Conservative Management of Tarsal Tunnel Syndrome in a Competitive Distance Runner

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ABSTRACT

Background and Purpose: Tarsal tunnel syndrome is an entrapment neuropathy of the posterior tibial nerve. A symptom triad of pain, paresthesia, and numbness is the most common clinical presentation. **Case Description:** This case describes a 23-year-old male collegiate cross-country and track runner who complained of bilateral medial ankle pain and foot numbness with running. **Interventions:** Consisted of trigger point dry needling, augmented soft tissue mobilization, strength, flexibility, and balance exercises. A running video gait analysis detected inconsistencies in the patient's footstrike pattern, running cadence, and hyperpronation at the midstance phases of the running gait cycle. **Outcomes:** The patient demonstrated minimal improvements in bilateral gastrocnemius and soleus flexibility, improvements in bilateral hip abduction strength, and was able to train himself to strike with a midfoot pattern when running. **Clinical Relevance:** This case study describes a successful conservative intervention program of a collegiate runner diagnosed with tarsal tunnel syndrome.

Key Words: cadence, entrapment neuropathy, pronation, trigger point dry needling

BACKGROUND

Peripheral nerves are subject to entrapment at various anatomical locations in the upper and lower extremities. Carpal tunnel syndrome followed by cubital tunnel syndrome are the most common types of peripheral nerve entrapment in the human body.[1,2] Since other peripheral nerve entrapment syndromes are less common, clinicians are less likely to recognize them. Most peripheral nerve entrapment syndromes result in local pain at the compression site, in conjunction with a myriad of other variable symptoms.[1]

Tarsal tunnel syndrome (TTS) is an entrapment neuropathy of the posterior tibial nerve within the fibro-osseous passageway posterior to the medial malleolus.[1] Entrapment most commonly occurs deep to the flexor retinaculum posterior and inferior to the medial malleolus, but may also occur at the proximal and distal aspect of the fibro-osseous tunnel exiting to the plantar aspect of the foot.[3,4] Besides affecting the posterior tibial nerve, entrapment may also involve branches of the nerve including the medial calcaneal nerve to the heel, and medial and lateral plantar nerves to the sole of the foot and toes.[3,5] Anatomical causes of TTS include space occupying lesions, talocalcaneal coalition, accessory muscles, bony fragments, and malalignment of the foot and ankle related to flat foot syndrome.[6] Tarsal tunnel syndrome has a high incidence in an athletic population.[5] Kinoshita et al identified that of all cases between 1986 and 2002 in their clinic 39.1% were athletes.[5] The higher incidence in this population may be associated with the increase in pressure on the tibial nerve in the tunnel as the ankle is repetitively dorsiflexed during sprinting and jumping activities. This premise is supported by the belief that increased pressure occurs on the tibial nerve in the tarsal tunnel as the ankle is dorsiflexed.[7]

Diagnosis of TTS relies on the history, physical examination, electrodiagnostic tests, and imaging. Symptoms may include pain along the pathway of the nerve, medial ankle pain, numbness, burning, tingling, and/or electrical sensations through the foot and heel. Symptoms may also radiate to the toes, and produce pain across the sole of the foot. Symptoms associated with TTS may be described as pain being a dull ache to even a vice-like tense feeling, hot and cold sensations in the foot, and weakness of the muscles of the foot, especially of the toe flexors.[6] Prolonged standing or walking typically exacerbates symptoms whereas rest relieves symptoms.[8] Common diagnostic tests used during the physical examination to differentiate tarsal tunnel from other pathologies, include Tinel's sign and the dorsiflexion-eversion test.

