Therapeutic Ultrasound and Exercise for the Treatment of Myositis Ossificans Traumatica in a 16-Year Old Male with History of Factor VIII Hemophilia

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PTY 768
Capstone Project

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ABSTRACT

Background and Purpose: The likelihood of developing myositis ossificans traumatica (MOT) may be increased in individuals with hemophilia. The purpose of this case report is: to investigate the clinical signs and symptoms of MOT; determine whether a patient with hemophilia is predisposed to developing MOT; and identify the most effective treatment options for MOT.

Case Description: A 16-year old male with hemophilia was seen for the treatment of recurrent thigh bleed. Clinical signs and symptoms were consistent with MOT.

Exam/Evaluation: The patient complained of increased pain and girth; decreased lower extremity range of motion, strength, and function with activities of daily living; and antalgic gait.

Interventions: Treatment consisted of pulsed ultrasound and therapeutic exercise.

Outcomes: The patient achieved all goals within 6 weeks.

Discussion: MOT is difficult to detect initially as it may mimic other conditions. Developing MOT increases after sustaining a muscle contusion due to complications from an intramuscular bleed. Evidence is limited regarding the predisposition of MOT in patients with hemophilia. Further research needs to be conducted.

Conclusion: The patient attained excellent results with pulsed ultrasound and therapeutic exercises, even though the efficacy of therapeutic ultrasound has been disputed.

INTRODUCTION

The incidence of heterotopic ossification (HO) in patients with factor VIII hemophilia is poorly understood and rarely reported.[1] HO, which is often used interchangeably with the term myositis ossificans (MO), is defined as the abnormal non-neoplastic formation of bone within extraskeletal soft tissue.[2,3] The various types of MO can be classified into one of several categories based on etiology: myositis ossificans traumatica, pseudomalignant myositis ossificans, and myositis ossificans progressiva.[4] Of the various types of MO, myositis ossificans traumatica will be discussed primarily.

Myositis ossificans traumatica (MOT) is the most common form of HO, comprising of 60-75% of all documented cases, occurring typically with repetitive soft tissue injury, fracture, burns, surgery, or direct muscular/soft tissue trauma usually incurred with sports.[5] It has the highest rate of incidence among adolescents and young adults, with males affected more often than females.[6] Areas of the body that have an increased susceptibility at developing MOT include large muscle groups of the thigh and upper arms.[1] Early clinical presentations (within first 2-4 weeks) of MOT involve localized pain, swelling, and decreased range of motion (ROM) of the involved joints. However, these findings often mimic other conditions such as intramuscular hemorrhage or hematoma, deep venous thrombosis, cellulitis, osteomyelitis, or acute arthritis. In patients with factor VIII hemophilia, the likelihood of developing recurrent soft tissue bleeds or experiencing intramuscular hemorrhage is highly reported, while there is little literature to substantiate the potential development of MOT.[1,7-8]

Differentially diagnosing MOT in a patient that has clotting factor VIII deficiency is very difficult to do in the acute phases of the injury. Diagnostic testing often does not reveal

MOT early on and radiographic changes are not detectable until days to weeks after the date of the initial injury.[9] In addition, patients with factor VIII hemophilia traditionally undergo prophylactic treatments consisting of clotting factor infusions, which may mask the initial signs and symptoms of MOT. Therefore, it is not uncommon for patients with hemophilia to be diagnosed with either intramuscular hemorrhage or hematoma as opposed to MOT.[1] As the disorder progresses and matures (approximately 3-12 weeks after injury), localized pain and swelling may diminish. However, the patient may continue to experience a loss in ROM of the affected joints, which subsequently affects their daily function. Radiographic imaging and diagnostic testing at this time may suggest the formation of MOT. Along with experiencing dramatic functional limitations, the patient may also report the presence of a palpable mass at the initial site of injury or trauma, typically without tenderness to palpation.[9]

Depending on when the patient is seen in the clinic and the stage of MOT, there are several treatment options available. During the acute phase of injury, it is recommended that the RICE principle of rest, ice, compression, and elevation be applied to the affected limb. The patient's physician may also prescribe non-steroidal anti-inflammatory drugs (NSAIDs) to be taken in conjunction with the RICE principle to alleviate any pain and swelling. The literature also suggests that heat, massage, stretching, exercise, and continuous ultrasound be avoided during the early stages of injury to prevent further bleeding to the injured area.[1,6,10-14] If the condition progresses, the patient may slowly initiate ROM/strengthening program within physical therapy, provided that they are exercising within the pain free range. Along with this conservative treatment approach, several modalities including acetic acid iontophoresis and pulsed ultrasound may be applied to help decrease and promote reabsorption of the calcification.[10] If MOT is severe and all conservative approaches have

been exhausted, surgical excision of the ossification may need to be performed in order for the patient to regain their function. [1,10,12]

The interventions that were primarily implemented consisted of pulsed therapeutic ultrasound and therapeutic exercise. The rationale for using pulsed therapeutic ultrasound was to assist with the resolution of the recurrent left thigh bleed, while therapeutic exercises were performed to improve knee ROM and lower extremity (LE) strength, specifically the quadriceps muscle group. The patient's physician approved these interventions, as she opted for a more conservative approach during the patient's initial phase of rehabilitation. The purpose of this case report is multidimensional: to investigate the clinical signs and symptoms related to MOT in a patient with factor VIII hemophilia; to determine whether or not a patient diagnosed with hemophilia is predisposed to develop MOT; and to identify the most appropriate and effective treatment options for MOT. The Institutional Review Board at The Sage Colleges in Troy, NY has approved this research.

