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Barefoot Training In The Rehabilitation Of Stage II Posterior Tibialis Tendon Dysfunction: A Case Report

Matthew Heindel
University of New England

University of New England
Department of Physical Therapy
PTH 608/708: 2018 Case Report Template

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Barefoot Training in the Rehabilitation of Stage II Posterior Tibialis Tendon Dysfunction: A Case Report

Matthew Heindel

Matthew Heindel is a DPT Student at the University of New England, 716 Stevens Ave. Portland, ME

Address all correspondence to Matthew Heindel at mheindel@une.edu

The patient signed an informed consent permitting use of his medical history for this case report. He received information from the university's Health Insurance Portability and Accountability Act (HIPPA) policies.

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(110 words)

Key words: barefoot training, posterior tibial tendon dysfunction

ABSTRACT

Background and Purpose: This case report explored the inclusion of barefoot training with intrinsic foot musculature strengthening a patient with stage II posterior tibialis tendon dysfunction (PTTD). Barefoot training and intrinsic musculature strengthening have been effective interventions for other ailments but have yet to be included in rehabilitating PTTD. Therefore, the purpose of this case report was to examine barefoot training with foot intrinsic musculature strengthening within a comprehensive physical therapy (PT) plan of care (POC) for stage II PTTD.

Case Description: The patient was a 39-year-old male who presented with stage II PTTD. His goal was to run without pain. The Lower Extremity Functional Index Scale (LEFS), single leg heel rise test, manual muscle testing (MMT), and dorsiflexion (DF) range of motion (ROM) were used to evaluate progress. The interventions included barefoot training with the short-foot exercise, resisted inversion, gastrocnemius and soleus stretching and strengthening, and gluteal strengthening.

Outcomes: The patient improved from 49/80 to 71/80 on the LEFS. On the single leg heel rise test, the patient improved from 0 to 18 repetitions on the left. With MMT, the patient improved from a 3+/5 to 5/5 on the left. Lastly, the patient's left ankle DF ROM improved from 2° to 10° with full knee extension and from 5° to 15° with 90° of knee flexion.

Discussion: Barefoot training and intrinsic musculature strengthening within a comprehensive PT POC demonstrated improvement in this case of stage II PTTD. This improvement was illustrated by improvements in LEFS, single heel rise test, DF ROM, and posterior tibialis strength. Future PTTD research should explore barefoot training and foot intrinsic muscular strengthening in a larger cohort of subjects.

(Abstract word count: 274 words)

(Manuscript Word Count: 2,502)

BACKGROUND and PURPOSE

Posterior tibialis tendon dysfunction (PTTD) is a chronic degenerative disorder of the posterior tibialis tendon with a reported prevalence of roughly 10% of the population.[1] This condition is often accompanied by medial plantar pain, gait abnormalities, foot deformities, and decreased force production.[2,3,4] PTTD is typically classified according to the severity of its presentation along a spectrum of 4 stages.[2,4] Stage 1 lacks a foot deformity while medial arch pain, possible pain with heel elevation, and mild ankle and foot swelling persist.[4] Stage 2, in addition to the previous findings, consists of a flexible flatfoot deformity at the insertion of the posterior tibialis tendon, while stage 3 progresses to a fixed flatfoot deformity.[4] The 4th stage is characterized by "valgus tilt of the talus in the ankle mortise, leading to tibiotalar degeneration".[4] While the established treatment for stages 3 and 4 is surgical repair, several studies have sought insight into the efficacy of conservative management for stages 1 and 2.[2,3,4]

Conservative management has explored the efficacy of orthoses prescription in conjunction with stretching the gastrocnemius and soleus, strengthening the gastrocnemius, soleus and posterior tibialis, and using manual therapy techniques to address joint restrictions.[2,3,4,5] These studies have demonstrated success with patient reported increased function and decreased pain, often avoiding the need for surgical repair.[2,3,4]

Barefoot training has demonstrated advantageous results in the reduction of running injuries and increased activation of the foot intrinsic musculature while performing the short-foot exercise.[6,7,8] The intrinsic foot musculature demonstrated the highest EMG results while performing the short-foot exercise and was used to improve balance in patients with chronic ankle instability, decrease navicular drop in patients with pes planus and hyper-pronation, and further support the medial longitudinal arch with and without foot orthoses.[9,10,11] Barefoot

training has also shown to improve proprioceptor stimulation of the foot's plantar surface.[7]

While barefoot training and intrinsic strengthening have been effective interventions for other ailments, they have not often been implemented in the conservative care of PTTD.[12] Therefore, the purpose of this case report was to examine barefoot training with foot intrinsic musculature strengthening in addition to a comprehensive PT plan of care for a 39-year-old patient with stage II PTTD.