Electrodiagnostic, specifically electromyography (EMG), and nerve conduction velocity (NCV) findings can be employed to assist with the diagnosis of TTS. A pattern of EMG abnormality that would support the diagnosis includes denervation of intrinsic foot muscles isolated to the symptomatic limb of patients with unilateral disease, with sparing abnormalities of the extensor digitorum brevis.[1] Magnetic resonance imaging (MRI) may also be helpful to rule out the presence of any mass, lesion, or tumor.[6]

Traditional conservative intervention for TTS focuses on decreasing pressure, pain, and inflammation.[9] Neutral immobilization of the foot and ankle may relieve symptoms of posterior tibial nerve entrapment in TTS by minimizing pressure on the nerve and maximizing tarsal tunnel compartment volume for the nerve.[9,10] Theoretically, an orthotic device that provides support to the medial longitudinal arch when excessive pronation is present should also provide symptomatic relief. Rehabilitation includes comprehensive stretching, strengthening, soft tissue mobilization, and neural mobilization.[2,11-13] Additional conservative interventions may include extracorporeal shock wave therapy, laser, local anesthetic injections, heel pads and cups, night splints, strapping, foot orthoses, soft-soled shoes, and ultrasound.[14] A short leg cast may be used in the case of acute trauma to keep the ankle from moving while inflammation in the tarsal tunnel region decreases.[6] Nontraditional conservative intervention includes use of trigger point dry needling (TPDN). Trigger point dry needling has been shown to be effective for treating musculoskeletal injuries involving muscular trigger points and or nerve pain.[15,16]

When conservative interventions fail, surgical interventions may be necessary. In a review of literature, Campbell and Landau[1] identified that patients with TTS showed symptomatic improvement in 91% of the cases treated surgically. Similarly, in a retrospective chart review by Mook et al,[17] improvements were reported on the Visual Analog Scale (VAS) from 6.3 to 1.4 when combining a distal tarsal tunnel release with partial plantar fasciotomy. Specific, postoperative outcome measures revealed a decrease in pain as quantified by the VAS and 67% of patients achieved a rating of excellent or good on the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scores. Further, only one of the 15 heels treated surgically reported a poor outcome at the final follow-up visit.[17]

As minimal information related to the successful conservative management of TTS exists, we attempted a unique conservative approach in a runner with TTS to see if we were able to achieve a positive outcome. The approach taken in this case study is different from previous studies as it incorporates running gait analysis and TPDN into the conservative management of TTS along with traditional methods of rehabilitation, including orthotic management and traditional stretching and strengthening exercises.

CASE DESCRIPTION

History

The patient was a 23-year-old male collegiate cross-country and track runner referred to physical therapy by a physiatrist. The patient had been experiencing pain in his left ankle with running for two months duration. At the time of initial evaluation, the patient had not run in two weeks and was biking approximately 10 miles per day without symptoms. The patient was previously running up to 40 miles per week. The EMG results revealed severe TTS on the patient's left ankle and moderate TTS in the patient's right ankle. Current running footwear was the minimal Nike Free Run (Nike, Inc., Beaverton, OR) with custom orthotics and rearfoot medial posting. The custom orthotics were approximately one month old at the time of initial evaluation.

On the first visit, the patient completed the Lower Extremity Functional Scale (LEFS). The LEFS measures a patient's degree of difficulty with various functional activities. The overall score is determined out of 80 points. Greater scores represent less difficulty in functional activities involving the lower extremities. The patient's score on the first visit was a 59/80. The patient indicated difficulty with standing, descending stairs, running fast and making sharp turns, running on uneven ground, and walking one mile. The LEFS was employed because it has been used by previous investigators examining foot and ankle injuries, and it has been shown to demonstrate excellent reliability (.94-.98).[18,19]

Examination

Pain

Pain was assessed using a verbal 0-10 pain scale (0/10 was considered no pain and 10/10 was considered pain that was severe enough to warrant a visit to the emergency room). Upon initial evaluation by the primary author, the patient described his pain as 0/10 at rest and 8/10 with activity. The patient described his pain as sharp and burning in nature. Pain gradually increased in bilateral medial ankles and feet following 8 minutes of running at a 7 minute per mile pace that forced him to discontinue running and seek medical care. The patient reported pain when walking in unsupportive shoes, but denied pain with other functional activities including, stairs and squatting.