CASE DESCRIPTION

The patient is a 16 year-old full-time high school student that lives at home with his biological parents, younger brother, and pet dog. He is a very active teenager that enjoys playing sports, participating in numerous outdoor activities, attending summer camp, and spending time with his friends and family. The patient was referred to physical therapy by his physician with a diagnosis of recurrent left thigh bleed, with the potential for MOT formation; a diagnosis that is complicated by the patient's longstanding history of factor VIII hemophilia. The referring prescription for physical therapy read, "Physical therapy evaluation and treatment for recurrent left thigh bleed." The patient was seen in an outpatient

orthopedic setting as a new client, approximately 12 weeks after the date of his initial injury. He was evaluated by a student physical therapist (SPT) along with the supervising physical therapist (PT).

Examination:

The patient reported that he incurred an injury while playing basketball with his friends. He stated that he was "kneed in his [left] thigh." The patient continued to play basketball and a few hours later applied ice to his left thigh. A couple of days after his initial injury, the patient saw his hematologist because he had noticed a significant amount of bruising at the site of injury. According to the patient's mother, a diagnostic ultrasound was performed which detected a fairly large hematoma over the patient's anterior left thigh, measuring approximately 3" x 1" (length x width). The hematologist ran a course of infusion treatments and the patient noted an improvement with pain very soon thereafter. However, nearly ten weeks after his injury, the patient began to have difficulty bending his left knee. The patient reported that his symptoms appeared to come on suddenly and had progressively worsened within a time span of five days. The patient revisited his hematologist for another course of infusion treatments.

During his initial evaluation (approximately 12 weeks after the initial injury) the patient complained of having pain that occurred intermittently with knee flexion, which was rated as a "2-3" out of 10 on the visual analog scale (VAS), a reliable and valid pain assessment tool.[15] Refer to Figure 1 for an illustration of where the patient complained of having pain. He likened his pain and discomfort as "stiffness." The patient noted that his pain increased with activities such as bending, squatting, and walking; and decreased (or felt less stiff) after infusion treatments. The patient reported having numbness and weakness in his

left LE and occasionally experienced a "buckling" sensation in his left knee during ambulation. In addition, difficulties with walking were compounded by numbness and tingling felt at the dorsal aspect of his left foot, increased LE stiffness, and decreased left knee flexion; all of which resulted in an antalgic gait pattern.

Upon examination by the SPT, the patient presented with visible ecchymosis located at the anterior proximal one-third aspect of the left thigh. The patient also presented with three fairly large greenish-yellow bruises located at the lateral distal aspect of the left thigh near the knee. During palpation, there was increased warmness noted (as compared to the right LE) at the anterior proximal one-third aspect of the left thigh along with a well-defined palpable "mass." Refer to Table 1A for circumferential measurements of left thigh girth. The patient denied tenderness to palpation in this region, however, noted an increase in pain and discomfort with active and passive knee flexion. Sensation to light touch was intact for all dermatomes of the lower extremity bilaterally.

During the gait assessment, the patient was able to ambulate functional distances independently without the use of an assistive device. However, the patient presented with a highly antalgic gait; exhibiting decreased left knee flexion during the swing phase of gait as well as decreased stance time and weight bearing on the left LE during ambulation. Examination of the patient's LE strength revealed atrophy or decreased muscle definition of the left vastus medialis oblique (VMO) and rectus femoris (RF) muscles during a quadriceps set. A positive extensor lag was observed with a supine straight leg raise into hip flexion. Manual muscle testing (MMT) of the left quadriceps and hamstrings indicated significant weakness compared to his right LE. Left quadriceps (knee extension) was graded as a 2+ to 3– out of 5 and left hamstrings (knee flexion) was graded as a 2+ out of 5, while right

quadriceps and hamstrings were graded as a 5 out of 5.[16] Assessment of left LE active range of motion (AROM) of flexion and extension revealed significant limitations of flexion to 62˚ and extension to 2˚ as assessed in sitting.[17] However, left knee flexion improved to 90˚ after the patient completed eight minutes of exercise on the Nu-Step recumbent stepper at a resistance level of one. Right LE AROM of flexion and extension was within normal limits (WNL).[17] Reflex testing of the lower extremities was not performed.

In order to measure the patient's functional capabilities, the Lower Extremity Functional Scale (LEFS) was administered. The LEFS is a 20-item self-questionnaire that rates the patient's level of difficulty with various household tasks or activities of daily living (ADLs) as it relates to a lower limb(s) problem. The LEFS has been found to have high test-retest reliability and is sensitive in detecting functional impairments in individuals with LE issues. The LEFS has a maximum score of 80 points, which indicates "no difficulty" with any of the functional tasks listed. The lower the score, the greater the level of disability.[18] The patient completed the LEFS prior to therapy and obtained a score of 33/80 indicating fairly significant functional limitations.[18] Refer to Figure 2 for a visual representation of the patient's level of difficulty ratings.

Items that the patient rated as having extreme difficulty with or was not able to perform included: usual hobbies, recreational, or sporting activities; squatting; walking a mile; running on even ground; running on uneven ground; and making sharp turns while running fast. Items that the patient rated as having quite a bit of difficulty performing involved putting on shoes and socks. Items that the patient rated as having moderate difficulty performing included: any usual work, housework, or school activities; getting in or out of the bath; light activities around home; heavy activities around home; getting into or

out of the car; going up and down a flight of stairs; sitting for one hour; and rolling over in bed. Items that the patient rated as having a little bit of difficulty performing included: walking between rooms; lifting an object, like a heavy bag of groceries from the floor; walking two blocks; and hopping. Lastly, the item that the patient rated as having no difficulty performing consisted of standing for one hour.[18] Overall, the patient reported having more functional impairments with higher-level activities and activities of daily living (ADLs).