Case Description

Patient History and Systems Review

The patient was a 39-year-old male who arrived at outpatient PT with complaints of persistent, dull pain along the plantar portion of his left, medial longitudinal arch. The patient was referred to PT by his primary care physician following a medical diagnosis of unspecified plantar foot pain. The patient noted that weight-bearing activities increased his pain, particularly rising onto his toes. The patient verbalized that the discomfort and weakness in his foot was hindering his ability to tolerate increased physical activity. After being discharged from the military, the patient noted that he was not consistently exercising for several months. The pain began after he attempted to return to running after the period of inactivity. The patient did not report any significant past medical history including prior treatment for the pain, medication intake, surgical history, or significant family medical history. He stated that his primary goal was to return to high-level physical activity such as running and biking.

The patient reported independence with all activities of daily living. The patient stated that the onset of pain occurred gradually over time and limited his ability to run. The patient was happily married, had 2 young children, and worked at a shipping company packaging boxes. The patient stated that his home life was a positive motivator to get back in better shape. The patient

signed an informed consent permitting the use of his deidentified medical information for this case report. Please see table 2 for a complete systems review.

Examination – Tests and Measures

The patient's initial evaluation began with active range of motion (ROM) coupled with manual muscle testing (MMT). MMT demonstrated good external and internal validity as well as pragmatic clinical utility.[13] The patient's ROM was gathered by goniometric measurements which demonstrate good intra-rater reliability with plantarflexion and dorsiflexion.[14] Ligamentous testing followed which included external rotation and anterior drawer.[15] External rotation test showed a 99% specificity for a syndesmotic ankle sprain while anterior drawer demonstrated 58% sensitivity and 100% specificity for lateral ankle sprain.[15] The tarsal tunnel was also inspected by the triple compression stress test which has shown 86% sensitivity and 100% specificity for tarsal tunnel syndrome.[15] Since the pain was within the tibial nerve distribution, the lumbar spine was cleared with sciatic nerve tension test which has demonstrated ample stressing of the tibial nerve in testing without calculation of psychometric properties.[16] The patient also completed a lower extremity functional scale (LEFS) which demonstrated clinical utility and responsiveness across many LE injuries.[17] Ottawa ankle rules were used to rule out a fracture as the test has shown a sensitivity near 100%.[18] Single leg heel raise test was also employed to measure plantarflexion strength functionally and reportedly had acceptable reliability and face validity.[19]

Clinical Impression: Evaluation, Diagnosis, Prognosis

The hypothesis was consistent with the presentation of stage II PTTD on his left LE. The noted impairments were tenderness with palpation over the tendon, pain with heel elevation, mild ankle and foot swelling medially, and a flexible flatfoot deformity in standing. Differential

diagnosis included a fracture of the navicular or cuboid bones, tarsal tunnel syndrome, and an eversion ankle sprain. A fracture was ruled out due to negative x-ray imaging results in addition to negative Ottawa ankle rules.[18] Tarsal tunnel syndrome was ruled out due to negative triple compression stress test and negative sciatic nerve tension test.[15,16] An eversion ankle sprain was also ruled out due to negative external rotation test and negative anterior drawer test.[15] Supplemental assessment involved ankle ROM, ankle MMT, single leg heel rise test, and the LEFS.[14,19,17]

The objective tests performed during the examination were consistent with the diagnosis of PTTD. The patient's medical diagnosis and PT diagnosis was M76.821 (posterior tibial tendinitis, right leg). The patient's flexible flatfoot deformity was consistent with conservative care management seen in the literature, thus the patient was retained as an appropriate case report participant.[2]

The procedural interventions included foot orthoses, stretching, strengthening, and manual therapy. The orthoses were given by the prosthetist and prescribed according to the prosthetist's expertise.[2,3,4] The stretching aspect was done according to what has been observed to be successful in the literature which included both standing gastrocnemius and soleus stretches.[2,3,4] The strengthening component emphasized the plantarflexors of the foot and muscles involved in arch support, particularly the intrinsic musculature.[2,3,4,6,7,8] The manual therapy component involved mobilization of the talocrural joint to increase ROM.

