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Case Reports and Series

Nonsurgical Approach in Management of Tibialis Posterior Tendinopathy With Combined Radial Shockwave and Foot Core Exercises: A Case Series

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ABSTRACT

Tibialis posterior tendinopathy is a common debilitating condition seen by foot and ankle providers. Non-operative management is difficult as patients often present in later stages of the disease. This case series evaluated the combination of radial shockwave therapy and a foot core progression exercise regimen on 10 patients who had failed standard conservative treatment techniques. Median follow-up time was 4 months. Clinically important differences in the Foot and Ankle Ability Measure were met in 9 (90%) and 8 (80%) of patients for activities of daily living and sport sub-scores, respectively. No adverse effects were observed.

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Tibialis posterior tendon dysfunction/tendinopathy (PTTD) is a common debilitating condition with an estimated prevalence as high as 4% (1). Due to a lack of a mesotendon, the tibialis posterior is prone to degeneration secondary to an area of hypovascularity immediately distal to the medial malleolus. The diagnosis is largely clinical with plain radiographs typically being unremarkable in early stages. Patients will commonly have complaints of pain in both the medial foot and behind the medial malleolus that worsens with prolonged standing and activity. As disease progresses, there is progressive loss of foot function and global weakness accompanied by worsening pain. Increasingly fixed deformity and loss of function are well described in the Bluman and Myerson staging system (2).

Functions of the tibialis posterior include ankle planter flexion, midfoot inversion through subtalar joint adduction and supination, and dynamic stabilization of the medial longitudinal arch (3). When diseased, patients experience a progressive loss of foot function, global weakness, progressive flatfoot deformity, altered biomechanics, and worsening pain. Physical examination is sufficient to make the diagnosis. Imaging is helpful in uncertain cases and for determining severity. Stages I and II of PTTD are characterized by tendinopathic changes and tendinopathic changes with correctable foot and medial longitudinal arch deformity, respectively (2).

Current conservative management approaches are often ineffective and poorly described, as shown by a recent systematic review (4). Initial immobilization with a plantar cast or removable fracture boot and oral anti-inflammatories are mainstays. Traditional physical therapy usually focuses on tibialis posterior and ankle strength/flexibility with frequent concurrent use of orthotics (5,6). Corticosteroids can then be considered in recalcitrant cases, although utility is limited given the condition's degenerative etiology and concern for tendon rupture. Operative treatment is later considered with synovectomy or reconstruction with toe flexor tendon transfers and ligament plication being most common.

Extracorporeal shockwave has evidence in management of tendinopathy and soft tissue conditions of the foot and ankle (7). Radial shockwave (R-SWT) is a low-energy form of treatment that can be performed safely and may promote tissue healing and reduce pain. However, to our knowledge there are no prior reports of R-SWT use in the management of tibialis posterior tendinopathy. Additionally, there are no publications evaluating the use of foot strengthening programs based on the "foot core paradigm" for tibialis posterior tendinopathy. Conceptually, the foot core describes 3 components to foot capacity: (1) passive system consisting of ligaments and connective tissue, (2) active system of intrinsic and extrinsic muscles of the foot and ankle, and (3) proprioception.

The purpose of the present case series was to assess changes in functional outcomes after treatment with the combination of R-SWT and a physical therapy program using the foot core paradigm in the management of patients with refractory PTTD. We hypothesized the majority of patients would achieve minimal clinically important differences (MCID) in functional outcome measures after treatment.

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Table 1
Demographics and Clinical Characteristics (N = 10)

Patient	Age	Gender	Symptoms (mo)	Follow-up (mo)	Prior PT	Prior Orthotic	No. of R-SWT Sessions	FAAM ADL Change	FAAM Sport Change
1	23	Female	6	3	Yes	No	5	11	10
2	26	Female	3	5	Yes	Yes	5	12	9
3	58	Male	24	3	Yes	Yes	5	13	6
4	24	Female	7	12	Yes	Yes	8	16	10
5	19	Male	8	5	Yes	Yes	5	11	15
6	36	Female	9	4	Yes	Yes	6	0	-1
7	32	Female	4	3	Yes	No	4	30	21
8	56	Female	4	5	Yes	Yes	5	11	11
9	58	Female	19	3	Yes	Yes	5	14	11
10	68	Male	12	4	Yes	Yes	4	15	10
Median	34		7.5	4			5	12.5	10
Interquartile range	24 to 58		4 to 12	3 to 5			5 to 5	11 to 15	9 to 11

Abbreviations: PT, physical therapy; R-SWT, radial shockwave therapy; FAAM, Foot and Ankle Ability Measure; ADL, activities of daily living.