Range of Motion

Initial evaluation range of motion measurements were taken using a standard goniometer with the knee extended (Table 1). For plantar flexion, dorsiflexion, inversion, and eversion of the ankle, the measures were taken using standard goniometric landmarks.[20,21] Intraclass correlation coefficients for foot and ankle ROM reliability in patients with orthopaedic conditions have been previously reported by Elveru et al[21] with values ranging from 0.78 for rearfoot eversion to 0.89 for plantar flexion.

Muscle Strength

Manual muscle testing revealed 5/5 strength in the patient's bilateral ankles for all motions. The patient demonstrated slight right hip abduction weakness of 4+/5 in a sidelying position while the tester resisted hip abduction for 10 seconds. The patient also appeared to demonstrate dynamic valgus at the knee with a unilateral squat on the right. Dynamic valgus was operationally defined as a combination of hip adduction and internal rotation.

Palpation

Palpation of the patient's left foot and ankle revealed tenderness posterior to the medial malleolus and in the medial longitudinal arch of his foot. Palpation to the patient's right foot and ankle did not reproduce any tender areas. Thickening was perceived in the tissue of the patient's left posterior lower leg.

Assessment of accessory motions/joint glides of the (talocrural and subtalar joint)

The patient demonstrated decreased mobility in subtalar pronation, as assessed with anterolateral glide of the calcaneus on the talus, and normal mobility in the talocrural joint in his left ankle. Additional mobility testing revealed decreased extension of his first metatarsal phalangeal joint, midtarsal joint mobility (longitudinal and oblique axis), and dorsiflexion of the 1st ray of his left foot.

Posture

Upon visual inspection with the patient quietly standing, decreased medial longitudinal arch height and a calcaneal valgus posture were appreciated on his left. When the patient performed a bilateral squat, visual analysis identified decreased ankle dorsiflexion, foot eversion, and increased hip internal rotation and adduction bilaterally. Unilateral squat testing on the right revealed increased hip adduction, internal rotation, and a contralateral pelvic drop on the unaffected side.

Special Tests

The patient demonstrated a positive Tinel's sign over the posterior tibial nerve posterior to the medial malleolus on his left lower extremity (LLE) and negative Tinel's sign on his right lower extremity (RLE). The Tinel's sign is meant to elicit the patient's symptoms by having the practitioner tap on the posterior tibial nerve where compression is expected. Electrical sensations felt locally or radiating into the foot indicate a positive test.[6]

The patient demonstrated a positive dorsiflexion-eversion stress test on his LLE,

Table 1. Range of Motion at Initial Evaluation

	AROM-Right	PROM-Right	AROM-Left	PROM-Left
Dorsiflexion	10°	15°	12°	18°
Plantar flexion	35°	38°	30°	35°
Rearfoot Inversion	33°	45°	31°	37°
Rearfoot Eversion	10°	13°	9°	15°
Abbreviation: AROM, active range of motion; PROM, passive range of motion				

though this was negative on the RLE. The dorsiflexion-eversion test was performed by placing the foot and ankle in maximal dorsiflexion and eversion with the metatarsophalangeal joints in extension and holding for 5 to 10 seconds in an attempt to reproduce symptoms. This test is deemed positive if the patient's symptoms are reproduced.[1,22,23] Alshami et al[24] identified that the dorsiflexion-eversion test was more sensitive when performed in combination with hip flexion and knee extension.

Neurological Exam

Sensation and Proprioception

Sensation was assessed in response to light touch. Specifically, the therapist swiped the patient with the tip of his finger while the patient's eyes were closed. The patient noted whether the sensation was felt and compared the sensation bilaterally. A 4 cm by 1 cm area located 10 cm proximal to the base of the patient's calcaneus on the postero-medial side of the distal leg was appreciated.