The patient's prognosis of making a pain-free return to recreational activity was promising. One study noted that a 12-week exercise program with eccentric and concentric strengthening, coupled with gastrocnemius and soleus stretching while wearing orthoses, reduced

pain and improved perceptions of function.[2] Another similar 12-week strengthening and stretching program demonstrated improved pain and function.[3] Furthermore, a study with similar methodology demonstrated 89% patient satisfaction after 10 PT visits over a median period of 4 months.[4] The patient was, therefore, expected to make a recovery consistent with these studies by demonstrating decreased pain, increased perceived function, increased ROM, and increased strength over the 10 weeks of supervised, skilled PT.

Coordination of care was performed with the referring primary care physician, and a reassessment was performed at visit number 5 with a re-evaluation at visit number 10. The LEFS was distributed at these visits, along with reassessment of ankle ROM, single leg heel raise test, and MMT of the LEs.

The short-term goals, which were to be met in 5 weeks, included an increase of 5 single leg heel raises bilaterally and an improved LEFS score greater than the minimal clinically importance difference (MCID). Long term goals, which were to be met at 10 weeks, included equal ROM and MMT bilaterally, a LEFS score increase greater than double the minimal clinically importance difference, and an increase of 10 single leg raises bilaterally.

Intervention and Plan of Care

The patient underwent 10 weeks of PT rehabilitation that consisted of foot orthoses, stretching and strengthening the gastrocnemius and soleus, strengthening the posterior tibialis and intrinsic muscles of the foot, manual therapy and barefoot training. The interventions were performed barefoot to engage the foot intrinsic musculature, while the orthotics were worn with community ambulation to add supplemental arch support.[2,6]

The patient was instructed to perform a standing gastrocnemius stretch with the posterior LE in hip and knee extension, while the soleus stretch had the posterior LE in hip extension and knee flexion. Similar stretches were prescribed in several studies with favorable outcomes and

were therefore utilized for this case report.[2,3,4] The patient performed the stretches 5 times per week for 2 sets of 30 seconds, as this dosing regimen indicated maximal change in a recent study.[20]

The strengthening for the gastrocnemius and soleus consisted of 3 sets of 10 reps of double heel raise with single leg descent on an elevated surface to maximize dorsiflexion ROM. The patient was initially unable to perform a single leg heel raise on his impaired LE, so this exercise allowed for both concentric and eccentric strengthening of the impaired LE. The patient performed the task for 3 sets of 10 reps 1 time per day with a gradual, decreased need for upper extremity support on a raised surface. Eccentric loading has been utilized in the literature with concentric strengthening of the plantarflexors with good results.[2,3,4,7] The posterior tibialis specific strengthening was done by inversion of the foot in supine with a red elastic band for 150-600 reps.[4] The repetitions were increased by increments of 50 based upon patient response. The high repetition dosing was utilized due to the endurance requirements of the posterior tibialis.[3,4] The patient performed strengthening exercises barefoot to further explore barefoot training as a means of injury prevention and intrinsic musculature activation.[6]

The strengthening of the intrinsic muscles of the foot were included to aid in medial longitudinal arch support, as has been supported in the literature.[6,7,8,9,10,11] The patient performed the short-foot exercise by being prompted to shorten the medial arch by drawing the metatarsals posteriorly without flexing the toes.[8] This exercise improved static and dynamic balance in patients with chronic ankle instability in 4 weeks.[10] Fatigue of these muscles showed increased navicular drop, while performance of the exercise showed increased dynamic support of the medial longitudinal arch.[8,11] The short-foot exercise also recorded the highest EMG activity for the foot intrinsic muscles.[9]

