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The value of high-resolution imaging in an occult peroneal intraneural ganglion cyst: illustrative case

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BACKGROUND Foot drop is a common complaint with a broad differential diagnosis making imaging a key part of the diagnostic workup. The authors present a patient with an occult peroneal intraneural ganglion cyst who underwent imaging with high-frequency ultrasound (US) and high-resolution magnetic resonance imaging (MRI) to highlight the role of such techniques in cases of peroneal neuropathy.

OBSERVATIONS Intraneural ganglion cysts are emerging as a common cause of common peroneal neuropathy. Imaging with US and MRI is a valuable tool used to illustrate the pertinent anatomy and identify the articular branch joint connection and cyst as part of the surgical planning and definitive management.

LESSONS Intraneural ganglion cysts can be small or nearly invisible and failure to appreciate the intraneural cyst can lead to symptom or cyst persistence or recurrence. High-resolution modalities can be useful in the diagnosis and surgical planning of difficult cases.

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KEYWORDS common peroneal nerve; fibular nerve; intraneural ganglion cyst; musculoskeletal ultrasound; ultra-high-frequency ultrasound; high-resolution MRI

Weakness of dorsiflexion of the foot causing foot drop is a common complaint that can be associated with subsequent injury and recurrent falls. Peroneal (aka fibular) neuropathy is a common cause of foot drop[1] with a broad differential diagnosis and is most commonly caused by external compression and trauma. Imaging plays a key role in the diagnosis and treatment planning in these patients by the identification of masses, cysts, and entrapment of the nerve at the fibular tunnel.[2,3] In some cases, these lesions may be small or occult,[4] or may occur in anatomical locations apart from the fibular neck that makes proper localization and characterization of the pathology with appropriate imaging and clinical examination important. Intraneural cysts can spontaneously partially regress or rupture; therefore, they may be subtle at the time of imaging. Without a thorough workup with appropriate imaging undertaken, misdiagnosis and inappropriate treatment may occur.

We present a case of a patient with an occult peroneal intraneural ganglion cyst to emphasize the importance of imaging patients with peroneal nerve palsy and to highlight the utility of high-resolution imaging in patients with small cysts. The intraneural ganglion cyst could have easily been missed based on clinical examination alone without imaging, or with routine imaging, leaving the patient with the potential risk for persistent or recurrent symptoms or cyst. Thus, the intraneural cyst would not been identified or treated operatively had the mildly enlarged articular branch not been identified with imaging.

Illustrative Case

An 80-year-old female presented to the clinic with a history of mechanical left knee pain for many years and a left foot drop of 6 weeks duration. Her symptoms were immediately preceded by 2

ABBREVIATIONS EMG = electromyography; MRI = magnetic resonance imaging; STFJ = superior tibiofibular joint; US = ultrasound.

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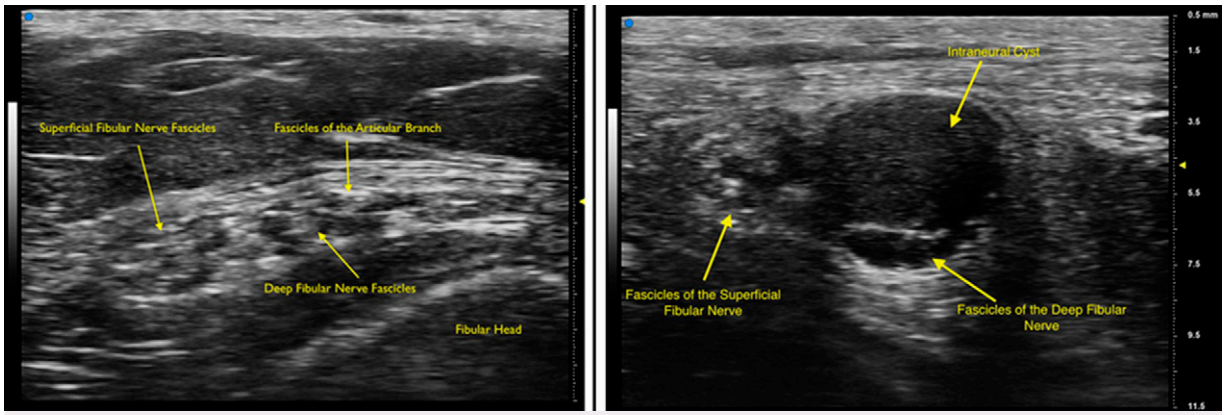

