foam disks with 1 LE while maintaining stance with opp. LE

*= Same as previous treatment session.

Table 4: Land-based Exercises by Session.

Session/Duration Exercises	6 30min	7 40min	8 30min	9 30min	10 30min	11 30min	12 30min	13 30min	14 30min
Slouch Overcorrect	R								
Supine Bridging	20	10							
Prone Back Extension with B arm raises	20	10							
Prone Hip Extension (B)	10								
Toe Raises (B)	20			5					
LAQs (B)	10								
Mini-lunges		40' x 3							
Recumbent Bike		2min	5min	5min	6min	8min			
Stair Negotiation (up and down)			20 x 3	3 x 3 I					
Standing Balance			2min x 2 (Airex)		1min x 2 (BOSU)	15 x 3 (BOSU)	15 x 3 (BOSU)		
LE stabilization (B)					SLS with 2# ball toss to rebounder x 10				
BOSU					Squats x 10 SLS x 1min (B)				
Sidestepping 2" pipes (L & R)			10ft x 3						
Sidestepping 6" hurdles (L & R)			10ft x 2						
Standing Balance			20sec x 3 UE Support EC						
UBE (forward and backward)				120rpm x 1 min					
March in place on balance pad				2 min I					
Squats on balance pad				x 8 UE Support x 10 with 4# medicine ball					
Lateral step up & over 4" balance pad (B)				x 10					
Forward/Lateral step up & over 8" stool onto balance pad (B)								x 5ea	
Single-leg Stance on balance pad (B)				x 5 cones			30sec		
Sidestepping lunges (L & R)					20' x 2			5	
Tandem Stance (alternating lead foot)						30sec x 2 EO I 30sec x 2 EC UE Support	30sec	10 beanbag tosses x 2 (Airex)	
Leg Press (B)								55,65# x 10ea	65,75,85,95# x 10ea
Horizontal & vertical rows, Lat pull-downs									10 x 2ea

Table 4 (Continuation): Land-based Exercises by Session

Session/Duration	15 33min	16 30min	17 28min	18 30min
Exercises				
Leg Press (B)	85,95,105# x 15ea	*		
Horizontal & vertical rows, Lat pull-downs	25,35,45# x10ea	* x 15ea	35# x 15 45# x 10	
Squats on Total Gym	Level 8 x10	Level 9 x 15 L LE x 10 R LE x 10		
Hamstring Pull (B) on Total Gym	Level 1 x 10ea	* x 15ea		
Rowing Machine			Level 5 x 4min	
NuStep			Level 4 x 5min	
Review				HEP Prevention of overexertion Community based exercise

R= review; EO= eyes opened; EC= eyes closed; #= pounds; Rep= repetitions; *= same as previous treatment

Table 5: Comparison of Muscle Strength at Initial Evaluation, Reassessment, and Discharge.

	Initial Evaluation (5/29)		**Reassessment (6/29)**		**Discharge (8/24)**	
Muscle Tested	Right	Left	Right	Left	Right	Left
Shoulder Flexion	4	4	4	4	4+	4+
Shoulder Extension	4	3+	4	4	4+	4+
Shoulder Abduction	4	4	4	4	4+	4+
Shoulder External Rotation	4	4	4+	4+	4+	4+
Shoulder Internal Rotation	4	4	4+	4+	4+	4+
Elbow Flexion	4	4	4+	4+	4+	4+
Elbow Extension	4	4	4+	4+	4+	4+
Hip Flexion	4	4	4	4+	4	4+
Hip Extension	4	3+	4+	4	4+	4+
Hip Abduction	NT	NT	5	4+/5	5	4+/5-
Hip Adduction	NT	NT	5	5	5	5
Hip External Rotation	4	4	3+*	3+*	4	4
Hip Internal Rotation	3	3	3+*	3+*	4	4
Knee Flexion	4	4	4+	4	4+	4
Knee Extension	4	4	4+	4+	4+	4+
Ankle Dorsiflexion	5	5	5	5	5	5
Ankle Plantarflexion	5	5	4+	4+	4+	4+
Ankle Inversion	NT	NT	4+	4+	4+	4+
Ankle Eversion	NT	NT	4+	4+	4+	4+

*= Tested in prone position