Running Video Gait Analysis

A two-dimensional running video gait analysis was performed with Kinesio Capture software (Spark Motion LLC, Baltimore, MD) using the iPad 2 (Apple Inc, Cupertino, CA) with the subject running at 7:00 per mile pace. The iPad 2 was held stationary on an adjustable tray table during video capture while the table was set at a height of 48 inches. Video was recorded for two 5 second and one 10 second durations from anterior, posterior, and lateral views respectively. Video was analyzed on an iPad 2 using the Kinesio Capture software. Running video gait analysis revealed increased left pelvic drop during RLE midstance, bilateral heel striking with the right knee at 0° of knee extension at initial contact, bilateral overstriding (heel striking at initial contact excessively in front of one's center of gravity), and increased stride length on RLE compared to LLE. The patient demonstrated asymmetrical foot inclination angles of 33° on his RLE and 23° LLE (Figures 1 and 2). A posterior view revealed bilateral foot hyper-pronation at midstance and toe off bilaterally though this was greater on his LLE when compared to his right.

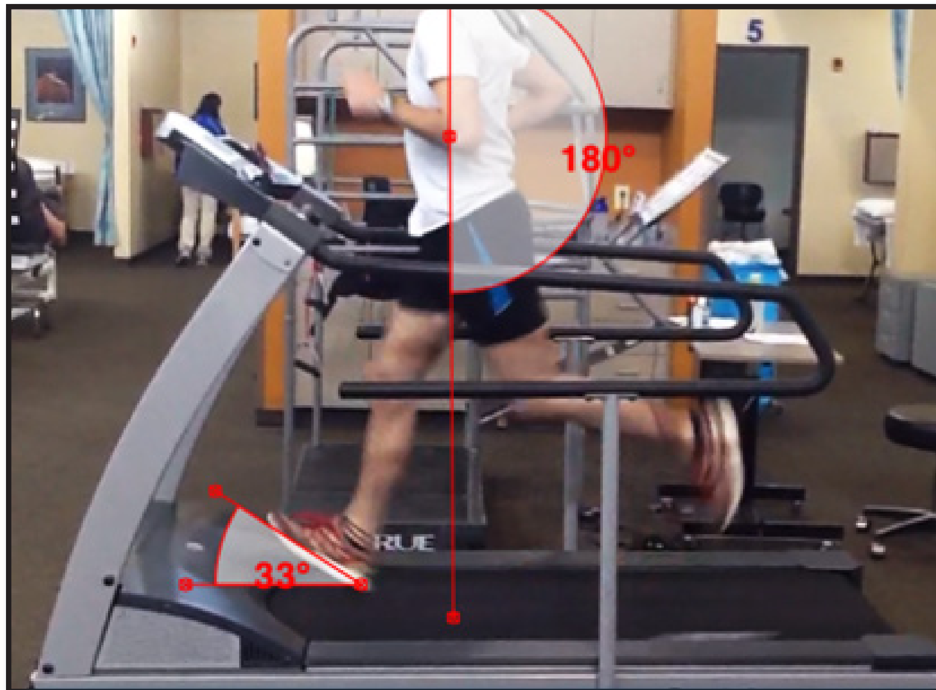

Figure 1. Heel striking right lower extremity at initial evaluation.

