2023

Treatment of Posterior Tibial Tendon Dysfunction: A Case Study

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TREATMENT OF POSTERIOR TIBIAL TENDON DYSFUNCTION: A CASE STUDY

by

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Bachelor of Science in Athletic Training, University of Nebraska – Lincoln, 2020

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine & Health Sciences

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota

May

2023

This Scholarly Project, submitted by Baylee Reiser in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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Date 4/13/2023

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ACKNOWLEDGEMENTS

I would first like to thank my classmates (Nicholas Hatfield and Isaac Scott) for their insights in peer review. I would additionally like to thank Scholarly Project Advisor, Ricky Morgan, PT, DPT, OCS, Cert. MDT. His guidance and input were instrumental in the development of a thorough and well-written case study. Lastly, I would like to thank my parents for their endless support throughout my education.

ABSTRACT

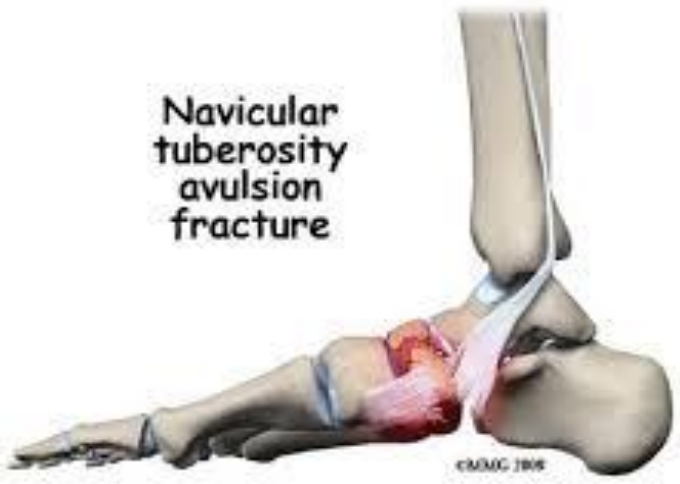
Background and Purpose. Posterior tibial tendon dysfunction (PTTD) is a progressive and debilitating disease that can lead to bony involvement or deformity. Common symptoms of PTTD include medial ankle and foot pain and acquired flat foot deformity. The purpose of this case study is to examine physical therapy interventions in a patient with chronic PTTD. **Case Description.** This case study describes the 15-week physical therapy management in an outpatient clinic for a 34-year-old female with unstaged PTTD presenting with pain, decreased range of motion, strength deficits and muscle imbalance, impaired balance, and impaired gait. The patient lived a very active lifestyle prior to treatment that had been negatively affected due to pathology. **Intervention.** The physical therapy treatment included stretching, strengthening, proprioceptive training, cold laser, ASTYM, rigid taping techniques, bracing, primal reflex release techniques (PRRT), and diaphragmatic breathing. **Outcomes.** Following physical therapy, the patient had improved strength and range of motion, as well as improved function with walking and fitness activities. The patient had an improved Focus on Therapeutic Outcomes (FOTO) score from 52/100 to 63/100. The patient did continue to have increased pain with prolonged standing, long-distance walking, and was not able to fully return to her prior level of function without pain. The patient was referred to podiatry due to a plateau in progress. The patient opted to pursue surgical intervention. **Discussion.** The patient's response to treatment and ultimate need for surgery was congruent with prognosis for Stage 2A PTTD and beyond. Future research is needed to determine the effect of specific interventions on each stage of PTTD.

CHAPTER I

BACKGROUND AND PURPOSE

An avulsion fracture of the navicular from excessive pull of the posterior tibialis tendon is a rare injury that occurs mostly in young athletes. This injury is typically caused by trauma, such as a fall. An illustration of this injury is shown in Figure 1 below.[1] Fractures of the navicular occur at the medial aspect and at the tuberosity from pulling of the posterior tibial tendon. Navicular fractures have a high risk of nonunion and osteonecrosis due to poor blood supply.[2] Failure to heal properly can cause dysfunction of the posterior tibialis that may become chronic.

Figure 1: Illustration of navicular tuberosity avulsion fracture.

