



## EMG Case No. 82, October 2006

### Presenting Symptom(s):

**Left lower extremity pain with exertion followed by ankle weakness**

## This case is no longer available for CME Credit.

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**Disclosures:** RP Farhat, None; R Werner, None.

**Appropriate Audience:** Residents and practicing physicians.

**Learning Objectives:** After completing this educational activity, participant will be able to: (1) utilize the patient's history and physical to devise an adequate differential diagnosis of lower extremity symptoms, (2) perform appropriate nerve conduction studies and needle examination to evaluate for lower extremity pain and weakness, and (3) identify exertional compartment syndrome.

**Level of Difficulty:** Advanced.

### History

A 31-year-old man presents for electrodiagnostic evaluation of his left lower extremity pain. For the past several years, this pain starts approximately ten minutes into exercise, worse with running or fast walking. The pain is described as a burning sensation that intensifies with continued activity. After twenty minutes, the patient notices significant ankle dorsiflexion weakness that results in a foot drop. This series of symptoms resolve after 20-30 minutes of rest. He does confirm occasional low back pain, but no radiation down the left leg. No symptoms are noted on the right. X-rays taken of the leg were negative for fractures or any other clinically significant pathology.

- Prior to continuing, please develop a differential diagnosis and list each possible diagnosis in order of likelihood.
- Is there any additional information regarding the clinical history that might be helpful in clarifying your differential list or changing its order of priority?

### Commentary I

At this point the differential diagnosis includes:

Radiculopathy-L4 or L5

Compression neuropathy-deep fibular (formerly peroneal) nerve

Compartment syndrome

Sciatic neuropathy

Common fibular (formerly peroneal) mononeuropathy

Deep fibular (formerly peroneal) mononeuropathy

Superficial fibular (formerly peroneal) mononeuropathy

Peroneal longus tendonitis



Anterior tibialis tendonitis  
Medial tibial stress syndrome  
Stress fracture  
Popliteal artery entrapment syndrome  
Peripheral neuropathy  
Motor neuron disease  
Myopathy  
Myofascial pain syndrome

Considering the patient's history of intermittent back pain and one-sided lower extremity pain, a radiculopathy is a possibility. Pain with exertion is an interesting history that suggests a tendonitis, but these symptoms resolve with rest. The pain could also relate to a myofascial component, but less likely in view of the isolated area. A mononeuropathy is conceivable, but no history of trauma has been noted. The age of the patient may help eliminate some of the differential. Motor neuron disease typically begins in the fifth to seventh decades.<sup>1</sup> A peripheral neuropathy is also probably unlikely because of the lack of risk factors, but still possible if hereditarily linked. The patient reports a foot drop after prolonged activity, which would indicate a deep fibular nerve disorder. The foot drop may also be secondary to pain inhibition, which would confuse the picture.

### **History, continued**

In addition to the pain, the patient also describes paraesthesia, initially between the first web space of the left foot and along the dorsum of the left foot with continued activity. The patient's medical history is negative for any major medical issues. His surgical history includes right knee surgery and left shoulder surgery. There is no family history of neurological disorders. He takes no medication.

- If necessary, revise your differential diagnosis based on the additional clinical history.
- On which details of the physical examination should you focus at this point?

### **Commentary II**

With the additional history, this patient's differential can be shortened to include:

Radiculopathy-L4 or L5  
Compression neuropathy-deep fibular nerve  
Compartment syndrome  
Sciatic neuropathy  
Common fibular mononeuropathy  
Deep fibular mononeuropathy  
Superficial fibular mononeuropathy  
Peripheral neuropathy

Peripheral neuropathy is less likely considering the asymmetrical presentation. Tendonitis, medial tibial stress syndrome, stress fracture, myopathy, motor neuron disease, and vascular syndromes can be dropped from the differential mainly because of the sensory changes reported with prolonged activities. This symptom alone can focus the differential to primarily a peripheral neuropathic process. Compartment syndrome is still likely because



with high compartmental pressures, neuroparxia can occur. The exam should be focused to the lower extremities.

**Physical Examination**

The lower extremity reflexes are 2+ at the patella and Achilles bilaterally. Sensation is intact to light touch throughout the bilateral lower extremities. Muscle bulk is preserved. Strength testing through ten repetitions does not demonstrate decrement in ankle dorsiflexion, ankle eversion or great toe extension on the left. The remainder of the strength testing is 5/5 in all the major muscle groups of the bilateral lower extremities. Seated and supine straight leg raise was negative for radicular symptoms bilaterally.

- At this point, review your differential diagnosis and revise as appropriate.
- Are there additional observations on physical examination that might be helpful in narrowing your differential list?