FIG. 1. Ultra high-frequency sonogram (48 MHz) of a short-axis view of a normal common fibular (peroneal) nerve just proximal to its entrance into the fibular tunnel (**left**). At this level of resolution, the individual fascicles within the common epineurium that will diverge into separate branches can be identified. Ultra-high–frequency sonogram (48 MHz) of a short-axis view of a common fibular (peroneal) nerve just proximal to the entrance into the fibular tunnel with an intraneural ganglion cyst (**right**). In this case, the articular branch was not dramatically enlarged but the cyst with two loculations could be traced to the articular branch fascicles. The cyst also had more significant mass effect on the fascicles of the deep fibular nerve relative to the superficial fibular nerve, which was consistent with the clinical presentation.

weeks of spontaneous onset of pain in her left leg and ankle, which had resolved at the time of clinical evaluation. During this time, she had suffered several falls, and had no improvement in her left foot function, which prompted her to seek evaluation. Her past medical history was significant only for marked osteoarthritis in her left knee. Physical examination revealed complete paralysis of the tibialis anterior, the extensor hallucis longus, and all the toe extensors. She retained strong eversion, inversion, plantarflexion, and toe flexion in her left foot and ankle. Her sensation was decreased on the dorsal aspect of the left foot, particular in the first dorsal webspace. There was no appreciable sensitivity over the nerve.

Electromyography (EMG) demonstrated a left, deep peroneal neuropathy in the area of the knee. Conventional and ultra-high–frequency (48 MHz) ultrasound of the peroneal nerve, as illustrated in Fig. 1, was undertaken. Higher-resolution ultrasound (US) better showed the cystic articular branch and its connection to the superior tibiofibular joint (STFJ) as well as abnormal cystic enlargement of the deep peroneal portion of the fibular nerve. Conventional high-frequency ultrasound (10–15 MHz) also demonstrated early denervation changes limited to the muscles of the anterior compartment of the involved leg. Magnetic resonance imaging (MRI) at 1.5 and 7 T, shown in Fig. 2 was also performed. The MRI at 1.5 T demonstrated the intraneural ganglion cyst and communication to the STFJ. The pathology was further defined by the 7 T MRI showing cyst within the epineurium of the common peroneal nerve, with marked enlargement and edema of the anterior portion of the nerve.