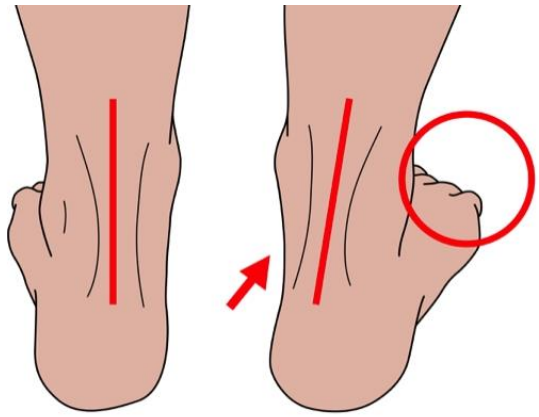


Repetitive stress is another cause of injury to the posterior tibialis. Dysfunction or insufficiency of the posterior tibial tendon is the leading cause of acquired flatfoot deformity.[3] Posterior tibial tendon dysfunction (PTTD) is a progressive and debilitating disease that can lead to bony involvement or deformity. The prevalence of PTTD has been reported to be anywhere between 3.3 to 15% but varies based on sex and age.[4,5] PTTD most commonly occurs in women, especially over the age of 40.[6] Risk factors may include hypertension, obesity, diabetes, previous trauma, and steroid exposure.[4]

The normal anatomical course of the posterior tibialis includes origin on the posterior proximal tibia, interosseous membrane, and proximal fibula. It runs through the deep posterior compartment of the leg vertically and turns to run horizontally at the medial malleolus.[7] The posterior tibialis inserts on the plantar medial midfoot, navicular tuberosity, and the sustentaculum tali.[5] The cause of PTTD may be due to the anatomical pathway of the posterior tibial tendon, as it makes an acute turn around the medial malleolus, causing a large amount of tension to be placed on the distal end of the tendon.[7] Additionally, abnormal anatomy may lead to PTTD. Other potential causes of PTTD include preexisting pes planus, degeneration associated with osteoarthritis, and compression from the flexor retinaculum.[7]

To the best of our knowledge, there is no diagnostic tool specific to PTTD and diagnosis occurs through thorough physical examination. Pes planus will be obvious in patients with PTTD and too many toes will be seen laterally upon posterior postural assessment due to valgus alignment.[7] See Figure 2 below for an illustration of the “too many toes” sign.[8] Dorsiflexion may be limited due to equinus contracture. An equinus contracture is defined as dorsiflexion of less than 5 degrees with the knee extended due to contracture of the gastrocnemius.[9]

Figure 2: Illustration of "too many toes" sign.



A single leg heel raise can be utilized for staging this condition. A stage 1 PTTD will be able to perform this test with no pain. Patients with stage 2 PTTD may be able to complete the test but will have pain. Later stages of PTTD may have a deformity that prevents them from completing the test. Imaging, including magnetic resonance imaging (MRI) and radiographs, can also aid in diagnoses.[7] Table 1 below outlines the stages of PTTD and the characteristics of each stage.

Table 1: Stages of PTTD and Associated Characteristics.[7]	
Stage 1	• Able to perform single leg heel raise • Mild tenosynovitis • Normal radiographs
Stage 2A	• Unable to perform single leg heel raise • Flexible flat foot deformity • Arch collapse on radiograph
Stage 2B	• Unable to perform single leg heel raise • Flexible flatfoot deformity • Forefoot abduction ("too many toes") • Arch collapse and talonavicular uncoverage over 40% on radiograph
Stage 3	• Unable to perform single leg heel raise • Flatfoot deformity with rigid forefoot abduction and hindfoot valgus • Subtalar on a radiograph
Stage 4	• Unable to perform single leg heel raise

Stage 4 (continued)	• Flatfoot deformity with rigid forefoot abduction and hindfoot valgus • Talar tilt due to deltoid ligament compromise • Valgus deformity of talus in the ankle mortise and subtalar arthritis on radiographs