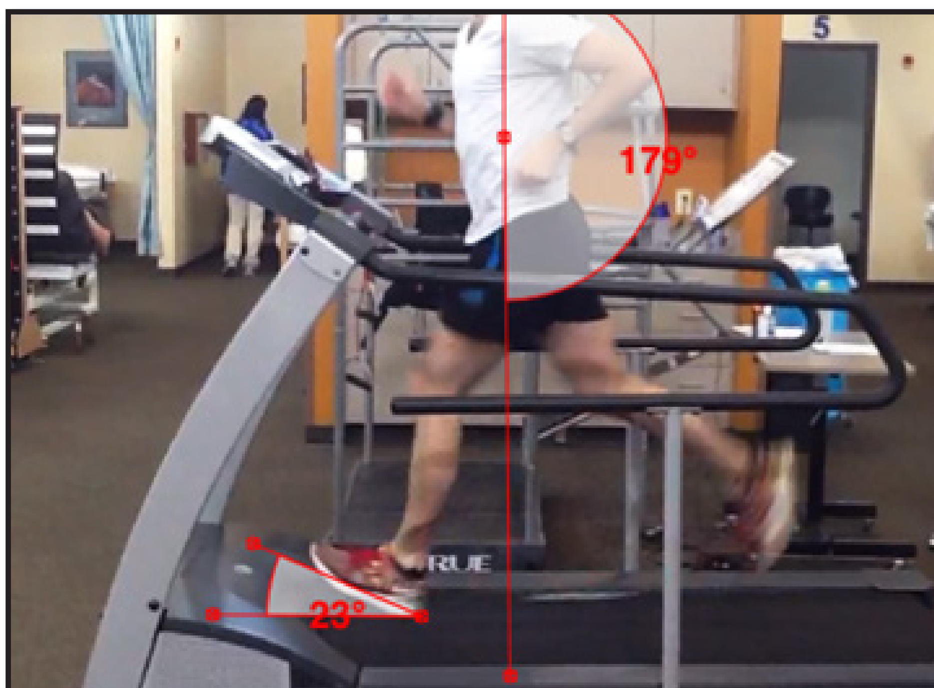

Figure 2. Heel striking left lower extremity at initial evaluation.

DIAGNOSIS

Multiple diagnoses were assigned to this case according to the *Guide to Physical Therapist Practice*[25] Practice Patterns. Specific diagnoses included (1) 4D Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Connective Tissue Dysfunction; (2) 4E Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Localized Inflammation; and (3) 5F Impaired Peripheral Nerve Integrity and Muscle Performance Associated with Peripheral Nerve Injury.[25]

PROGNOSIS

Given the limited number of cases of TTS in the literature, the prognosis for conservative intervention was unclear. Several reports touted the success of surgical intervention,[27,28] suggesting conservative intervention with a traditional approach is fair at best.

GOALS

The patient wished to return to recreational distance running. Anticipated goals for this patient at initial evaluation included (1) return to recreational distance running a minimum of 3 miles per session, 5 times per week at a pace of 8:30 per mile. (2) run 800 meters at maximal intensity on a track; (3) improve right hip abductor strength to 5/5; and (4) normalize running mechanics as quantified using the iPad 2 and Kinesio-Capture software.

INTERVENTION

The patient was seen for 9 visits. Conservative physical therapy management included modalities, TPDN, augmented soft tissue mobilization (ASTYM), strength, flexibility, and balance exercises.[26-30] Based on the initial evaluation data, the patient was instructed to perform a home exercise program consisting of range of motion and strength exercises for his bilateral feet and ankles. These exercises included active range of motion of his right ankle in all planes of motion, Thera-Band (The Hygenic Corporation, Akron, OH) exercises, gastrocnemius and soleus stretching on a 6" step, single-leg stance balance activities, and TheraBand hip abductor strengthening exercises.

Static and dynamic balance exercises included heel/toe walking, single leg stance on various surfaces, and heel-toe raises on flat surface and 4" and 6" steps. Pain was managed early in the rehabilitation phase with ultrasound, and Kinesiotaping (Kinesio, Albuquerque, NM) to assist the posterior tibialis muscles bilaterally.[31] Kinesiotape was applied at the plantar surface of the patient's medial heel bilaterally and pulled with a 50% stretch, in one strip, toward the origin point of the patient's posterior tibialis muscle, thereby placing the patient's ankle in 30˚ of plantar flexion.

