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Diagnosis and Successful Management of an Unusual Presentation of Chronic Foot Pain using PET/MRI and a Simple Surgical Procedure

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Abstract

A 61-year-old man presented with chronic dorsal foot pain of nine years that worsened with ambulation. Conventional diagnostic imaging and medical workup were unrevealing, and ankle arthrodesis had been recommended by an orthopedic surgeon for pain relief. Instead, the patient participated in a clinical imaging trial designed for identifying pain generators using whole-body fluorodeoxyglucose (18F-FDG) positron emission tomography/magnetic resonance imaging (PET/MRI). The scan revealed not only high 18F-FDG uptake at the site of pain, but also a hematoma and an inflamed, fibrotic, ruptured plantaris muscle. The fibrotic plantaris likely altered biomechanics with walking, explaining why symptoms worsened with activity. A simple tenotomy of the plantaris tendon was performed to decouple ankle movement from the plantaris injury, resulting in pain relief. This case illustrates the potential of whole-body 18F-FDG PET/MRI to better localize pain generators.

Keywords

Plantaris muscle; foot pain; tennis leg; 18F-FDG; PET/MRI

INTRODUCTION

There is a lack of objective, diagnostic tools for accurately identifying sources of chronic pain. Simultaneous 18F-FDG PET/MRI offers joint examination of anatomic abnormalities (MRI) and hypermetabolic/inflammatory abnormalities (PET), and has recently shown promise for improved detection of chronic pain generators^{1–3}. Here, we describe a

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successful application of whole-body 18F-FDG PET/MRI to a case of unsolved chronic foot pain of nine years. Our imaging findings led to the modification of the treatment plan from ankle arthrodesis to a lower risk tenotomy of the plantaris tendon, which achieved pain relief. This case report highlights how our 18F-FDG PET/MRI approach identified the pain generator, allowing for tailored treatment.

CASE REPORT

A 61-year-old man presented with pain, persisting for nine years, in his right dorsal foot that would radiate upwards through his lateral shin to his thigh with weight-bearing activities. The pain was described as “sharp, shooting, stabbing, cramping, aching, and burning.” Standing or walking would exacerbate the pain, and sitting would relieve it. On average, the pain was 2/10 on the 0-10 pain scale (0 = none, 10 = worst imaginable), but would rise to a maximum of 9/10 with activity. Orthotic devices (braces, shoe inserts, and supports) and cortisone injections into the foot provided no relief. The initial onset of the pain was sudden, and the patient did not recall any triggering event; he first experienced it while walking in a parking lot and immediately began to limp. He did, however, note a waterskiing accident that had occurred four years before this onset. During the incident, he fractured his foot (anterior process of the calcaneus) and felt a “pop” in his leg. He experienced some pain following the event, but felt fully recovered after a month.

The patient saw multiple specialists before consulting with our foot and ankle surgeon, and had been recommended an ankle arthrodesis. Ultrasound studies of the right leg did not reveal any vascular problems. Weight-bearing radiographs of the foot showed possible abnormalities in the third tarsometatarsal joint and the anterior process of the calcaneus. A computed tomography (CT) scan of the foot showed a well-corticated ossicle, likely the result of the fracture and no definite evidence of degenerative joint disease in the midfoot. Ankle arthrodesis was advised by a surgeon, but other specialists referred the patient for electrodiagnostic testing, suspecting entrapment of the superficial peroneal and tibial nerves. Physical examination revealed tenderness of his right, central midfoot and limited inversion-eversion of the right foot compared to the left. No sensory loss, edema, or temperature changes in the skin were identified. Electromyography (EMG) suggested right peroneal neuropathy at the fibular head, but Tinel’s sign over the right fibular head and over the Tarsal tunnel was negative.

At this point, the findings from the CT scan, physical exam, and EMG still did not identify a specific pathology to explain the patient’s foot pain. The patient then participated in our ongoing clinical trial ([ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT03195270) identifier: NCT03195270), which is a cohort study that employs simultaneous whole-body 18F-FDG PET/MRI with the aim of determining whether 18F-FDG PET/MRI can serve as a spatial biomarker for chronic pain. Analysis is currently underway, comparing MR images and 18F-FDG uptake (using maximum standardized uptake values) in chronic-pain patients to that of healthy volunteers. PET/MR images, obtained using a time-of-flight PET/MR scanner (SIGNA; GE Healthcare, Chicago, Illinois), showed high 18F-FDG uptake in the plantaris muscle and increased uptake in the dorsal surface of the midfoot, where the patient described his main symptoms (Fig 1). The scan also revealed a large hematoma in the expected location of a plantaris muscle and

tendon (Fig. 2). These findings suggest the exacerbated pain during ambulation might be caused by altered mechanics due to fibrosis of the inflamed plantar muscle belly.