Treatment of PTTD is dependent on staging of the pathology. All stages begin with conservative management, initially, which includes use of non-steroidal anti-inflammatory drugs (NSAIDs) and activity modification for up to 4 months. Stage 1 intervention includes immobilization for up to 4 weeks. An ankle foot orthotic (AFO) with emphasis on medial forefoot posting may also be required for continued management of symptoms.[7] Stage 2A treatment is surgical intervention if conservative management fails. This includes medial calcaneal osteotomy with posterior tendon debridement and repair. Additional procedures may also include flexor digitorum tendon transfer, spring ligament reconstruction, or Achilles tendon lengthening. Stage 2B includes the same intervention as stage 2A with the addition of lateral column lengthening or isolated joint arthrodesis.[5] Stage 3 warrants surgical intervention due to rearfoot arthritic changes, often a medial double arthrodesis or triple arthrodesis involving subtalar, calcaneocuboid, and talonavicular arthrodesis. Deltoid ligament repair may also be required for stage 3 intervention.[5] Treatment of stage 4 PTTD includes any combination of triple arthrodesis with Achilles tendon lengthening, deltoid ligament reconstruction and total ankle arthroplasty. If significant valgus alignment of the talus in the mortise joint is present, then tibiotalocalcaneal arthrodesis is indicated.[7] Conservative management is always the first choice for intervention no matter the staging of PTTD.

Arthrodesis is the surgical fusion of the bones in a joint for the purpose of immobilization of the joint. The most common indication for ankle arthrodesis is severe arthritis. The ankle is

composed of 2 joints: the tibiotalar and the subtalar joints.[10] A triple arthrodesis, involving subtalar, calcaneocuboid, and talonavicular joints, has traditionally been the choice of intervention for adult-acquired flatfoot. Selective arthrodesis of the talonavicular joint and the subtalar joint via a medial approach has been developed to reduce the risk of complications typically associated with a triple arthrodesis.[11] The complications associated with a triple arthrodesis include risk of degeneration in surrounding joints, inadequate realignment if severe transverse plane deformity is present, risk of residual supinatus or varus deformity in those with severe peritalar subluxation, and lateral wound problems in those with a combination of severe valgus deformity and deficient lateral skin.[11]

The purpose of this case presentation is to report outcomes for a 34-year-old female patient with chronic PTTD that resulted from an avulsion fracture of the navicular. Interventions that will be examined in this case report include stretching, strengthening (eccentric and concentric), proprioceptive training, cold laser, ASTYM, rigid taping techniques, bracing, primal reflex release techniques, and diaphragmatic breathing. Past research has provided limited definitions of conservative management and focuses more on surgical interventions after conservative therapy fails. This case report will explore specific conservative interventions in further detail in stage 1 to 2 PTTD. Much of the literature focuses on avulsion fractures in a young population or PTTD in older patients ages 40-60 but does not address a generalized population.[2,4,7] This case report will examine the episode of care for this patient while taking into consideration the chronic nature of the case, prior conservative treatment, and the social and psychological aspects affecting patient outcomes.

CHAPTER II

CASE DESCRIPTION

The subject was a 34-year-old female that presented to physical therapy with pain in the posterior tibialis tendon. Her pain had been ongoing for over a year. The injury occurred when she was descending stairs, twisted her ankle, and heard a pop. She did not seek medical attention at the time of the injury, as she believed it to be a minor ankle sprain. The pain persisted which led her to seek care from her primary care physician. Through MRI, it was identified that the patient had an avulsion fracture at the navicular. The fracture was healed but the soft tissues continued to produce pain in her foot. She had received previous physical therapy treatment in July of 2021 that was unsuccessful in treating her symptoms. She wore a lace up athletic brace and supportive footwear.