Scar tissue thickness was managed with the ASTYM procedure. The ASTYM procedure was applied to the patient's legs, feet, and ankles with the ASTYM evaluator, localizer, and isolator tools. Cocoa butter was used to minimize irritation that might have otherwise been caused by the ASTYM tools. The ASTYM procedure was applied to decrease fibrotic tissue in the patient's lower extremities, particularly in his left foot, ankle, and lower leg.[32]

Trigger point dry needling was initiated at visit three. This procedure involved placing small ½", 1", and 1.5" acupuncture needles into the patient's lumbar spine bilaterally at levels L2-S1, specific lower extremity acupoints, and symptomatic painful and numb areas in the patient's bilateral feet and ankles. Needles were placed in the low back, hip, and lower extremity nerve acupoints; posterior cutaneous L2, posterior cutaneous L5, superior cluneal, inferior gluteal, iliotibial, lateral popliteal, sural, saphenous, common fibular, tibial, and deep fibular. Additional acupuncture needles were placed in the area of the tarsal tunnel bilaterally (Figures 3 and 4). The patient completed 4 sessions of TPDN before his symptoms resolved.

RUNNING

Running cadence training was initiated on visit 6. Intervention focused on encouraging the patient to adopt a midfoot strike running pattern with an initial cadence of 180 steps per minute at 8:30 per mile pace. Running cadence was practiced on a treadmill with a metronome. Verbal cues were provided to increase or decrease running cadence.

RESULTS

At discharge, the patient scored a 78/80 on the LEFS with limitations in running fast and making sharp turns. The difference score (discharge minus initial evaluation) was 19 points.

The patient described his pain as 0/10 at rest and with running. The patient did not have pain when walking in unsupportive shoes, and he denied pain with other functional activities including stairs and squatting.

The patient demonstrated minimal improvements in AROM of his right and left ankles (Tables 1 and 2), though a significant difference in plantar flexion from initial evaluation to discharge was documented. While it is expected that dorsiflexion would be limited in cases of TTS, this was not the case in this study. It is unclear why plantar flexion was so limited in this patient in comparison to dorsiflexion.

The patient also improved his right hip abduction strength from 4+/5 to 5/5. Palpation of the patient's bilateral feet and ankles did not reproduce any tender areas. The patient demonstrated normal mobility in subtalar pronation and normal mobility in the talocrural joint in bilateral ankles. Additionally, mobility testing revealed normal extension of his first MTP joint, midtarsal joint mobility (longitudinal and oblique axis), and dorsiflexion of the 1st ray of his left foot.

When the patient performed a bilateral squat, visual analysis identified normal ankle dorsiflexion and foot eversion, and improved hip internal rotation and adduction bilaterally. Unilateral squat testing on the right revealed normal hip adduction, internal rotation, and a no contralateral pelvic drop on the unaffected side. The patient demonstrated a negative Tinel's sign over the posterior tibial nerve posterior to the medial malleolus bilaterally. All light touch sensation testing was normal 10 cm proximal to the base of the patient's calcaneus on the postero-medial side of the distal leg.

Figure 3. Trigger point dry needling of the foot and ankle.

Figure 4. Trigger point dry needling of the lower leg.

Table 2. Range of Motion at Discharge

	AROM-Right	PROM-Right	AROM-Left	PROM-Left
Dorsiflexion	13°	17°	12°	18°
Plantar flexion	55°	60°	55°	60°
Rearfoot Inversion	33°	45°	32°	38°
Rearfoot Eversion	10°	15°	9°	14°
Abbreviation: AROM, active range of motion; PROM, passive range of motion				