Upon review of the scan results, the patient noted that the region of his plantaris muscle felt tight. The surgeon suggested tenotomy of the plantaris tendon to mitigate aggravation of pain with activity, as this procedure was low-risk and would sever the connection between ankle movement and the ruptured plantaris muscle. With the patient under local anesthesia with sedation, the plantaris tendon was identified just medial to the Achilles tendon. It was dissected proximally and distally, and a centimeter was excised. A soft wrap was placed, and the patient was allowed to bear weight immediately.

The patient was seen two weeks after surgery and reported no significant pain in either his foot or calf. At 3-month follow-up, the patient was free of pain and able to walk without limitations.

DISCUSSION

We describe a case of chronic foot pain resolved by dividing the plantaris tendon after whole-body 18F-FDG PET/MRI identified a chronically ruptured plantaris muscle as a potential pain generator. The plantaris tendon is an accessory structure absent in an estimated 7%-10% of humans⁴ and can be sacrificed without significant side effects. For example, this tendon is sometimes used as donor tissue for tendon graft surgery, and plantaris tenotomy has been performed to allow for increased range of motion in ankle dorsiflexion^{5,6}. However, to our knowledge, the application of plantaris tenotomy to alleviate pain as in this report has not been reported before. Rupture of the plantaris muscle occurs most commonly in middle-aged men as a sports injury known as “tennis leg”^{7,8}. Patients often report having felt a “pop” in their leg, as our patient experienced during his waterskiing accident. Patients may have pain and tenderness in the mid-Achilles region but can move their ankle through its full range of motion with little pain or discomfort^{7,9}. However, our patient primarily experienced dorsal foot pain that worsened with ambulation. This unusual symptomatic manifestation of chronic tennis leg may be due to altered mechanics coupling the chronic hematoma (and presumed fibrosis) to the cutaneous sensation of the medial and dorsal foot¹⁰. Dividing the tendon, thus, may provide symptomatic relief by preventing ankle movements from irritating the inflamed muscle injury.

Radiographs of the patients acquired prior to our PET/MRI study included only the foot (i.e. the primary location of pain), revealing abnormalities from the unrelated foot fracture. This case illustrates the benefit of a wider field of view in diagnosing chronic pain, because pain is often referred. While the abnormality in the plantaris muscle is visible on MRI alone (Fig. 2), the metabolic information from PET increases the certainty that this abnormality is, in fact, related to the cause of pain. The increased cost from the dual PET/MRI imaging and currently limited availability of the PET/MRI scanner can be a limiting factor in the clinical viability of this approach. In this particular scenario, however, the cause of the patient’s years of suffering was never found using conventional approaches. Subsequent workup would have likely included additional MRIs (of the lumbar spine, pelvis, and possibly the

knee), electromyography, multiple clinic visits, missed time at work, and possible invasive procedures. All of these would have required resources that would have easily surpassed the cost of a single whole-body PET/MRI and may have in fact resulted in misguided treatments and an undesirable outcome. Therefore, use of whole-body or near whole-body PET/MRI method can potentially serve as a useful additional tool for the challenging chronic pain cases once preliminary standard diagnostic approaches have been exhausted.

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Figure 1.

Increased ^{18}F -FDG uptake related to chronic foot pain. (A) Coronal view of lower portion of whole-body PET, showing increased radiotracer uptake in the right plantaris muscle belly (red arrow) and in the right foot and ankle (green arrows). (B) Axial ^{18}F -FDG PET (top) in the dorsal part of the ankle/proximal foot shows increased tracer uptake where the patient describes his main symptoms (white arrow). Axial time-reversed FISP (PSIF) MR image (bottom) at the same level shows this to be in the vicinity of the right deep fibular nerve but appears normal.

Figure 2.

Ruptured plantaris tendon with hematoma. (A) Axial double-echo in steady state (DESS) MR image, showing the ruptured right plantaris (red arrow) compared to the normal, left plantaris (green arrow). A large, partially liquefied hematoma is located between the soleus muscle and medial gastrocnemius muscle, visible as increased signal on MRI, likely causing mass effect on surrounding structures. (B) 18F-FDG PET/MRI co-registered image, showing that increased radiotracer uptake coincides with the abnormality visible on MRI (white arrow).