The patient worked as a health coach and choreographer. Her job requirements included climbing a ladder, carrying large boxes, demonstrating basic exercises, and desk work. She had reduced her workload from full-time to part-time due to her injury. She was not taking any medications for the pain. The patient primarily stayed on the main level of her home. She did have one flight of stairs in her home to her basement, which she ambulated to do laundry. She retired from the Air Force and was previously active and independent in all tasks. She remained independent in household tasks and activities of daily living (ADLs) but had to make some modifications in how she completed tasks. For example, she had difficulty descending stairs, especially when she was carrying a laundry basket, so she resorted to scooting down the stairs on

her bottom. She had minimal social support as her husband was on deployment and she had no family in the area. She had expressed dissatisfaction with her current employment. She recently became a certified personal trainer and prolonged changing jobs as she wanted to wait until she returned to her prior level of function. Her goal was to return to her prior level of function and be able to complete job requirements of a personal trainer. Her prior level of fitness may have had a positive impact on prognosis, and she did not have any known behavioral risk factors that would negatively affect prognosis. She enjoyed going to the gym and going for walks for recreation and leisure, but she had been unable to participate in these activities due to her injury.

The patient presented with left ankle pain, weakness, decreased range of motion, pes planus, and decreased functional mobility. See Table 2 and Table 3 below for strength and range of motion values collected during the initial evaluations. Clinical tests used to evaluate the patient included manual muscle testing (MMT), range of motion (ROM), posture and biomechanical evaluations. Special tests conducted were kleiger's and anterior drawer (both negative), squeeze test (negative), and heel thump test (negative). These tests were used to rule out a ligamentous sprain or a fracture. See Table 4 below for reliability data related to these tests. There are no diagnostic tests specific to posterior tibialis tendon dysfunction. The heel raise test was performed to aid in staging. The patient was able to complete 5 repetitions with moderate to severe pain. The Focus on Functional Outcomes (FOTO)[12] assessment was used as a functional outcome measure to track the patient's progress.

Table 2: Lower Extremity Active Range of Motion on Initial Evaluation		
AROM	Right	Left
Knee flexion	135° (WNL)	135° (WNL)
Knee extension	0° (WNL)	0° (WNL)
Ankle plantarflexion	50° (WNL)	20°
Ankle dorsiflexion	25° (WNL)	23° with pain at end range
Ankle inversion	25° (WNL)	15°
Ankle eversion	10° (WNL)	8° with pain at end range

Table 3: Lower Extremity Strength on Initial Evaluation		
	Right	Left
Knee flexion	5/5	5/5
Knee extension	5/5	5/5
Ankle plantarflexion	5/5	3/5
Ankle dorsiflexion	5/5	4+/5
Ankle inversion	5/5	4-/5
Ankle eversion	5/5	4+/5

Table 4: Reliability Data of Special Tests[13,14,15]				
Test	Sensitivity	Specificity	Likelihood ratio (+)	Likelihood ratio (-)
Kleiger's[13]	.20	.85	1.31	.94
Anterior drawer[13]	.58	1.00	infinity	.42
Squeeze test[13]	.30	.93	4.60	.75
Heel thump[14,15]	Statistics not available			

It was found through the examination that the patient had chronic posterior tibialis tendon dysfunction caused by an avulsion fracture of the navicular (ICD-10 code M76.2). Additional diagnoses related to plan of care included pain in left ankle and joints of left foot (M25.572), posterior tibial tendinitis, left leg (M76.822), and other fracture of lower end of left tibia, subsequent encounter for closed fracture with routine healing (S82.392D). These diagnoses were reached through strength testing, ROM assessment, biomechanical analysis, ruling out differential diagnoses, and MRI clinical impressions. Impairments included pain, decreased ankle range of motion, and lower extremity strength deficits and muscle imbalance. Functional

limitations included the inability to walk, run, lift weights, and descend stairs, loss of income due to decreased work hours, inability to participate in recreational activities for enjoyment and fitness, as well as an inability to complete household tasks as her laundry room was located in the basement of her home. The established problem list included pain, decreased range of motion, strength deficits and muscle imbalance, impaired balance, and impaired gait. The established goals are represented in Table 5. Taking into consideration the patient's age, prior level of activity and fitness level, lack of co-morbidities, and motivation, her prognosis was good to make a full return to prior level of function.