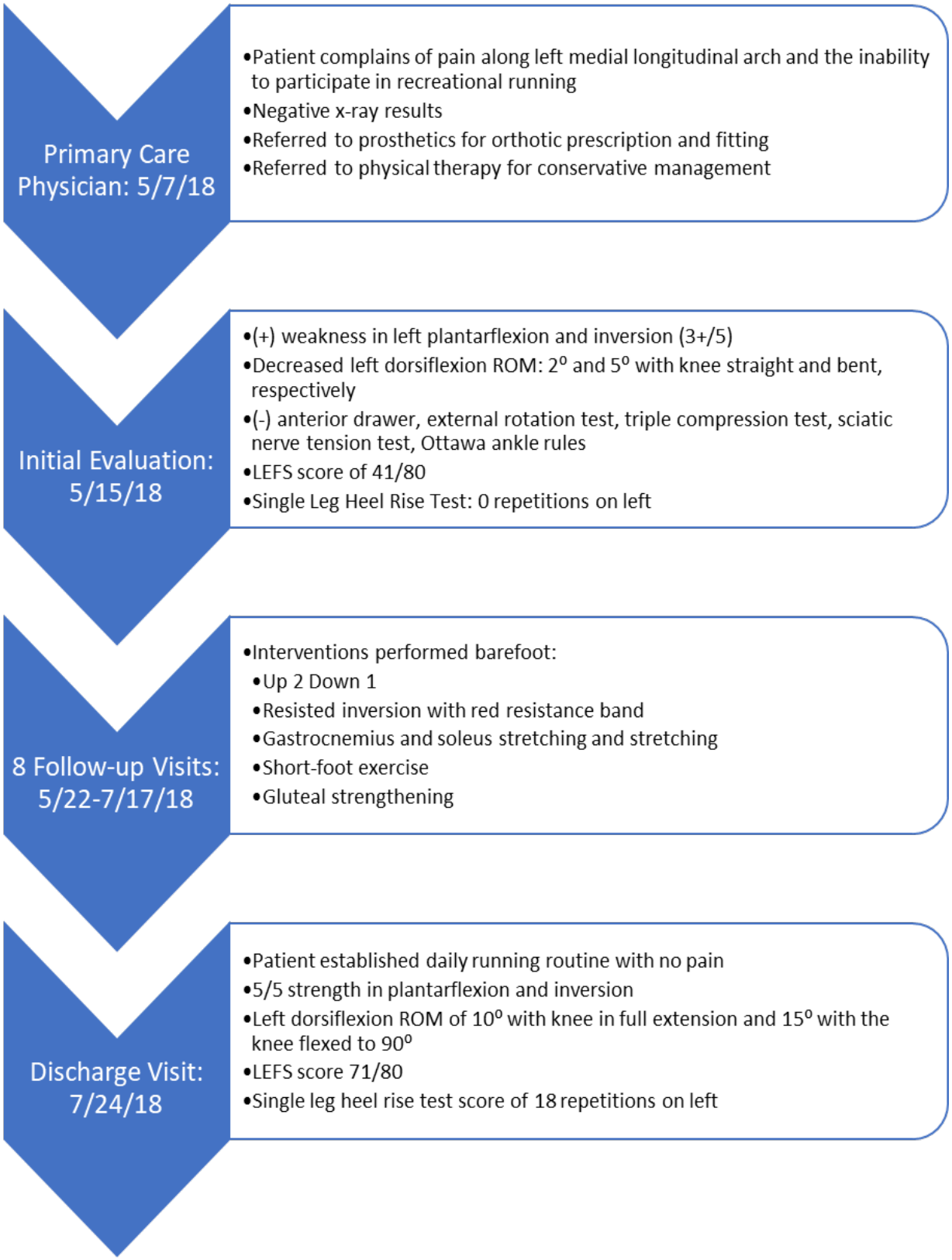
Manual therapy included a mobilization with movement which was intended to increase

ankle ROM. It was performed standing with his right foot placed on top of a knee-high chair. The therapist blocked the talus while the patient rocked forward and backward into end range, closed-chain, plantarflexion and dorsiflexion. This was performed for 5 minutes as a dynamic warm-up at the beginning of each session. This is a variation of the popular Mulligan technique that saw immediate improvements in ankle dorsiflexion ROM in patients with subacute ankle sprains.[21]