Evaluation:

The patient presented with the following body structures and functions, activity limitations, and participation restrictions: increased left thigh pain (2-3/10), decreased left knee passive and active ROM (2˚- 62˚), decreased left quadriceps strength (2+ to 3-/5), decreased left hamstrings strength (2+/5), increased circumferential girth of left proximal thigh, decreased muscle bulk of left thigh distally, decreased weight bearing and stance time on left LE, decreased efficiency with ambulation, decreased ability to negotiate stairs, decreased function with ADLs, and decreased ability to play sports.

Diagnosis:

The physical therapy diagnosis for this patient fit the inclusion criteria for Preferred Practice Pattern – Musculoskeletal 4E: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Localized Inflammation.[19]

Prognosis:

The patient was alert and oriented in time, person, and place (A x O x 3) and was able to follow verbal, written, and auditory instruction. The patient's prognosis for functional recovery of left LE strength, ROM, ambulatory status, and independence with ADLs was

good as it related to his age, general health status, motivation, and activity level. The patient was a good candidate for outpatient physical therapy services in combination with a comprehensive home exercise program (HEP).

Patient Goals:

The patient's goals for physical therapy were to decrease left knee stiffness, increase left knee ROM, and return to normal activities including sports.

Short-Term Goals: (2 weeks)

Physical therapy goals were established and documented during the initial evaluation. Short-term goals that were to be met within 2 weeks were as follows:

1. Patient will be independent with HEP.
2. Patient will increase left knee AROM by 15 degrees without discomfort.
3. Patient will increase left LE strength to 4/5 without pain.
4. Patient will demonstrate a decrease in antalgic gait without an assistive device as measured by PT observation.

Long-term Goals: (4-6 weeks)

Physical therapy goals were established and documented during the initial evaluation. Long-term goals that were to be met within 4-6 weeks were as follows:

1. Patient will increase left knee AROM to within functional limits without discomfort so that he can safely ride his bike.
2. Patient will increase left LE strength to $\geq$ 4+/5 so that he can safely negotiate stairs.
3. Patient's left thigh girth will decrease by 0.5 cm to facilitate more efficient gait.

Plan of Care:

The patient was seen twice a week for 30-45 minute sessions, for a period of 6 weeks in order to meet the established goals. Planned interventions consisted of modalities (acetic acid iontophoresis and therapeutic pulsed ultrasound per MD approval); gentle passive range of motion (PROM), gentle active assisted range of motion (AAROM), gentle active range of motion (AROM) all within the pain-free range; therapeutic exercise; patient education; home exercise program (HEP); and moist heat and/or cold pack as needed.

INTERVENTIONS

The patient was seen for a total of nine visits over the course of six-and-a-half weeks. Treatment sessions generally consisted of pulsed therapeutic ultrasound combined with therapeutic exercises. During the patient's first visit, a thorough history was taken and a comprehensive examination was performed. Upon completion of the evaluation, the patient began his treatment program. The patient's initial treatment session was modest due to time constraints and consisted of therapeutic exercises. To warm up, the patient completed eight minutes of exercise on the Nu-Step recumbent stepper at a resistance level of one (lowest possible). Afterwards, the patient performed isometric and ROM exercises in supine and sitting. Isometric exercises included: left hip adduction with a soft pillow in the hook lying position; and left quadriceps sets in long sitting. The patient completed five (5) repetitions of each exercise with a hold time of five (5) seconds for each repetition. ROM exercises that the patient performed during his initial visit included: AAROM heel slides of the left LE with a towel in long sitting; and AAROM of left knee flexion/extension in sitting with the right LE assisting. The patient completed five (5) repetitions of each exercise, along with a five (5)

second hold for each repetition of the heel slide exercise. The patient completed all exercises appropriately within the pain free range and received occasional verbal cuing from the student physical therapist to correct form and maintain adequate hold time. Additionally, the patient was given a written home exercise program (HEP), which contained the same four exercises that he had completed during his initial visit. The patient was instructed to complete his HEP on a daily basis, eventually building up his activity tolerance so that he could perform the HEP twice per day. Refer to Figure 3 for HEP. Pulsed ultrasound was not performed during the patient's initial visit, as the patient's physician had not yet approved treatment modalities.

Following the patient's initial visit, the supervising physical therapist made contact with the patient's physician, and received approval to administer pulsed ultrasound as an initial treatment modality. The physician specified that in the event the patient did not make any progress using pulsed ultrasound, acetic acid iontophoresis may be used instead. Therefore, pulsed ultrasound was administered at the patient's next visit, and all subsequent visits, as the patient did in fact make excellent progress throughout the course of therapy. Pulsed ultrasound was administered for a total of eight treatment sessions, prior to the completion of therapeutic exercises.