**Commentary III**

At this point, the most likely differential includes:

- Compression neuropathy-deep fibular nerve
- Compartment syndrome
- Sciatic neuropathy
- Common fibular mononeuropathy
- Deep fibular mononeuropathy
- Superficial fibular mononeuropathy

With a benign physical exam, the differential can be reduced. The presence of a radiculopathy is still possible, but with the negative physical exam findings and no historical evidence of radicular symptoms, this is less likely. Peripheral neuropathy is improbable considering the unilateral symptoms and no sensory changes on exam.

The most likely diagnoses are a mononeuropathy, compression neuropathy of the common fibular nerve at the knee, or compartment syndrome. The EMG will be able to localize the problem and rule out other possibilities. The patient may be able to reproduce the symptoms by running for 10-20 minutes, but this may be difficult to accomplish in a lab setting.

**Electrophysiologic Data**

| MOTOR NERVE CONDUCTION STUDIES |      |            |        |      |     |         |      |
|--------------------------------|------|------------|--------|------|-----|---------|------|
| Nerve                          | Side | Stim Site  | Record | cm   | AMP | Latency | CV   |
| Fibular (formerly peroneal)    | L    | Ankle      | EDB    | 9    | 4.8 | 4.2     |      |
|                                | L    | Below Knee | EDB    | 29   | 4.5 | 10.1    | 49.2 |
|                                | L    | Above Knee | EDB    | 10   | 4.1 | 12.4    | 43.5 |
|                                | R    | Ankle      | EDB    | 9    | 5.5 | 4.4     |      |
|                                | R    | Below Knee | EDB    | 31.5 | 5.0 | 10.3    | 53.4 |



|                   |   |            |         |    |      |      |      |
|-------------------|---|------------|---------|----|------|------|------|
|                   | R | Above Knee | EDB     | 10 | 4.9  | 12.3 | 50.0 |
| Tibial            | L | Ankle      | ABD Hal | 8  | 13.5 | 3.3  |      |
| Tibial F-response | L | Ankle      | ABD Hal |    |      | 52.2 |      |

| SENSORY NERVE CONDUCTION STUDIES        |      |           |              |    |     |         |      |
|-----------------------------------------|------|-----------|--------------|----|-----|---------|------|
| Nerve                                   | Side | Stim Site | Record       | cm | AMP | Latency | CV   |
| Sural                                   | L    | Calf      | Ankle        | 14 | 19  | 3.2     | 51.9 |
| Superficial Fibular (formerly peroneal) | L    | Ankle     | Foot         | 12 | 5.0 | 2.6     | 66.7 |
|                                         | R    | Ankle     | Foot         | 12 | 3.5 | 3.0     | 52.2 |
|                                         |      |           |              |    |     |         |      |
| Temp                                    | L    | Calf      | 32.0 Celsius |    |     |         |      |
|                                         | R    | Calf      | 32.6 Celsius |    |     |         |      |

| NEEDLE ELECTROMYOGRAPHY                |                           |       |     |     |     |      |      |      |      |
|----------------------------------------|---------------------------|-------|-----|-----|-----|------|------|------|------|
| INSERTIONAL activity: N, sust, unsust  |                           |       |     |     |     |      |      |      |      |
| FIB: 0, 1+, 2+, 3+, 4+                 |                           |       |     |     |     |      |      |      |      |
| OTHER: 0 or fascic, myotonia, myokymia |                           |       |     |     |     |      |      |      |      |
| EFFort: N, decr                        |                           |       |     |     |     |      |      |      |      |
| RECRuitment: N, I or D 1+, 2+, 3+, 4+  |                           |       |     |     |     |      |      |      |      |
| AMPLitude: N, I or D 1+, 2+, 3+, 4+    |                           |       |     |     |     |      |      |      |      |
| DURATION: N, I or D 1+, 2+, 3+, 4+     |                           |       |     |     |     |      |      |      |      |
| POLyphasia: N, I or D 1+, 2+, 3+, 4+   |                           |       |     |     |     |      |      |      |      |
| (N=Normal, I=Increase, D=Decrease)     |                           |       |     |     |     |      |      |      |      |
| R/L                                    | MUSCLE                    | INSER | FIB | OTH | EFF | REC  | AMP  | DUR  | POL  |
| L                                      | Anterior Tibialis         | N     | 0   | 0   | N   | N    | N    | N    | I 1+ |
| L                                      | Peroneus Longus           | N     | 0   | 0   | N   | D 1+ | I 1+ | N    | I 1+ |
| L                                      | Ext Hallucis Longus       | N     | 0   | 0   | N   | D 2+ | I 1+ | I 2+ | I 2+ |
| L                                      | Ext Digitorum Brevis      | N     | 0   | 0   | N   | D 3+ | N    | I 3+ | I 3+ |
| L                                      | Biceps Femoris-short head | N     | 0   | 0   | N   | N    | N    | N    | N    |
| L                                      | Gluteus Medius            | N     | 0   | 0   | N   | N    | N    | N    | N    |