Patients and Methods

Approval was obtained from our institution's quality improvement advisory board; IRB approval was not required by the institution. Chart review of consecutive patients with PTTD who presented to the senior authors' (A.T.) outpatient sports medicine clinic for consideration of R-SWT from January 2018 through July 2019 was performed by 3 authors (D.R., M.M., A.T.). Clinical data obtained included injury, clinical, and treatment characteristics, demographics, and functional outcomes (Table 1). Inclusion criteria were: (1) primary diagnosis of PTTD, (2) nonresponse to previous physical therapy, and (3) completed baseline and follow-up functional outcome measures. Exclusion criteria were (1) presence of conditions treated concurrently outside the foot and ankle region, (2) known connective tissue disease, and (3) use of anticoagulation as it may theoretically interfere with treatment response due to its effect on the coagulation cascade. The diagnosis of PTTD was made clinically for all with imaging obtained to exclude alternative etiology when indicated.

Fourteen consecutive patients were treated during the study period. Two were excluded for having multiple primary pathologies treated (proximal hamstring tendinopathy and bilateral plantar fasciitis), 1 for warfarin use, and 1 with connective tissue disease. This resulted in 10 patients for analysis. Functional outcomes using the Foot and Ankle Ability Measure (FAAM) were completed by the patients at baseline and periodically throughout follow-up visits. The FAAM is divided into 2 subscales, activities of daily living (ADL) and sport. The ADL subscale ranges from 84 (no limitations) to 0 points while the sport subscale ranges from 32 (full performance, asymptomatic) to 0 points. A change in 8 points for the ADL subscale and 9 points for the sport subscale were used for the MCID, respectively (8).

Shockwave Procedure

Shockwave was provided over a minimum of 3 weekly sessions by the senior author (A.T.), with an additional series of treatment provided if positive but not complete clinical response. The R-SWT treatment is performed with the patient prone or supine. The location of maximum pain is identified through palpation. The distal portion of the tibialis posterior tendon including at the tarsal tunnel and insertion on the tarsal navicular is most accessible with the patient lying prone with the foot extended off the bed. The more proximal portion of tibialis posterior including the myotendinous region and proximal muscle origin is best accessed with the patient supine and leg externally rotated.

The treatment described was performed using the Storz extracorporeal pulse activation technology (EPAT®) device (Storz Medical, Tägerwilen, Switzerland). Initially the C15 (ceramic head) is applied over the tibialis posterior tendon at the level of the medial malleolus (Fig. 1). Treatment is started at low level to allow for patient comfort, minimum of pressure unit (bar) threshold with 1.8 was tolerated and then applied at 15 Hz for total 3000 count. Given that the tibial nerve is positioned close to the tibialis posterior tendon, each patient was instructed to communicate sensation of nerve pain or symptoms into

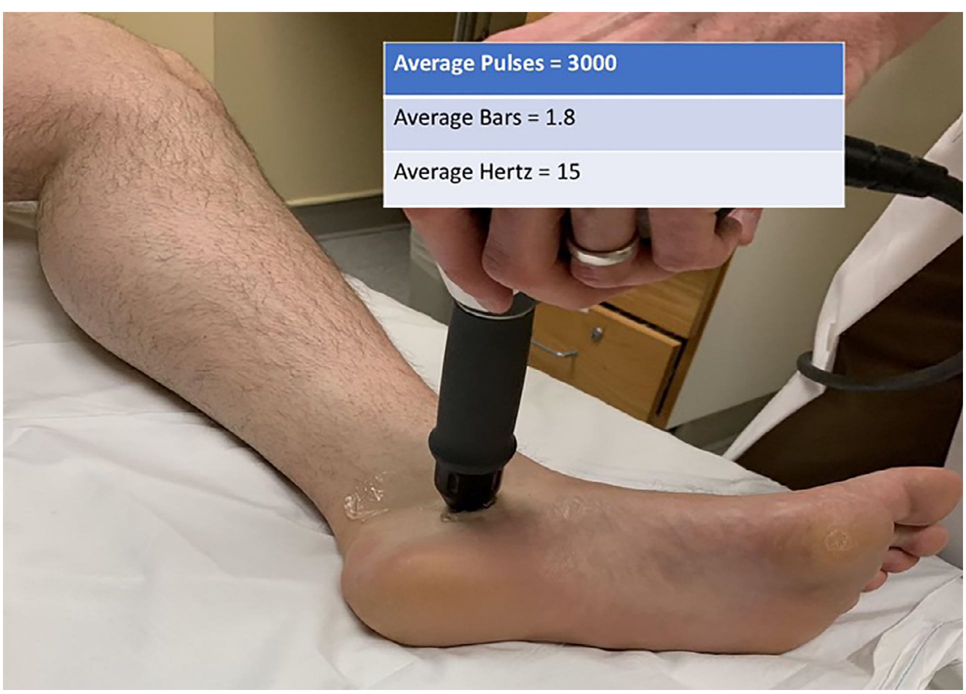

Fig. 1. Shockwave application and optimal settings. Treatment is started with the C15 ceramic head over the tibialis posterior tendon at the level of the medial malleolus. Optimal device settings are depicted.