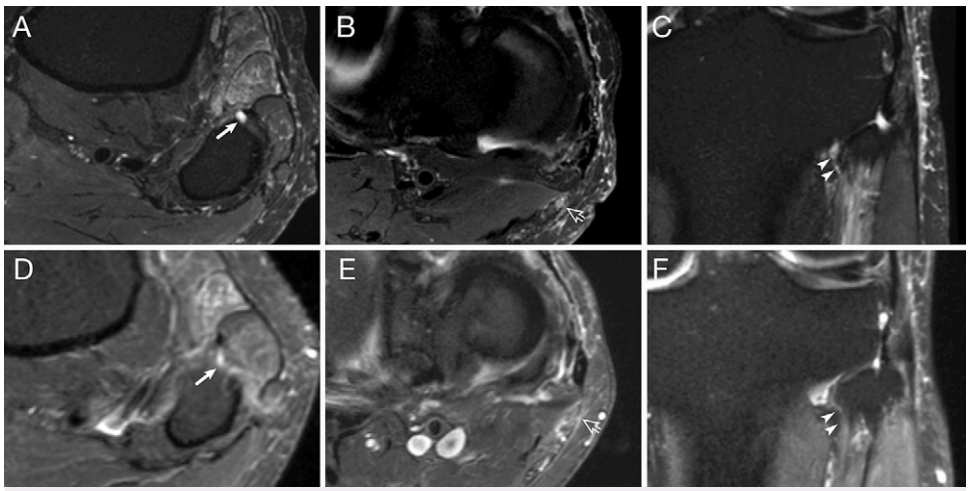

FIG. 2. Axial (**A and B**) and coronal (**C**) T2 weighted fat saturation images from 7 T (Tesla) MRI. The cyst is arising from the anterior aspect of the superior tibiofibular joint (**C**, *arrowheads*). Noncontiguous cyst is seen in the articular branch compatible with a transverse limb sign (**A**, *arrow*). The anterior component of the common peroneal nerve proximal to the superior tibiofibular joint demonstrates enlargement and edema (**B**, *curved arrow*). Matching images from a 1.5 T examination (**D–F**) demonstrate the difficulty of identifying the cyst and communication with the joint to confirm an intraneural ganglion cyst.

The patient underwent surgical intervention using a U-shaped technique[5] to expose the common peroneal nerve and its articular branch to the anterior aspect of the STFJ. A small linear streak in the deep fascicular bundle of the common peroneal nerve was seen. The remainder of the common peroneal nerve appeared normal, although the articular branch was mildly enlarged. This was transected, and a small amount of cyst, shown in Fig. 3, drained spontaneously. Pathology confirmed an intraneural cyst.

Postoperatively, the patient noted marked improvement in foot dorsiflexion beginning at 3 months. By 6 months she had regained grade 5 function and had weaned herself from the ankle foot orthosis. Conventional US (Fig. 4) showed no intraneural cyst. Ultra-high–frequency US (Fig. 4) clearly demonstrated the discontinuity in the articular branch near the STFJ. She is currently considering total knee replacement surgery.

Discussion

Observations

In this study, we present a case of foot drop caused by an intraneural ganglion cyst of the common peroneal nerve that required high-resolution imaging techniques for diagnosis and surgical planning. Imaging played a key role in this case and is a vital diagnostic tool for evaluating foot drop. A wide differential diagnosis should be considered when evaluating a patient with foot drop, with consideration of uncommon pathologies such as lumbar plexopathy, radiculopathy, anterior horn cell disease, central causes, in addition to peroneal nerve compression and entrapment.[1] Additionally, tumors and masses are not uncommon along the course of the common peroneal nerve and its branches and should be considered in the differential diagnosis. Additionally, both benign and malignant lesions may present similarly, such as lipomas, benign and malignant nerve sheath tumors.[1] Imaging is a valuable tool for not only identifying lesions and avoiding misdiagnosis, but also differentiating between these pathologies for surgical planning and successful intervention.