Therapeutic pulsed ultrasound was applied to the proximal anterolateral aspect of the left thigh, with the patient in supine. Towels were draped at the proximal thigh region (near the groin) and distally (near the knee). Warm ultrasound gel was used as the coupling agent and was placed directly over the region of the palpable mass. The parameters for pulsed ultrasound consisted of: 50% duty cycle, 3.3MHz, 1.0 W/cm^2, 5 cm^2 sound head, for a treatment time of 8 minutes. Pulsed therapeutic ultrasound at a 1:1 duty cycle at 50% was

selected for its non-thermal effects to facilitate tissue healing and reabsorption of the hematoma. A frequency of 3.3 MHz was used to target the hematoma superficially to a depth of 1-2 cm, without affecting the deeper tissues and structures. An intensity of 1.0 W/cm^2 was selected to assist with tissue healing beyond the acute phase of injury. The sound head size of 5 cm^2 was the standard size available and was used as a moving applicator over the region of the palpable mass. The sound head maintained contact with the ultrasound gel for the entire duration of the treatment, moving in a clockwise and counterclockwise fashion. A treatment time of 8 minutes was necessitated in order to cover an effective radiating area (ERA) twice the size of the sound head.[21] Pulsed ultrasound parameters remained consistent throughout the entire treatment program.

At visit #2, four additional exercises were included in the treatment program. The treatment session began with the application of therapeutic pulsed ultrasound followed by eight minutes of cardiovascular exercise on the Nu-Step recumbent stepper at resistance level one. All previous isometric and ROM exercises were once again performed, at an increased number of repetitions (10 repetitions). The added exercises consisted of 10 repetitions of: standing marches, standing hip abduction, standing hamstring curls, and bilateral heel raises. The additional exercises contributed to the patient's left LE flexibility and strengthening program.

Visit #3 followed the usual progression: pulsed ultrasound, cardiovascular exercise on the Nu-Step (at increased duration of 10 minutes), ROM exercises, isometric exercises, and standing exercises. Following the completion of the modality and all therapeutic exercises, one final strengthening exercise was added to the treatment program. The remaining exercise was especially difficult for the patient to perform, as it required strong

recruitment of the quadriceps muscle group. The added exercise was a supine straight leg raise (of left LE) into hip flexion. The patient was able to perform 10 repetitions of the straight leg raise, however had a challenging time in maintaining proper form. The patient exhibited a significant extensor lag as he lifted his left LE off of the mat. The patient also noted a slight increase in discomfort over the anterior aspect of his left thigh during the straight leg raise.

As the patient continued with his treatment plan, he made noticeable improvements with pain, form, flexibility, and strength. The patient reported a decrease in pain or stiffness, completed exercises with a decreased amount of verbal cuing, demonstrated improved tolerance to increased exercise intensity, and exhibited tremendous gains with left knee ROM. The treatment plan was progressed continuously with regards to the number of repetitions for ROM, isometric, and strengthening exercises; and increased resistance on the Nu-Step recumbent stepper. Refer to Table 2 for methods of intervention. Along with his treatment program inside the clinic, the patient verified completion of the HEP on a daily basis.

After approximately four weeks of therapy, a progress report was sent to the patient's physician. The progress report described in detail the patient's progress toward goals, along with a description of the goals he had already met. At this point, the patient was still working toward goals involving ROM, strengthening, and pain. Goals that were met included improved function with ADLs and independent performance with HEP. The progress report also listed all treatment options that the patient had received up to date (modalities – pulsed ultrasound, therapeutic exercise, HEP instruction, and patient/family education) along with objective findings of left knee ROM, circumferential girth, and

palpable mass measurements. Once the patient's physician reviewed the progress report, the prescription for physical therapy was renewed so that the patient could continue to work toward his goals.

Nearly two weeks later, after the progress report had been written and reviewed, the patient met all of his goals. The patient no longer complained of pain or stiffness. Left knee ROM was measured within normal limits. Left quadriceps and hamstrings strength also measured within normal limits. Circumferential girth measurements and palpable mass measurements revealed a fairly large decrease in mass size. The patient no longer exhibited an antalgic gait and was functionally independent with all ADLs. Considering the nature of the patient's progress and achievement of all established goals, the patient was discharged from physical therapy services.

OUTCOMES

The patient responded well to therapy as noted by meeting all four short-term goals and all three long-term goals. The patient also made considerable gains in left knee AROM, without any complaints of pain. Refer to Table 3 for left knee AROM measurements. The "palpable mass" also decreased in size throughout the course of therapy, resulting in a decrease in left thigh girth. Refer to Table 1B for left thigh girth measurements during therapy. The patient was now able to perform a straight leg raise into hip flexion without the presence of an extensor lag. Palpable mass measurements were completed informally by measuring the widest aspects of the mass both horizontally and vertically; similar to completing a wound assessment/measurement.[20] This was done by palpating the edges or borders of the well-defined firm mass, located at the proximal anterolateral aspect of

the patient's left thigh. The borders of the mass were then demarcated on the patient's skin. The widest aspects of the mass were measured vertically (from 12 o'clock to 6 o'clock) and horizontally (from 9 o'clock to 3 o'clock). Please refer to Table 4 for palpable mass measurements to note the decrease in size throughout the course of therapy. MMT of left knee flexion and extension revealed that quadriceps and hamstrings strength had improved to WNL.[16]

As therapy progressed, the patient exhibited a decrease in antalgic gait. Toward the end of his treatment, the patient demonstrated symmetrical weight bearing between the right and left lower extremities, along with equal step length, stride length, stance time, swing time, and within functional ROM of right and left lower extremities during gait. The patient was eventually able to ambulate independently and efficiently without the presence of an antalgic gait. Once all goals were met, the LEFS was administered again. The patient obtained a score of 80/80, indicating that he achieved a maximum level of functional ability.[18] Refer to Figure 2 for a comparison of LEFS scores before and after therapy. Overall, the patient was able to achieve all of his goals with excellent results within a relatively short period of time (6 weeks).