Table 5: Established Goals.
The patient's ankle pain will improve, enabling her to sleep without disruptions for 6 hours so that she can achieve adequate rest, to be achieved in 3 weeks.
The patient's ankle pain will improve to 0-2/10, enabling her to perform sustained standing for 4 hours daily so that she can participate in prior level of occupational activities, to be achieved in 3 weeks.
The patient's ankle pain and strength, endurance, and motor control will improve, enabling her to walk long distances to perform sustained walking for 2 hours daily so that she can participate in prior level of occupational activities, to be achieved in 6 weeks.
The patient's ankle pain and strength, endurance, and motor control will improve, enabling her to jump so that she can participate in prior level of occupational and recreational activities, including dancing, to be achieved in 6 weeks.
FOTO score will improve by 17 points for improved function with walking and ADLs, to be achieved in 6 weeks.

CHAPTER III

INTERVENTION AND PLAN OF CARE

Interventions included in the plan of care were stretching, strengthening, proprioceptive training, cold laser, ASTYM, rigid taping techniques, bracing, primal reflex release techniques (PRRT), and diaphragmatic breathing. Equipment utilized for these interventions included TheraBand (yellow through blue for progression), 4- and 6-inch step, 4- and 12-pound medicine balls, treadmill, BOSU ball, Multi Radiance Medical MR4 Pro Cold Laser, ASTYM therapy instruments, and Kinesio Tape. ASTYM treatment included lower extremity protocol to left lower extremity with focus on the tibialis posterior. Rigid taping with Kinesio Tape was used to facilitate the tibialis posterior muscle. Tape was placed from origin to insertion with 60% stretch and a cross strip at insertion for additional support. Cold laser at 250 Hz for 5 minutes was applied at tibialis posterior insertion on navicular. Primal reflex release techniques included plantar reflex release, palmar reflex release, frontalis release, orbicularis oculi release, and temporomandibular joint and zygomatic arch release.

A typical treatment session with this patient began with cold laser treatment, followed by PRRTs as listed above and diaphragmatic breathing for relaxation and down regulation of the sympathetic nervous system. The patient then completed progressive stretching, strengthening, and proprioceptive training with updates made to her home exercise program. See Table 6 below for further details on exercise interventions. Exercises were added and progressed as the patient was able to tolerate. The patient then received the lower extremity ASTYM protocol, and tape

was applied at the end of the session. The patient was instructed to wear her lace up athletic ankle brace at work, when exercising, and when she would be walking or standing for a prolonged period.

Table 6: Stretching, Strengthening, and Proprioceptive Interventions Implemented During Treatment Course

Visit #1	• Seated calf raises with focus on eccentric lowering 1x10 • Ankle inversion isometric with submaximal contraction (50-60%) 1x10 • Standing calf stretch 30 second holds x 3 reps
Visit #2	• Calf raises with bilateral upper extremity support 2x10 • Ankle inversion isometric with submaximal contraction (50-60%) 1x10 • Seated foot doming 1x10 • Standing calf stretch 30 second holds x 3 reps
Visit #3	• Calf raises with bilateral upper extremity support, up with bilateral lower extremity and eccentric lowering with affected lower extremity 1x10 • Ankle inversion isometric with submaximal contraction (50-60%) 1x10 • Seated foot doming 1x10 • Ankle inversion, eversion, and dorsiflexion with red TheraBand and focus on eccentric control 2x10 each direction • Standing calf stretch 30 second holds x 3 reps
Visit #4	• Ankle inversion, eversion, and dorsiflexion with red TheraBand and focus on eccentric control 2x10 each direction • Single leg stance with eyes open 15 second hold x 3 reps • Standing calf stretch 30 second holds x 3 reps
Visit #5	• Ankle inversion, eversion, and dorsiflexion with red TheraBand and focus on eccentric control 2x10 each direction • Single leg stance with eyes open 15 second hold x 3 reps • Single leg stance with eyes closed 15 second hold x 3 reps • Calf raises with bilateral upper extremity support, up with bilateral lower extremity and eccentric lowering with affected lower extremity 1x10
Visit #6	• Ankle inversion, eversion, and dorsiflexion with red TheraBand and focus on eccentric control 2x10 each direction • Eccentric lowering from 4-inch box with foot doming • Single leg stance with eyes open 15 second hold x 3 reps • Single leg stance on left lower extremity on stable ground and reaching with right lower extremity forward and to both sides x 3 bouts
Visit #7	• Ankle eversion with red TheraBand with focus on eccentric control 1x10 • Eccentric lowering from 4-inch box with foot doming • Single leg stance with eyes open 15 second hold x 4 reps