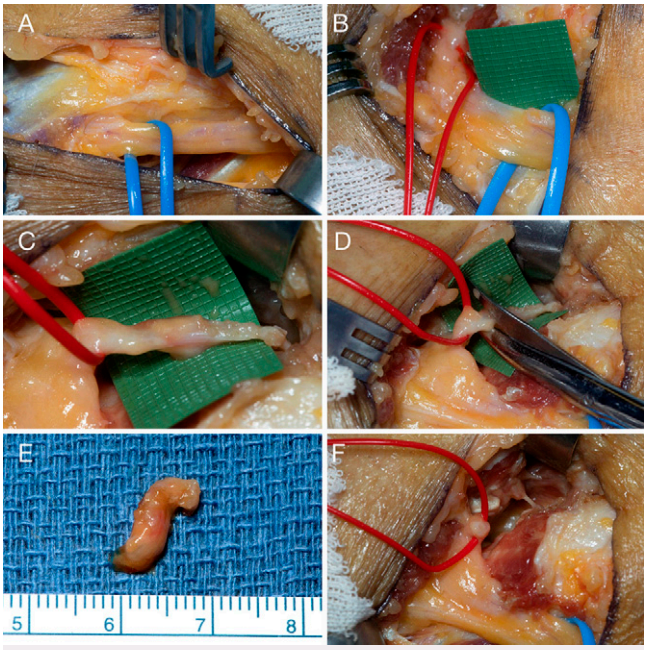

FIG. 3. The common peroneal nerve (in blue vasoloop) is seen just proximal to the fibular tunnel (**A**), demonstrating a subtle cystic streak can be visualized in the deep fascicular bundle. Subsequently, the fibular tunnel has been released, and the U-shaped technique exposing the articular branch (red vasoloop) (**B**). Further dissection of the articular branch to the STFJ reveals a suggestion of intraneural cyst (**C**). The articular branch is transected just above the branch to the tibialis anterior (**D**). The resected segment of articular branch (**E**). A small amount of cyst is seen is the articular branch stump (**F**).

Intraneural ganglion cysts are a common cause of peripheral neuropathy. In a study by Visser et al.,[6] 18% of patients with peroneal neuropathies had intraneural cysts demonstrated on US. They most frequently occur within the common peroneal nerve at the fibular neck.[7] These cysts are caused by pathology in neighboring synovial joint that leads to fluid egress along the articular nerve branch following a path of least resistance.[8] Peroneal cysts are formed through a dynamic process driven by changes in pressure,[9] which can lead dramatic fluctuations in cyst size and morphology; at times the cyst may be occult, and subsequently enlarge in size at a later time.[3,4,10] Indeed, in this study, we observed changes in the size of the peroneal intraneural cyst between studies being nearly occult or nearly invisible when assessed at the time of the 1.5 T MRI. Failure to image and/or diagnose an intraneural cyst can lead to persistence or recurrence of symptoms and cyst.

Both US and MRI were used in the diagnostic workup to compare their efficacy. Both imaging modalities provide important information about both the anatomy of the underlying nerves and muscles, as well as the pathoanatomy. US is widely available and less expensive, although is limited in its ability to penetrate bony structures and is highly variable in terms of image acquisition based on operator experience. However, US allows for high spatial resolution and continuous visualization of the nerve, and with the development of ultra-high–frequency transducers, the spatial resolution for visualizing the more superficial peripheral nerves can be as high as 30 μm.[6] MRI is a more expensive study and less available but carries less user dependence when imaging peripheral nerve lesions compared to US. Identification of the joint connections has historically been more common with MRI[11] however recent technological advances, cost-effectiveness and more widespread technical training could lead to an increasing role of US. Three-dimensional rendering techniques[12] and higher resolution MRI studies are becoming more commonly utilized and will likely improve the diagnosis of an intraneural ganglion cyst and establish the joint connection with increasing frequency.

Lessons

We believe that imaging should be performed in all patients with foot drop to identify potentially surgically treatable causes, such as intraneural ganglion cysts. In this case, high-resolution imaging (US and MRI) techniques facilitated the correct diagnosis and led to appropriate treatment. While the diagnosis of intraneural ganglion cysts can be readily established in most cases with routine imaging or at surgery, knowledge of the articular branch connection is necessary for surgeons, sonographers, and radiologists, regardless of imaging technique. More subtle (small, occult, or nearly invisible) examples of intraneural ganglion cysts prove challenging: the diagnosis and the joint connection may be harder to establish and easily missed. Routine decompressive surgery of the common peroneal nerve would not have been sufficient as the cyst would not have been visualized at surgery especially in those less familiar with this appearance, and the articular branch would not have been looked