Other strengthening interventions performed in-clinic included targeted strengthening of the gluteus maximus and medius muscles to aid in dynamic stability of the lower extremities.[22] Weak proximal musculature was found to be more prevalent in recreational runners suffering from overuse injuries.[22] The side plank with hip abduction and pelvic drop displayed amongst the highest EMG activity in a recent study for gluteus medius activation and was therefore utilized for this patient.[23] The side plank with hip abduction was performed in sidelying with the shoulders, hips, knees and ankles aligned before rising onto the forearm by lifting the hip off the table.[23] The patient then abducted the superior hip for 10 repetitions while maintaining a side plank.[23] This was performed for 3 sets. The pelvic drop was performed by instructing the patient to drop his heel to the floor while keeping straight knees and hips bilaterally.[23] Both hands were placed on the iliac crests to gather proprioceptive feedback to maintain proper technique. For gluteus maximus strengthening, the patient performed a front plank with extension, as this exercise displayed high EMG activity of the gluteus maximus.[23] The patient was asked to assume the prone position and rise onto the forearms while maintaining a neutral spine. The patient was asked to hold this position while alternating hip extension on both lower extremities for 10 repetitions and 3 sets without trunk rotation.

The patient demonstrated understanding of each intervention and verbalized adherence to the exercise program.

TIMELINE


Primary Care Physician: 5/7/18
•Patient complains of pain along left medial longitudinal arch and the inability to participate in recreational running
•Negative x-ray results
•Referred to prosthetics for orthotic prescription and fitting
•Referred to physical therapy for conservative management
Initial Evaluation: 5/15/18
•(+) weakness in left plantarflexion and inversion (3+/5)
•Decreased left dorsiflexion ROM: 2° and 5° with knee straight and bent, respectively
•(-) anterior drawer, external rotation test, triple compression test, sciatic nerve tension test, Ottawa ankle rules
•LEFS score of 41/80
•Single Leg Heel Rise Test: 0 repetitions on left
8 Follow-up Visits: 5/22-7/17/18
•Interventions performed barefoot:
•Up 2 Down 1
•Resisted inversion with red resistance band
•Gastrocnemius and soleus stretching and stretching
•Short-foot exercise
•Gluteal strengthening
Discharge Visit: 7/24/18
•Patient established daily running routine with no pain
•5/5 strength in plantarflexion and inversion
•Left dorsiflexion ROM of 10° with knee in full extension and 15° with the knee flexed to 90°
•LEFS score 71/80
•Single leg heel rise test score of 18 repetitions on left

OUTCOMES

Over the course of therapy, the patient reported a gradual decrease in pain. Final outcomes included an improvement on the LEFS from 49/80 to 71/80. On the single leg heel rise test, the patient improved from 0 to 16 repetitions on the left and from 10 to 20 repetitions on the right. The patient improved with MMT from a 3+/5 to 5/5 on the right, rendering it equal it to the left LE. Lastly, the patient's ROM in dorsiflexion improved from 2° to 10° with knee in full extension on the left and improved from 5° to 15° with the knee flexed to 90°. These findings show improved outcomes in the subject of this case report by including barefoot training and intrinsic foot musculature strengthening with the comprehensive PT management of PTTD.

DISCUSSION

This case report described the comprehensive PT management, with the addition of barefoot training and intrinsic foot muscular strengthening, in a patient diagnosed with stage II PTTD. The patient demonstrated improvement during the 10 PT sessions in strength, ROM, LEFS score, and the single leg heel rise test. The patient attained his goal of returning to running without pain.

The noted improvements were consistent with the information gleaned from the literature regarding successful conservative treatment of stage II PTTD.[1,2,3,4] A 12 week study, 10 week study, and 10 visit study over 4 months all reported outcomes similar to this case report.[2,3,4] These studies also included gastrocnemius and soleus stretching and strengthening, posterior tibialis strengthening, manual therapy, and orthoses prescription, but they did not include barefoot training with foot intrinsic musculature strengthening.[2,3,4] Therefore, it is difficult to account for the effect of including barefoot training and foot intrinsic musculature strengthening on the observed outcomes of this case report. However, it is important to note that barefoot training has demonstrated reduction in running injuries, stimulated the plantar foot

proprioceptors, and increased activation of the foot intrinsic musculature while performing the short-foot exercise.[6,7,8] The short-foot exercise displayed the highest EMG activity of the foot intrinsic muscles and improved balance in patients with chronic ankle instability, decreased navicular drop in patients with pes planus and hyper-pronation, and further supported the medial longitudinal arch with and without foot orthoses.[9,10,11]

The positive factors that contributed to a successful outcome were the patient's compliance, his motivation to return to running, and the prescribed interventions. Barefoot training and foot intrinsic musculature strengthening may be worth including in the care of PTTD clinically. Further research is warranted to determine the effectiveness of utilizing the short-foot exercise and barefoot training instead of only orthotic use in the management of stage II PTTD.