	• Single leg stance on left lower extremity on stable ground and reaching with right lower extremity forward and to both sides x 3 bouts
Visit #8	• Ankle eversion with red TheraBand with focus on eccentric control 1x10 • Eccentric lowering from 4-inch box with foot doming • Calf raises with bilateral upper extremity support, up with bilateral lower extremity and eccentric lowering with affected lower extremity 1x10 • Single leg stance with eyes open 30 second hold x 3 reps • Single leg stance eyes closed 10 second holds x 3 reps • Single leg stance on left lower extremity on stable ground and reaching with right lower extremity forward and to both sides x 3 bouts with focus on foot doming • Single leg Romanian dead lift unweighted with upper extremity support x1 2x5
Visit #9	• Ankle eversion with red TheraBand with focus on eccentric control 1x10 • Eccentric lowering from 6-inch box with foot doming • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Single leg Romanian dead lift unweighted with upper extremity support x1 2x10 • Alternating back lunges with foot doming 1x10 • Deadlifts with 12# medicine ball with foot doming 1x10 • Wide goblet squats 12# with foot doming 1x10
Visit #10	• Ankle eversion with red TheraBand with focus on eccentric control 1x10 • Eccentric lowering from 6-inch box with foot doming • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Single leg Romanian dead lift unweighted with upper extremity support x1 2x10 • Alternating back lunges with foot doming 1x10 • Deadlifts with 12# medicine ball with foot doming 1x10 • Wide goblet squats 12# with foot doming 1x10
Visit #11	• 5.5 minutes of treadmill training – 3 minutes at 3.5 mph, 30 seconds at 5.5 mph, 2 minutes at 3.5 mph) • Ankle inversion and eversion with green TheraBand with focus on eccentric control 3x10 • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Single leg Romanian dead lift unweighted with upper extremity support x1 2x10
Visit #12	• 5.5 minutes of treadmill training – 3 minutes at 3.5 mph, 30 seconds at 5.5 mph, 2 minutes at 3.5 mph)

	• Ankle inversion and eversion with green TheraBand with focus on eccentric control 3x10 • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Single leg Romanian dead lift unweighted with upper extremity support x1 2x10 • Alternating back lunges with foot doming 1x10 • Deadlifts with 12# medicine ball with foot doming 1x10 • Wide goblet squats 12# with foot doming 1x10
Visit #13	• Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Heel walking and toe walking 25 feet x2 • Double leg jumping with controlled, eccentric landing from 4-inch box 1x10 • Alternating back lunges with foot doming 1x10 • Deadlifts with 12# medicine ball with foot doming 1x10 • Wide goblet squats 12# with foot doming 1x10
Visit #14	• Weight shifts on BOSU ball 2x10 • Chops in semi tandem stance with 4# medicine ball 2x10 • Single leg pallof press with red TheraBand 2x10 with resistance from right and left • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10
Visit #15	• Weight shifts on BOSU ball 2x10 • Chops in semi tandem stance with 4# medicine ball 2x10 • Single leg pallof press with red TheraBand 2x10 with resistance from right and left • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Double leg jumping with controlled, eccentric landing from 6-inch box 1x10 • Heel walking and toe walking 25 feet x2
Visit #16	• Weight shifts on BOSU ball 2x10 • Chops in semi tandem stance with 4# medicine ball 2x10 • Single leg pallof press with red TheraBand 2x10 with resistance from right and left • Single leg calf raises with bilateral upper extremity support, focus on eccentric lowering 2x10 • Double leg jumping with controlled, eccentric landing from 6-inch box 1x10 • Heel walking and toe walking 25 feet x2

ASTYM and cold laser treatments were implemented to decrease pain and chronic inflammation through the posterior tibial tendon.[17,18,19] Bracing and rigid taping were used to support the ankle and allow healing during daily activity. Primal reflex release techniques and diaphragmatic breathing techniques were implemented to decrease pain and for relaxation to decrease sympathetic nervous system activity.[20,21] Stretching, strengthening, and proprioceptive interventions were utilized to restore muscle balance, strength, and improve functional mobility.