DISCUSSION

The purpose of this case report was to investigate the clinical signs and symptoms related to heterotopic ossification (HO) or more specifically myositis ossificans traumatica (MOT) in a patient with factor VIII hemophilia; to determine whether or not the patient with hemophilia had an increased predisposition to develop MOT; and to identify the most appropriate and effective treatment options for MOT. The patient discussed in this case

report was referred to an outpatient physical therapy setting for the treatment of a recurrent left thigh bleed. The patient presented with increased pain over the anterior aspect of his left thigh during active and passive ROM; visible bruising and ecchymosis observed in various regions over the anteromedial, anterior, and anterolateral aspects of the left thigh; decreased ROM of left knee flexion and extension; and a firm, well-defined palpable mass located over the anterior aspect of the left rectus femoris muscle centrally. All of the clinical signs and symptoms that the patient reported during his physical therapy evaluation occurred nearly three months after his initial sports related injury.

According to the literature review conducted by Smith et al. (2006), there are two major types of hematomas that may occur following a direct impact injury or muscle tear/rupture. The first type of muscle hematoma is known as an intramuscular hematoma. Intramuscular hematomas involve an increase of intramuscular pressure at the site of injury, in which the bleed is confined within the muscle sheath or fascia, thereby compressing the capillary beds. The muscle sheath and fascia remain intact. Signs and symptoms of an intramuscular hematoma are relatively localized and include swelling, pain, and tenderness, loss of muscle contractility and extensibility, and bruising. Most symptoms usually occur within the first 48–72 hours. The second type of muscle hematoma is known as an intermuscular hematoma. Intermuscular hematomas usually involve torn muscle or fascia, which allows for the bleed to spread between the muscle and fascia. Signs and symptoms of intermuscular hematomas include significant swelling (that is usually distal to the site of injury as a result of gravity forces acting upon it), dramatic bruising, and pain. However, the major difference between the clinical signs and symptoms of an intramuscular hematoma and

an intermuscular hematoma is that patients with an intermuscular hematoma generally report decreased pain within the first 24 hours after injury.[11]

Despite the fact that muscle contusion injuries resolve fairly quickly and uneventfully, complications may still arise. One of the most serious and common complications of muscle hematomas is the development of MOT, especially in patients that have had intramuscular hematomas. The clinical signs and symptoms associated with MOT include tenderness, swelling, muscle hardening detected by palpation, and radiological evidence of a calcification (usually 2–8 weeks after injury).[10] Considering that the patient studied experienced symptoms similar to that of an intramuscular hematoma during the acute phases of his injury and developed subsequent symptoms nearly three months later, it may be possible that the patient had developed MOT. Additionally, the literature suggests that in patients with hemophilia, muscle hemorrhages present in a localized fashion that may form a mass.[7] However, the patient did not have radiological exams performed. Therefore, it is difficult to conclude without a doubt that the patient had developed MOT.

For the purposes of this case report, a comprehensive search of the literature was performed to determine what the most efficacious treatment options are for MOT. Electronic search engines such as PubMed, CINAHL, Elsevier Science Direct, and Google Scholar were all used. Key words and phrases included in the search were “myositis ossificans,” “heterotopic ossification,” “treatment of myositis ossificans,” “treatment of heterotopic ossification,” “therapeutic ultrasound and myositis ossificans,” “ultrasound and myositis ossificans,” “therapeutic ultrasound and heterotopic ossification,” “ultrasound and heterotopic ossification,” “ultrasound and exercise for myositis ossificans,” “ultrasound and exercise for heterotopic ossification,” “pulsed ultrasound and therapeutic exercise for

myositis ossificans," "pulsed ultrasound and therapeutic exercise for heterotopic ossification," "physical therapy and myositis ossificans," "physical therapy and heterotopic ossification," "myositis ossificans and hemophilia," and "heterotopic ossification and hemophilia." Journal articles that were primarily referenced in this case report involved literature reviews and case reports of treatment options for patients that clinically present with muscle hematomas, MOT, or HO. Treatment options that were discussed typically consisted of rest, ice, compression, elevation, NSAIDs, and conservative treatment via physical therapy.[1,6,10-14] Several of the journal articles also made inferences between hemophilia and the increased likelihood of developing myositis ossificans.[1,7-8]

The patient in this case received a conservative treatment approach consisting of therapeutic exercises; gentle active assisted range of motion (AAROM) and active range of motion (AROM) within the pain free range; along with pulsed ultrasound. According to the case report written by Wieder (1992), acetic acid iontophoresis in combination with therapeutic ultrasound and gentle passive range of motion (PROM) is the most effective treatment option to address calcium reabsorption related to MOT. However, the patient's physician approved pulsed ultrasound as the initial treatment modality along with therapeutic exercises. The treatment method for the patient was unique due to the fact that the literature did not provide consistent evidence pertaining to the sole use of therapeutic ultrasound for the resolution of MOT or HO. The physician felt that pulsed ultrasound would be a good initial treatment choice. If the patient did not respond favorably to the pulsed ultrasound, the physician would then consider using acetic acid iontophoresis. Therefore, pulsed ultrasound (50% duty cycle, 3.3 MHz, 1.0 W/cm^2) was administered for 8 minutes over the palpable mass to assist with tissue healing and hematoma absorption.[21] Though the efficacy of

therapeutic ultrasound remains unclear based on the literature, with some studies yielding promising results and others reporting no significant benefits for the management of muscle hematomas,[11] the patient was able to achieve excellent outcomes. In this circumstance, therapeutic ultrasound seemed to be an effective treatment option. However, the benefits of ultrasound continue to be difficult to determine, as it was not administered in isolation, but rather was used in combination with therapeutic exercise to treat a probable case of MOT.