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TABLES and FIGURES

Table 1. Tests and Measures

Tests & Measures	**Initial Evaluation Results**		**Discharge Results**	
Lower Extremity Functional Scale	49/80		71/80	
Single Leg Heel Rise Test	Right	Left	Right	Left
	10 reps	0 reps	20 reps	18 reps
Ankle ROM	Right	Left	Right	Left
Dorsiflexion at 0□ knee flexion	10°	2°	10°	10°
Dorsiflexion at 90□ knee flexion	15°	5°	15°	15°
Manual Muscle Testing	Right	Left	Right	Left
Hip Flexion	5/5	5/5	5/5	5/5
Knee Extension	5/5	5/5	5/5	5/5
Knee Flexion	5/5	5/5	5/5	5/5
Ankle Dorsiflexion	5/5	5/5	5/5	5/5
Ankle Plantarflexion	5/5	3+/5 with pain	5/5	5/5
Great Toe Extension	5/5	5/5	5/5	5/5
Posterior Tibialis	5/5	3+/5 with pain	5/5	5/5

Table 2. Systems Review

Systems Review	
Cardiovascular/Pulmonary	Not Impaired
Musculoskeletal	Impaired ROM: left ankle dorsiflexion at 0 and 90□ of knee flexion Impaired Gross Strength: left ankle plantarflexion and inversion Impaired Body Habitus: body mass index > 30
Neuromuscular	Impaired gait and standing dynamic balance
Integumentary	Not impaired
Communication	Not impaired
Affect, Cognition, Language, Learning Style	Not impaired. Patient requested visual and written print-outs of exercises with parameters, descriptions, and instructions.

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406 ## CARE Checklist

407 ***Final Parts One & Two, PTH708:*** Completed for the final submission to document the locations of key case report components.

CARE Content Area	Page
1. **Title** – The area of focus and "case report" should appear in the title	2
2. **Key Words** – Two to five key words that identify topics in this case report	2
3. **Abstract** – (structure or unstructured) a. Introduction – What is unique and why is it important? b. The patient's main concerns and important clinical findings. c. The main diagnoses, interventions, and outcomes. d. Conclusion—What are one or more "take-away" lessons?	3
4. **Introduction** – Briefly summarize why this case is unique with medical literature references.	4
5. **Patient Information** a. De-identified demographic and other patient information. b. Main concerns and symptoms of the patient. c. Medical, family, and psychosocial history including genetic information. d. Relevant past interventions and their outcomes.	5
6. **Clinical Findings** – Relevant physical examination (PE) and other clinical findings	6-8
7. **Timeline** – Relevant data from this episode of care organized as a timeline (figure or table).	11
8. **Diagnostic Assessment** a. Diagnostic methods (PE, laboratory testing, imaging, surveys). b. Diagnostic challenges. c. Diagnostic reasoning including differential diagnosis. d. Prognostic characteristics when applicable.	6-8
9. **Therapeutic Intervention** a. Types of intervention (pharmacologic, surgical, preventive). b. Administration of intervention (dosage, strength, duration). c. Changes in the interventions with explanations.	8-10
10. **Follow-up and Outcomes** a. Clinician and patient-assessed outcomes when appropriate. b. Important follow-up diagnostic and other test results. c. Intervention adherence and tolerability (how was this assessed)? d. Adverse and unanticipated events.	12
11. **Discussion** a. Strengths and limitations in your approach to this case. b. Discussion of the relevant medical literature.	12-13

c. The rationale for your conclusions. d. The primary "take-away" lessons from this case report.	
12. **Patient Perspective** – The patient can share their perspective on their case.	6
13. **Informed Consent** – The patient should give informed consent.	6