The patient was educated on plan of care, prognosis, and intervention rationale. The patient was instructed on a walking program and home exercise program. Home exercise program included calf stretching, resisted inversion, eversion, and dorsiflexion following progression as described above, calf raises following progression as described above, and foot doming incorporated into functional activities. She was also instructed to return to the gym, beginning with upper extremity strengthening and gradually progressing with lower extremity strengthening as tolerated. Additionally, she was instructed to modify work activity as able to prevent an increase in her pain level.

The patient presented for physical therapy sessions 2 times per week for 5 weeks. She was then re-evaluated, and the plan of care was updated. She was seen 2 more times and then continued independently with an exercise program and walking program with a re-check in 1 month. Following the second re-evaluation, she was seen once a week for 4 weeks and then referred to a podiatrist to address continued deficits. Re-examination and evaluation included retesting measures assessed during the initial evaluation.

Documentation was performed through OptimisPT, a rehab specific electronic documentation system. This platform does not allow for immediate coordination and communication with other disciplines outside of this private practice setting. Notes were sent to

the referring provider as necessary, and a referral was made to a podiatrist after 3 months as a plateau in progress was noted.

CHAPTER IV

OUTCOMES AT DISCHARGE

Following 16 visits over the course of 15 weeks, the patient had improvement of symptoms, as demonstrated by decreased pain and improved range of motion and strength. See Table 6 and Table 7 for complete data. The patient also demonstrated improvement in the heel raise test. Upon initial evaluation, the patient was able to complete 5 repetitions with the heel raise test with moderate to severe pain with all repetitions. At discharge, the patient was able to complete all 50 repetitions of the heel raise with mild pain during the last 10 repetitions. She was able to increase walking distance and was able to begin participation in some fitness activities; however, she was still experiencing low levels of pain up to 3/10 with these activities. The patient had an improved FOTO score from 52/100 to 63/100 after 16 visits. The predicted FOTO score was 68/100 within 12 visits. The patient was compliant with her home exercise program and all recommendations.

Table 7: Lower Extremity Active Range of Motion on Evaluation and Discharge

AROM	Right – Initial	Right – Discharge	Left – Initial	Left – Discharge
Knee flexion	135°	135°	135°	135°
Knee extension	0°	0°	0°	0°
Ankle plantarflexion	50°	50°	20°	40°
Ankle dorsiflexion	25°	25°	23° with pain at end range	24°
Ankle inversion	25°	25°	15°	20°
Ankle eversion	10°	10°	8° with pain at end range	10°

Table 8: Lower Extremity Strength on Evaluation and Discharge				
	Right – Initial	Right – Discharge	Left – Initial	Left – Discharge
Knee flexion	5/5	5/5	5/5	5/5
Knee extension	5/5	5/5	5/5	5/5
Ankle plantarflexion	5/5	5/5	3/5	5/5
Ankle dorsiflexion	5/5	5/5	4+/5	5/5
Ankle inversion	5/5	5/5	4-/5	4+/5
Ankle eversion	5/5	5/5	4+/5	5/5

The side hop test, front-to back hop test, and functional hop test are additional functional outcome measures that could have been used to gauge patient progress. The side hop test has the participant hop side to side on a single leg at a rate of 1 to 2 hops per second for 50 repetitions.[22] The front-to back hop test follows the same parameters as the side hop test but the participant performs forward and back over the line, rather than side to side.[22] The functional hop test requires the participant to hop from one foot to the other on either side of an 8 meter long line, first forwards and then backwards. The participant should take approximately 4 hops forward and 4 hops backward. This is repeated 5 times or approximately 40 hops.[22] These tests were not performed on initial evaluation due to severity of the patient's pain but could have provided useful objective data about the patient's progress and functional level.