The literature also had little supporting evidence regarding the link between hemophilia and MOT.[1,7-8] It was unclear as to whether individuals with hemophilia have a definite increased risk of developing MOT from mild-moderate injuries. Other areas in which the research lacked evidence pertained to quality of life (QOL) measures among patients with hemophilia and/or MOT. Therefore, further research needs to be conducted in this area. Topics for future research studies may include: screening of individuals with hemophilia and the incidence of developing MOT among them; risk factors associated with developing MOT within the hemophilia patient population; QOL measures among patients with hemophilia that have also developed MOT; reliability and validity of the LEFS for MOT; standardized measurement tools for palpable masses; and MOT education/prevention strategies among patients with hemophilia.

Other limitations of this case report typically involved inconsistencies with objectives measures. As noted in the Tables section, measurements were not taken during each visit, making it difficult to determine the exact level of progress the patient made on a weekly basis. Additionally, issues of human error contributed to objective measure inconsistencies. Examples of human error included: incorrectly lining up the goniometer with the joint axis and/or reference points; incorrectly reading the goniometric measurement;

difficulty stabilizing the tape measure for girth measurements; and difficulty objectively defining "palpable mass" borders. Lastly, subjective differences in QOL perception and ADL performance between the patient and the patient's caregivers (biological parents) may also be viewed as a limitation of this case report. The patient's caregivers reported conflicting information regarding the patient's QOL. The caregivers viewed or perceived the patient as having increased difficulty performing ADLs, thereby resulting in lower health satisfaction/QOL; more so than what the patient perceived. However, the caregivers' perceptions were not measured and compared with the patient's perceptions using a standardized tool or scale, making it difficult to compare differences in QOL perception and health satisfaction. Only the LEFS was used on behalf of the patient. Nonetheless, administration of the LEFS improved the patient's overall plan of care. The patient was able to make tremendous progress during his time in physical therapy, with the establishment of specific functional goals. Within six weeks, the patient became functionally independent, regained full ROM and strength in his left LE, and was able to return to normal activities including recreational hobbies and sports.

CONCLUSION

Though the patient achieved good results with the interventions used, it is not entirely clear as to whether the patient truly had MOT. However, based on the patient's clinical signs and symptoms, mechanism of injury, and symptom progression; it is probable that the patient did in fact experience MOT. In order to properly diagnose a patient with MOT, radiographs must be taken to clearly identify the presence of abnormal calcification within the muscle tissue. For the treatment of MOT, the literature supports the use of acetic

acid iontophoresis to promote calcium reabsorption.[10] Despite this information, the patient's physician felt that a more conservative approach was appropriate, and opted to have the patient treated with pulsed ultrasound. Though the efficacy of therapeutic ultrasound to promote tissue healing has been largely criticized and disputed[11], the patient's palpable mass decreased significantly and his ROM was restored. Whether the patient's mass decreased in size as a direct result of the pulsed ultrasound or therapeutic exercises or a combination of both remains unclear. Regardless of the exact mechanism of action, the patient made tremendous progress within a relatively short period of time. Further research needs to be conducted that investigates the efficacy of pulsed ultrasound and therapeutic exercise for the treatment of MOT, compared with other treatment options consisting of acetic acid iontophoresis and/or surgical excision. These studies are essential for clinicians, so that the most beneficial and cost effective treatment options are used.

REFERENCES

1. Massey GV, Kuhn JG, Nogi J, Spottswood SE, Narla LD, Dunn NL, Russell EC. Case report: the spectrum of myositis ossificans in haemophilia. *Haemophilia*. 2004;10(2):189-193.

2. Goodman CC, Fuller KS, Boissonnault WG. *Pathology: Implications for the Physical Therapist*. 2nd ed. Philadelphia, PA: Saunders; 2003:1078.

3. Moore DS, Cho G. Heterotopic ossification. *eMedicine Radiology*. November 06, 2007.

4. Clements NC Jr, Camilli AE. Heterotopic ossification complicating critical illness. *Chest*. 1003;104(5):1526-1528.

5. Person DA, Pattekar MA. Myositis ossificans. *eMedicine Pediatrics*. July 17, 2006.

6. Beiner JM, Jokl P. Muscle contusion injury and myositis ossificans traumatica. *Clin Orthop Relat Res*. 2002;403(suppl):S110-S119.

7. Coblentz CL, Cockshott WP, Martin RF. Resolution of myositis ossificans in a hemophiliac. *J Can Assoc Radiol*. 1985;36(2):161-162.

8. Gindele A, Schwamborn D, Tsironis K, Benz-Bohm G. Myositis ossificans traumatica in young children: report of three cases and review of the literature. *Pediatr Radiol*. 2000;30(7):451-459.

9. Shehab D, Elgazzar AH, Collier BD. Heterotopic ossification. *J Nucl Med*. 2002;43(3):346-353.

10. Wieder DL. Treatment of traumatic myositis ossificans with acetic acid iontophoresis. *Phys Ther*. 1992;72(2):133-137.