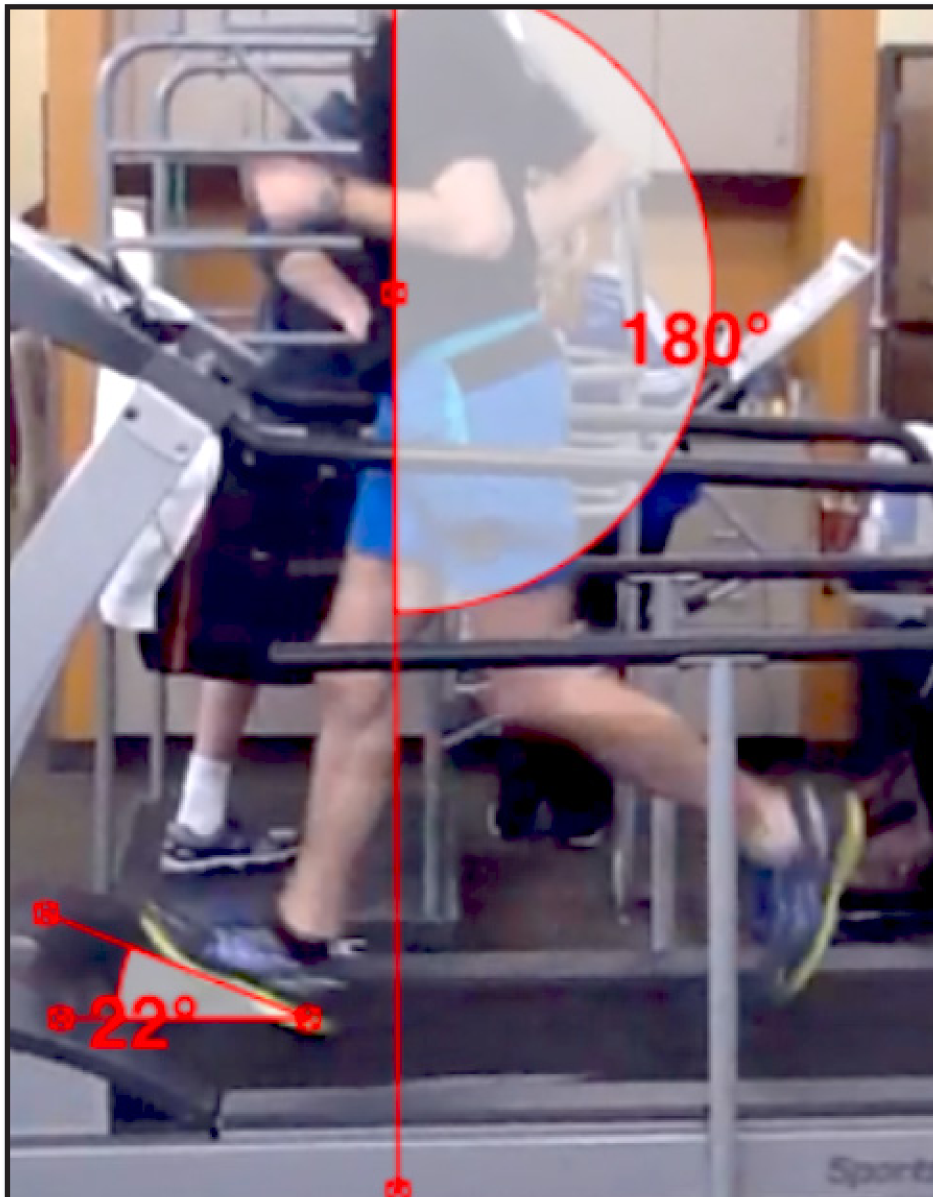

Figure 5. Heel striking right lower extremity at discharge.

Figures 5 and 6 illustrate the patient's footstrike patterns after running cadence training with a metronome at 182 steps per minute (spm). Note the decreased foot inclination angles of 22° on the right and 20°on the left.

DISCUSSION

This case study described a unique and multi-faceted approach to conservatively and successfully manage TTS in a collegiate athlete. Running video gait analysis was an integral part of managing this athlete's symptoms and returning him to competitive running. A midfoot type of footstrike pattern was recommended based on work by previous researchers.[33-37] These works demonstrated less peak impact force at initial contact in runners that land with a forefoot and/or midfoot striking pattern. Further evidence has shown a midfoot strike pattern is associated with a lower incidence of running injuries.[38-40] This is thought to be due to lower vertical ground reaction forces sustained from decreased vertical displacement of the center of mass of the runner and increased step frequency.[33,34,41,42]