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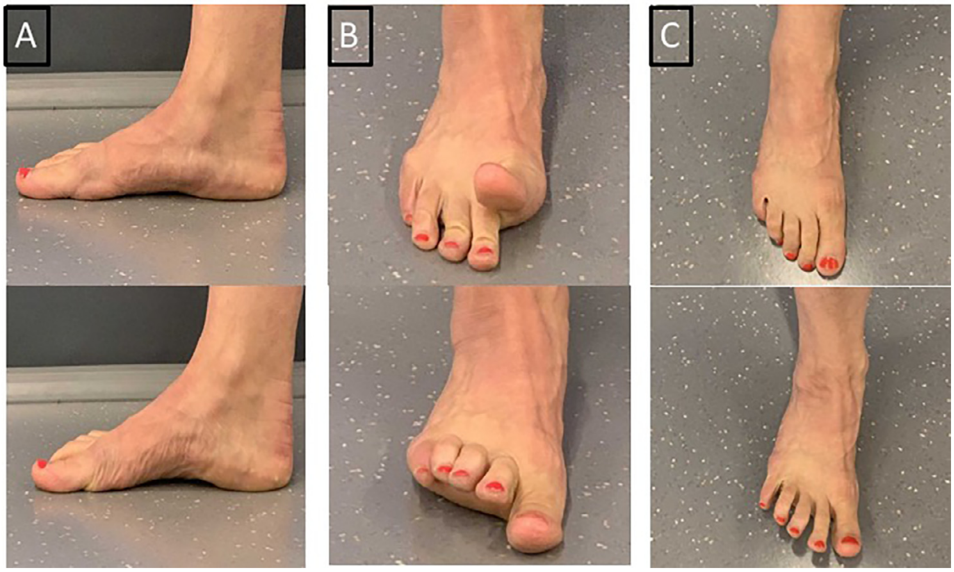

Fig. 2. Three primary exercises of foot core progression: (*A*) foot doming, (*B*) toe yoga, and (*C*) intrinsic foot abduction.

the foot. The clinical focusing technique should be used to advance treatment along the length of the tibialis posterior including advancing both proximally toward the myotendinous region and distally to the insertion onto the tarsal navicular. Next, the D20 “Standard Oscillator” is applied starting approximately 5 cm proximal to the medial malleolus and applied along the length of the tibialis posterior muscle to the level of the knee. Pressure is applied in the medial to lateral direction posterior to the medial border of the tibia, and typically 2 bar minimum threshold is tolerated for total 3000 count at 15 Hz.

Using the described settings, the treatment can be completed in less than 10 minutes, but additional treatment of other sites of pain can also be applied to improve overall pain and function in the foot (e.g., plantar fascia, Achilles tendon and other tendon/soft tissue sites of pain). It is advised to obtain a maximum preprocedure pain score and baseline functional outcome measure to track progress. Patients are instructed to not concurrently use nonsteroid anti-inflammatories and avoid icing throughout treatment and to continue generalized physical activity as tolerated.

Foot Core Exercise Program

All patients were concurrently prescribed a foot strengthening program based on the foot core principles (9). The mainstay of the foot core exercise program is the short foot exercise, otherwise known as “foot doming” (Fig. 2). Doming was performed by firming the toes, dragging the ball of the foot toward the heel and thus shortening the foot and creating an arch. The patient was guided to minimize extrinsic muscle activation by reducing use of tibialis anterior and long toe flexors. Additional exercises for foot core may include “toe yoga” and toe abduction/adduction. Toe yoga is performed by having the patient extend the big toe while keeping the small toes on the ground and then alternating by pushing the big toe back on the ground and lifting the small toes. Toe abduction/adduction is simply spreading the toes wide and then bringing them back together. These 3 foot core exercises (doming, toe yoga, toe abduction/adduction) can be performed up to 3 times a day to assist in consistent activation and recruitment of the intrinsic muscles.

Progressions of these exercises is recommended in weightbearing. Patients were provided with various single leg balance exercises performed barefoot while maintaining their foot dome. Hopping and landing exercises were prescribed as well with cuing for patients to activate their arch on takeoff and landing.

In addition, extrinsic foot muscles were strengthened as well, specifically the tibialis posterior muscle and gastrocsoleus complex. Isolated tibialis posterior exercises are performed with resistance band in open chain while calf raises were performed in weightbearing. Calf raises were performed on 1 leg with knee bent and with knee straight to improve both gastrocnemius and soleus strength with volume increasing up to 3 sets of 30 on each leg.