11. Smith TO, Hunt NJ, Wood SJ. The physiotherapy management of muscle haematomas. *Phys Ther Sport*. 2006;7(4):201-209.

12. Miller AE, Davis BA, Beckley OA. Bilateral and recurrent myositis ossificans in the athlete: a case report and review of treatment options. *Arch Phys Med Rehabil*. 2006;87(2):286-290.

13. Webner D, Huffman R, Sennett BJ. Myositis ossificans traumatica in a recreational marathon runner. *Curr Sports Med Rep*. 2007;6(6):351-353.

14. Sodl JF, Bassora R, Huffman GR, Keenan MAE. Case report: traumatic myositis ossificans as a result of college fraternity hazing. *Clin Orthop Relat Res*. 2008;466(1):225-230.

15. Summers S. Evidence-based practice part 2: reliability and validity of selected acute pain instruments. *J Perianesth Nurs*. 2001;16(1):35-40

16. Hislop HJ, Montgomery J. *Daniels and Worthingham's Muscle Testing: Techniques of Manual Examination*. 8th ed. St. Louis, MO: Saunders Elsevier; 2007:216-225.

17. Reese NB, Bandy WD. *Joint Range of Motion and Muscle Length Testing*. 1st ed. Philadelphia, PA: Saunders; 2002:301-306.

18. Binkley J, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. *Phys Ther*. 1999;79(4):371-383.

19. *Guide to Physical Therapist Practice*. 2nd ed. Alexandria, VA: American Physical Therapy Association; 2003:197-213.

20. Sussman C, Bates-Jensen B. *Wound Care: A Collaborative Practice Manual for Health Professionals*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2007:128.

21. Sparrow KJ. Therapeutic Ultrasound. In: Michlovitz S. Nolan TP Jr. *Modalities for Therapeutic Intervention*. 4th ed. Philadelphia, PA: F.A. Davis Company; 2005:79-96.

22. Pain Diagram page. Mind Body Medicine Web site. http://www.mindbodymedicine.com/PainDiagram.html. Accessed September 1, 2009.

23. How to Treat Your Knee Pain page. eHow Web site. http://www.ehow.com/how_4563327_treat-knee-pain.html. Accessed April 17, 2010.

24. Postoperative Exercises for the Knee Page. UK Orthopaedic Surgery & Sports Medicine Web site. http://ukhealthcare.uky.edu/cartilage/postop_care/knee_exercises.htm. Accessed April 17, 2010.

25. Patellofemoral Pain Syndrome page. MD Consult Web site. http://www.mdconsult.com/das/patient/body/197275636-2/0/10062/15543.html. Accessed April 17, 2010.

26. Goodman RJ, Reinbold KA, Iglarsh A, Neustadter LM, Oatis CA, Schumacher R. Phase I design and evaluation of an isometric muscle reeducation device for knee osteoarthritis rehabilitation. *J Rehabil Res Dev*. 2003;40(2):95-108.

TABLES

Table 1A. Circumferential Measurements of Thigh Girth (Initial Evaluation)

Reference Point: Midpatella	*Right Lower Extremity (cm)*	*Left Lower Extremity (cm)*
3" above	38.0	39.5
6" above	43.0	45.0
8.5" above	49.0	50.5
10.5" above	51.0	52.0

*Table 1B. Circumferential Measurements of **Left** Thigh Girth in Centimeters (cm)*

Reference Point: Midpatella	*Visit 4*	*Visit 7*	*Visit 8*
3" above	38.0	*	*
6" above	43.5	*	*
8.5" above	48.5	49.0	48.5
10.5" above	50.0	51.5	50.0

** = Not measured as mass was no longer palpable in this region.*

Table 2. Methods of Intervention

INTERVENTION	*VISIT 1 (INITIAL EVALUATION)*	*VISIT 2*	*VISIT 3*	*VISIT 4*	*VISIT 5*	*VISIT 6*	*VISIT 7*	*VISIT 8*	*VISIT 9*
Nu-Step Recumbent Stepper	*	➞	D	➞	R	➞	R	R	➞
Isometric Hip Adduction with Pillow	*	↑	➞	↑	➞	➞	↑	➞	➞
Quad Sets	*	↑	➞	↑	➞	➞	↑	➞	➞
Straight Leg Raises: Hip Flexion			*	↑	➞	↑	➞	↑	➞
AAROM Knee Flexion with Towel	*	↑	➞	↑	➞	➞	↑	➞	➞
AAROM Knee Flexion & Extension	*	↑	➞	↑	➞	↑	➞	↑	➞
Standing Marches		*	➞	↑	➞	↑	➞	➞	➞
Standing Hip Abduction		*	➞	↑	↑	➞	➞	➞	➞
Standing Hamstring Curls		*	➞	↑	➞	↑	➞	➞	➞
Standing Bilateral Heel Raises		*	➞	↑	➞	↑	➞	➞	➞
Pulsed Ultrasound	Awaiting MD approval	50% duty cycle, 3.3 MHz, 1.0 w/cm^2 for 8 minutes	➞	➞	➞	➞	➞	➞	➞

Key:

Started Treatment	Increased Resistance	Increased Duration	Increased Repetitions	Continued Treatment
*	R	D	↑	➞

Table 3. Left Knee AROM[17]

Visit	*Extension*	*Flexion*
1	2˚	62˚
3	*	80˚
4	*	115˚
5	*	115˚
6	3˚	125˚
7	1˚	130˚
8	0˚	140˚