A larger foot inclination angle results in greater amounts of knee extension at initial contact and larger peak impact forces.[42,43] Greater knee flexion angles at initial contact allow the patient to better absorb peak impact forces. This is proposed to result in lower peak impact forces on the patient's ankles and less stress on the tarsal tunnel from decreased dorsiflexion at initial contact and landing with more of a midfoot striking pattern. Footwear modification was not necessary as the patient's neutral footwear with his custom orthotics proved to provide

Figure 6. Heel striking left lower extremity at discharge.

ample support to prevent overpronation once his running cadence was increased to 182 spm; therefore potentially leading to lower peak impact forces at initial contact. While video analysis was an essential part of this case, the reader should appreciate the reliability and validity of Kinesio Capture software for iPad 2 has yet to be established.

Trigger point dry needling is a new type of conservative intervention gaining attention in the field of physical therapy. While it is not approved to be performed by physical therapists in all states, it has been shown to be effective for treating musculoskeletal injuries involving muscular trigger points and/or nerve pain.[15,16] Trigger point dry needling is a manual therapy procedure where acupuncture needles are inserted into the skin and muscle in areas of myofascial trigger points. Trigger point dry needling is based on Western medicine. It focuses on areas of fibrosis or myofascial trigger points, and the spinal levels that innervate those areas. It attempts to create a muscle "twitch response" that creates an analgesic effect. Trigger point dry needling was integral in decreasing the patient's numbness and tingling in his lower extremities. While there is no evidence that TPDN has been used to treat TTS, there is evidence that acupuncture has been used to successfully treat this condition.[15,16]

Following the series of ASTYM treatments, less texture was perceived in the subcutaneous tissues. This change may have resulted in decreased stress on the tibial nerve in the tarsal tunnel.

The patient demonstrated slight improvements in active range of motion of his right and left ankles following the treatment sessions. He also improved his right hip abduction strength and footstrike pattern when running. The LEFS demonstrated improved value from 59/80 at initial evaluation to 78/80 at discharge. This score demonstrates the patient's improvement in his ability to perform functional tasks and recreational activities, including competitive running. Given the minimal clinically important difference of the LEFS has been reported to be 9 points, we are confident the difference in score reveals a substantive change.[18]

CONCLUSION

Conservative intervention of TTS with use of a multi-faceted approach proved to be beneficial in resolving symptoms of TTS in a collegiate runner. While it is unclear whether it was one or an interaction of the interventions that was used in this case to resolve the patient's symptoms, the case provides additional literature supporting the use of conservative intervention for patients with TTS. Future work (ie, randomized clinical trials) is necessary with this population to provide stronger evidence further justifying the use of our conservative interventions.

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J. Haxby Abbott is the New Editor-in-Chief for *JOSPT*

On behalf of *JOSPT*'s Board of Directors, I am pleased to let you know that J. Haxby Abbott, PhD, DPT, FNZCP, has accepted the position of Editor-in-Chief for *JOSPT*, succeeding Dr Guy Simoneau. Dr. Abbott will be responsible for material published in *JOSPT* starting with the January 2016 issue. Consequently, he will begin work with *JOSPT* as of July 1, 2015.

Dr Abbott has been an associate editor for *JOSPT* since 2011 and has previous experience as editor for the *New Zealand Journal of Physiotherapy*. He has a strong background in high quality research with diverse design methodologies and has published extensively in a variety of journals. Dr Abbott also brings a vital international perspective to *JOSPT* through his past work experiences and ongoing research collaborations with colleagues from around the globe.

Dr Abbott, who currently resides and works in New Zealand, worked in the United States between 1993 and 1999 in Texas, Iowa, Colorado, and Florida, where he earned his MScPT degree at the University of St. Augustine for Health Sciences. In 2005, he was a visiting research fellow and teaching assistant at the University of Utah. He is a member of APTA and also the Orthopaedic and Sports Physical Therapy Sections.

The Orthopaedic Section welcomes Dr Abbott.