Statistical Analysis

Two-tailed paired Wilcoxon signed-rank tests were used to compare baseline and follow-up functional outcomes. Median and interquartile ranges are reported. Statistical significance was defined at the 5% ($p \leq .05$) level. The analyses were carried out by the primary author (D.R.).

Results

There were 7 (70%) female and 3 (30%) male patients (Table 1). Median age of the cohort was 34 (IQR 24 to 58) years with a median symptom duration of 7.5 (IQR 4 to 12) months. All 10 patients had failed conservative treatment, including traditional physical therapy. Eight patients had previously been prescribed shoe orthotics. Six had obtained magnetic resonance images that demonstrated tibialis posterior tendon pathology. Each patient was instructed to not use nonsteroidal anti-inflammatories and to avoid icing. Activities including running were allowed. No orthotics or other shoes were prescribed as an intervention.

Changes in FAAM ADL were significant from median baseline score of 61 (IQR 56 to 68) to final score of 76.5 (IQR 69 to 80) ($p = .001$) (Table 2). FAAM Sport changes were also significant from median baseline of 14 (IQR 11 to 16) to final 24.5 (IQR 18 to 26) ($p = .003$). The MCID was met in 9 (90%) and 8 (80%) of patients for ADL and sports outcomes, respectively at median 4 (IQR 3 to 5) months' time from baseline. In 2 cases, symptoms of tibial nerve irritation at the tarsal tunnel were described during treatment. All episodes were transient and resolved with refocusing of the device. No other complications were observed. Additionally, R-SWT was applied to the ipsilateral plantar fascia in patient 7 and peroneal tendons in patient 9. Of note, the 2 patients excluded for multiple primary diagnoses did not meet either MCID criteria and the patients excluded for anticoagulation use and with connective tissue disease met both MCID criteria.

Discussion

The purpose of this report is to evaluate the effectiveness of a treatment program of R-SWT combined with a foot core progression therapy

Table 2
Foot and ankle ability measure outcomes (N = 10)

	Baseline	Final	
FAAM ADL	61 (56 to 68)	76.5 (69 to 80)	$p = .001$
FAAM Sport	14 (11 to 16)	24.5 (18 to 26)	$p = .003$

Data are median and (interquartile range).
Abbreviations: FAAM, Foot and Ankle Ability Measure; ADL, activities of daily living.

program within a population of individuals with posterior tibial tendinopathy. Most patients using this combined program achieved clinically significant outcomes in function for ADL and activity. Alvarez *et al.* reported an 83% success rate in treating stage I and II PTTD with orthotics and foot extrinsic musculature strengthening, with 11% later requiring surgery (10). In the present case series, all 10 patients failed to respond to prior conventional physical therapy for their PTTD. Thus, we sought to evaluate an innovative conservative approach using R-SWT and the foot core paradigm to restore tibialis posterior function. Our results suggest R-SWT with a formal physical therapy program using foot core progression may be an effective and noninvasive treatment alternative approach for refractory tibialis posterior tendinopathy. No major complications were observed.

Foot core progression intuitively would be useful to address the strength deficits in PTTD. The active subsystem of the foot core consists of local stabilizers and global movers. Local stabilizers are the plantar intrinsic muscles that originate and insert on the foot, while global movers are the extrinsic muscles that originate on the lower leg and insert on the foot (9). Our patients completed the above described therapy regimen that focused on strengthening both. Typically, orthoses are often prescribed for patients with the goals of alleviating posterior tibialis stresses, limiting deformity progression, and improving biomechanics (11). While this method effectively provides external support, foot core progression focuses on intrinsic factors and avoids disuse atrophy. Notably most patients had prior orthotic prescription and persistent pain that subsequently completed the combined R-SWT and foot strengthening program.

While not previously described for treatment of tibialis posterior, shockwave therapy offers a noninvasive approach for the management of a variety of chronic, refractory tendinopathies. Radial shockwaves are produced via pneumatic/ballistic devices. Proposed mechanisms for their positive effects in tendinopathy include stimulation of neovascularization and stimulation of collagen synthesis through increased growth factor and protein synthesis (12,13). The analgesic effect may arise from nociceptor hyperstimulation and altered pain receptor neurotransmission (14). Anecdotally, we have found co-treatment of tendons affected by altered biomechanics of the primary pain generator to be beneficial. Results with shockwave have been best when coupled with a therapy regimen in management of other conditions (15).

This report is meant to serve as a description of an innovative conservative management technique for PTTD. While the findings are encouraging, results should be interpreted with caution. The main limitations are a small sample size and no control group. Selection bias of participants may influence results (including choice of procedure and out of pocket expense). Follow-up outcomes were obtained at a median of approximately 4 months and knowing longer-term success rates would be beneficial. In summary, our results suggest that foot core progression combined with R-SWT may be effective in the management of PTTD. These results may serve as a guide for future prospective investigation via cohort study or randomized control trial studying nonoperative treatment techniques for PTTD.

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