* = *Not measured.*

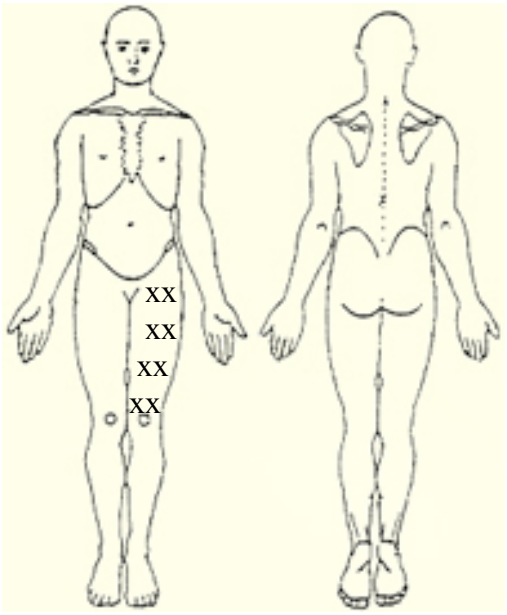
Table 4. Palpable Mass[20]

Visit	*12 o'clock to 6 o'clock (cm)*	*9 o'clock to 3 o'clock (cm)*
4	8.5	8.5
6	5	6
7	5	3.5
8	*	*

* = *Not measured due to indiscernible borders via palpation.*

FIGURES

Figure 1. Body Diagram of Pain Location[22]



Pain depicted by "x" marks located at anterior aspect of left thigh.

Figure 2. LEFS Comparison of Before & After

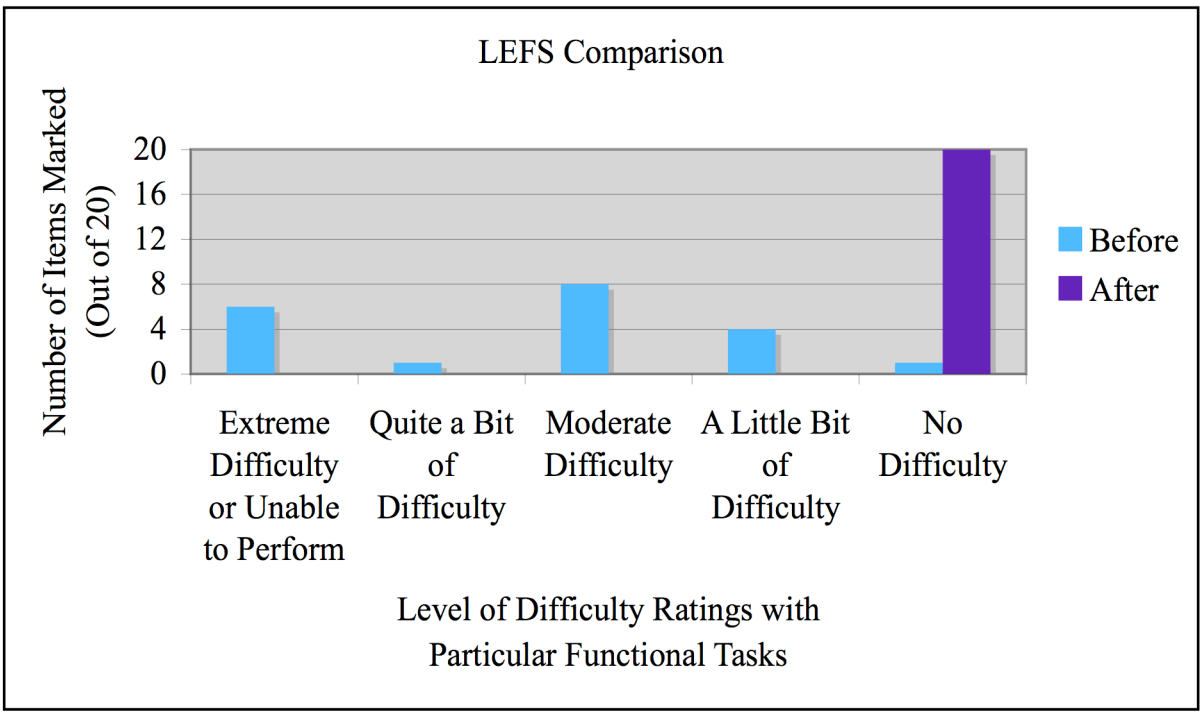
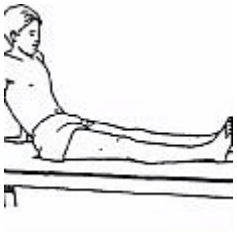


Figure 3. Home Exercise Program (HEP)

Quadriceps Set[23]

Tighten muscles on top of left thigh by pushing knee down into surface. Hold 5 seconds. Repeat 10 times. Do 2 sessions per day.



AAROM: Heel Slides with Towel[24]

With towel around left heel, gently pull knee up with towel until stretch is felt. Hold 5 seconds. Repeat 10 times per set. Do 1 set per session. Do 2 sessions per day.

Isometric Hip Adduction[25]

With a ball or folded pillow between knees, squeeze knees together. Hold 5 seconds. Repeat 10 times per set. Do 1 set per session. Do 2 sessions per day.

AAROM Knee Flexion & Extension[26]

Cross legs at ankles. With right leg in front, push left leg back (to bend left knee) until stretch is felt. Relax. Recross ankles. With right leg in back, lift left leg with right leg, straightening it. Repeat set 10 times. Do 2 sessions per day.