The nerve conduction studies are essentially normal. There is a slight difference when comparing the superficial fibular sensory amplitudes, but amplitudes can vary considerably



among subjects, even from side to side.<sup>1</sup> The needle exam findings reveal decreased recruitment and increased polyphasia in the muscles innervated by the common fibular nerve in the calf. The motor unit changes are consistent with the presence of axon loss with reinnervation of the superficial and deep fibular nerves. The normal findings in the short head of the biceps femoris help to localize the lesion distal to this muscle. There could also be a compression neuropathy of the common fibular nerve at the knee even though there is no slowing of conduction or conduction block across the knee; axonal loss alone would give this picture.

### **Diagnostic Impression**

The electrodiagnostic findings, in conjunction with the patient's history and symptoms, are consistent with a deep fibular mononeuropathy on the left. There is also some suggestion of a superficial fibular mononeuropathy, but to a lesser extent. The anterior tibialis is relatively spared possibly because of a common fibular nerve injury with variable severity in the two branches. At the time of this examination, there is no evidence of acute denervation, however there has clearly been some recent axon loss followed by reinnervation in the fibular nerve distribution. Within this distribution, the more distal muscles are affected to a greater degree than the more proximal ones. This is explained by the course of the nerve. The common fibular nerve starts superficial at the fibular head, but soon after the split into the deep fibular and superficial fibular nerves, these nerves tend to dive deeper into the compartment. The innervation of the anterior tibialis in the anterior compartment and the peroneus longus of the lateral compartment are relatively superficial, explaining the mild motor unit action potential changes. The remainders of the anterior compartment muscles show greater motor unit changes because the nerve is deeper in the compartment and more affected by increased pressure. There is no electrodiagnostic evidence of an L5 radiculopathy on the left or of a peripheral neuropathy. The electrodiagnostic evidence alone does not rule out an axonal common fibular neuropathy or a common fibular nerve entrapment at the knee, but can be excluded mainly because of the patient's suggestive history of exertional compartment syndrome resulting in a compression neuropathy.

### **Commentary IV**

Compartment syndrome is elevation of interstitial pressure in a closed fascial compartment that results in microvascular compromise. Exertional compartment syndrome is a classification of compartment syndrome, which is usually a chronic condition. Patients with this condition do not have a history of trauma, and the symptoms can last from weeks to years. The most commonly involved areas are the anterior and lateral compartments of the lower leg. Symptoms include a gradual onset of pain, a sense of fullness, and paraesthesia. The patients have a predictable onset of symptoms, usually a set time from the initiation of activity, which resolve shortly after rest.<sup>2</sup>

The etiology of exertional compartment syndrome is debatable. The patient is typically a sedentary person that engages in a strenuous exercise, which will result in muscle overuse and interstitial edema. This causes an increased intra-compartmental volume, perfusion deficit, and finally ischemia. Over time, the patient will also have an increased relaxation pressure secondary to muscle hypertrophy and this combination results in myoneural ischemia.<sup>3</sup> This is usually not proportional to the intensity of the exercise. There are also theories of mechanical damage, anatomical variants, and possibly thicker and stiffer fascia.<sup>4,5</sup>



Diagnosis for this syndrome is usually based on the history. Recently, there have been more diagnostic options, but the gold standard is still intra-compartmental pressure testing. This is done bilaterally in all four compartments of the lower leg, pre and post exercise. The criterion for diagnosis was developed by Pedowitz, et al in 1990.<sup>6</sup>

Treatment for exertional or chronic compartment syndrome can take many forms. Conservative treatment involves modification in activity, training regimens, training surfaces, shoes, muscle imbalance, flexibility, and limb alignment.<sup>4</sup> Botulism toxin therapy is a consideration, but there is a likelihood of prolonged post injection weakness. The definitive treatment after three months of symptoms is an elective fasciotomy.<sup>7</sup>

Our patient actually underwent the uncomfortable intra-compartmental testing. He did meet the pressure criterion set by Pedowitz, both pre and post exercise in the bilateral anterior and lateral compartments. Since the patient was only symptomatic on the left, an elective fasciotomy was done on that side for both the anterior and lateral compartments. The patient's symptoms did resolve after the surgery.

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