The patient continued to have reported limitations in functional mobility, such as descending stairs. Improvements had been made in pain, strength, and range of motion, but continued deficits remained. She continued to have increased pain with prolonged standing and long-distance walking. She was unable to start working as a personal trainer due to pain. She did not meet all established goals. Table 9 describes progress made toward each of the established goals.

Table 9: Established Goals and Progress at Discharge	
Goal	Progress
The patient's ankle pain will improve, enabling her to sleep without disruptions for 6 hours so that she can achieve adequate rest, to be achieved in 3 weeks.	Met
The patient's ankle pain will improve to 0-2/10, enabling her to perform sustained standing for 4 hours daily so that she can participate in prior level of occupational activities, to be achieved in 3 weeks.	Not met, patient's ankle pain continued to be between 3/10.
The patient's ankle pain and strength, endurance, and motor control will improve, enabling her to walk long distances to perform sustained walking for 2 hours daily so that she can participate in prior level of occupational activities, to be achieved in 6 weeks.	Not met, patient continued to have low levels of pain with distance walking, though she was able to walk further than prior to starting physical therapy
The patient's ankle pain and strength, endurance, and motor control will improve, enabling her to jump so that she can participate in prior level of occupational and recreational activities, including dancing, to be achieved in 6 weeks.	Met, patient was able to perform 10 reps of jumping from 4- and 6-inch boxes without increase in pain.
FOTO score will improve by 17 points for improved function with walking and ADLs, to be achieved in 6 weeks.	Not met, FOTO score improved by 11 points.

The FOTO survey includes a section on patient satisfaction. The patient's responses were as follows: "I am very satisfied with the information given about my condition. I am very satisfied with my input in setting treatment goals. I am very satisfied with the availability of convenient appointments. I am very satisfied with the access to the facility location. I am very satisfied with the level of courtesy and respect shown to me by my treatment team. I am very satisfied with the treatments for my condition. I am very satisfied with the overall results of my treatment. I would tell a friend that I was very satisfied with my experience at this facility."

Due to a plateau in progress and continued pain, the patient was referred to a podiatrist. A computerized tomography (CT) scan was ordered, and osseous fragments were located at the

anterior-inferior margin of the lateral malleolus and at the inferior margin of the medial malleolus. It was determined that the patient would be discharged from physical therapy at this time and explore the possibility of surgical intervention.

CHAPTER V

DISCUSSION

Physical therapy intervention through 16 sessions improved pain, strength, range of motion, and function in a 32-year-old woman with PTTD. The patient was not able to be pain free with all activity, but she did show considerable improvement as demonstrated in measures described above. Due to her remaining deficits, the patient opted to undergo surgical repair and discontinue physical therapy until after the procedure. This is consistent with the literature that describes treatment options for each stage of PTTD.

This patient likely had stage 2A or 2B PTTD, as she was unable to perform a single leg heel raise upon initial evaluation. It was more difficult to accurately stage the patient's PTTD because she did not have radiographs completed. According to the recent literature, it is recommended that patients should begin with conservative treatment no matter what their stage is of PTTD.[7] Literature suggests that surgical intervention may be required in patients that have a stage greater than 1 and if conservative treatment is unsuccessful.[5]

Utilizing range of motion and strength measurements, FOTO outcome measures, and the visual analog pain scale allowed the clinicians to objectively show improvement and recognize when the patient had plateaued. Due to a plateau of progress, the patient was referred to a podiatrist. The patient ultimately decided to pursue surgical intervention.

One potential limitation of this study could be psychosocial factors affecting the patient. The patient did not have family or social support as her husband was on deployment and she was not from the area. The patient also expressed dissatisfaction with her current employment on multiple occasions. Another limitation is that radiographs were not taken to assist in the staging of this patient's PTTD, so it is difficult to precisely compare the treatment course to literature. Additionally, as this is a case study, there is no control group, and therefore it is not possible to determine which intervention or combination of interventions was responsible for achieved outcomes. Further studies should utilize randomized control trials to determine the efficacy of specific interventions on each stage of PTTD.

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