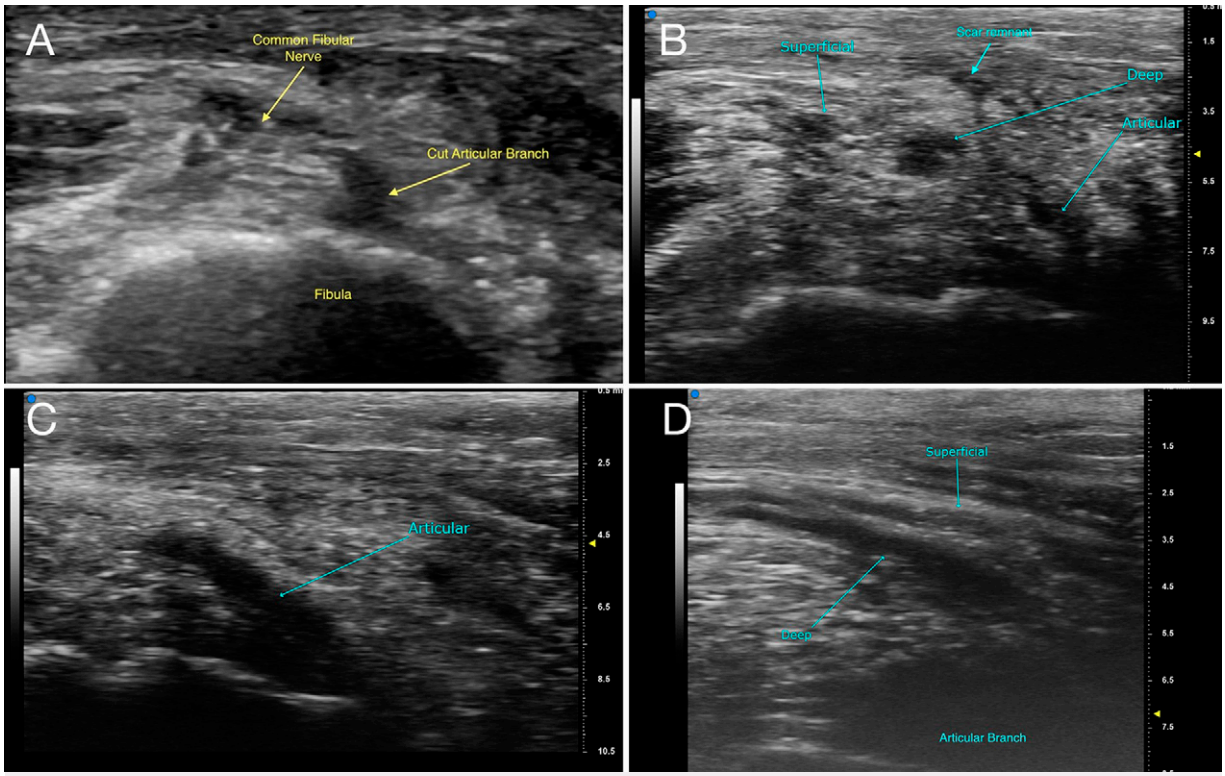

FIG. 4. Postoperative conventional and ultra-high–frequency sonograms of the postoperative peroneal (fibular) nerve. Conventional high-frequency (10–15 MHz) ultrasound of a short-axis view of the fibular nerve at the entrance to the peroneal tunnel demonstrates the position of the near relative to the cut but enlarged articular branch (**A**). Ultra-high–frequency (48 MHz) visualization of that same region demonstrates marked improvement of the enlargement of the deep branch fascicles with clear separation from the lysed articular branch. The presence and position of the postsurgical scar remnant is also evident (**B**). Ultra-high–frequency (48 MHz) sonogram of a long-axis view of the remnant of the articular branch demonstrates its persistent enlargement, the delineation of the cut end, and its position of connection with the superior tibiofibular joint (**C**). Ultra-high–frequency (48 MHz) sonogram of a long-axis view of the bifurcation of the superficial and deep peroneal nerves demonstrates significant improvement in the nerve diameter and separation of the deeper articular branch remnant (**D**).

for routinely and identified. Thus, the intraneural cyst would not been identified or treated and there would have been a high risk of recurrence.

We are excited that high-resolution imaging today will likely become low resolution tomorrow. Thus, advances in technology and imaging are needed to propel medicine to the next level in the future.

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Disclosures

The authors have no disclosures and report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Spinner, Amrami, Howe. Acquisition of data: Spinner, Lenartowicz, Amrami, Strakowski. Analysis and interpretation of data: all authors. Drafting the article: Spinner, Lenartowicz, Strakowski, Howe. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Spinner. Administrative/technical/material support: Spinner. Study supervision: Spinner.

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