Course: Clinical Interpretation and Advanced Imaging

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Highlights:

-Magnetic resonance imaging (MRI) neurography is increasingly being utilized as a noninvasive means of evaluating both central and peripheral nervous structures, complementing the clinical examination and electrodiagnostic studies in patients with suspected nerve pathology.

-MR imaging techniques available for evaluation of nerves range from conventional clinical pulse sequences to advanced sequencing specifically designed for nerve evaluation, many of which yield quantitative information regarding nerve structure, in addition to qualitative visual evaluation.

-Imaging findings suggestive of nerve pathology include changes in signal and morphology, ancillary findings such as mechanical entrapment, mass lesions, and muscle denervation, and changes in quantitative parameters such as diffusivity and anisotropy.

Talk Title: Neurography: How Do I Do It?

Target Audience: Radiologists, clinician scientists, and clinical care providers interested in the clinical application of magnetic resonance neurography techniques.

Objective: To review magnetic resonance imaging based techniques available for imaging nerves, including optimization of conventional pulse sequences for nerve visualization, advanced imaging techniques specifically designed for nerve evaluation, and more experimental techniques currently in development.

Introduction: MR neurography provides a noninvasive means of evaluating patients with suspected nerve pathology, complementing the clinical examination and electrodiagnostic testing in these patients. Characteristic magnetic resonance imaging findings allow differentiation of neuropathic conditions related to entrapment, trauma, iatrogenic injury, extrinsic mass effect, and tumors/tumor-like lesions of the nerves.

Imaging Techniques: A wide variety of MR imaging based techniques may be utilized for evaluation of nerves. High resolution routine clinical pulse sequences are useful for evaluating changes in expected nerve signal and morphology, as well as for identification of ancillary findings such as muscle denervation, in addition to potential alternate causes for the patients symptoms. Because nerves are relatively small structures, acquisition parameters must be optimized for adequate visualization. In general, nerve imaging is best performed at higher field strengths (eg 3.0T), with a small field of view (FOV) and high matrix. Planes should be oriented with consideration of the anatomic axis and path of the nerve(s) of interest. The imaging algorithm should include a high resolution anatomic sequence, such as T1 or proton density (PD) weighted images, as well as fat suppressed fluid sensitive images, such as inversion recovery (IR) or T2 with fat saturation, in order to assess for signal changes[1,4]. 3D isotropic imaging may be useful in that it allows for creation of multiplanar reformatted images[3].

The addition of diffusion weighting (DW) to a given pulse sequence provides a degree of vascular suppression, resulting in relatively greater nerve signal, allowing for better delineation of nerve versus vessel within the neurovascular bundle. This is employed in sequences such as DW PSIF and DW SPACE, though the addition of the diffusion gradient results in a decrease in signal to noise ratio (SNR)[3].

Advanced imaging techniques, such as diffusion tensor imaging (DTI), can provide additional qualitative and quantitative information regarding nerve structure and function. DTI exploits the anisotropic properties of nerves and axonal fiber tracts in order to allow creation of fiber tracts maps and calculation of parameters such as mean diffusivity (MD) and fractional anisotropy (FA), providing both a more advanced visual depiction, as well as quantitative evaluation of characteristics pertaining to nerve microstructure and function[1,2].

Utilization of conventional gadolinium based intravenous contrast may be helpful in assessment of nerve inflammation, and newer experimental gadolinium based agents have demonstrated potential utility for neurographic applications; for example, gadofluoride M has been shown in animal models to be useful in assessing demyelination and remyelination[2].

Imaging Findings: On conventional pulse sequences, normal nerves demonstrate a fascicular architecture, with intermediate signal intensity on T1 or PD weighted images, and iso- to slight hyperintensity relative to muscle on fat

suppressed fluid sensitive images. Normal nerves are typically surrounded by a thin rim of perineural fat, and should not enhance following the administration of intravenous contrast[1,4].

Imaging findings suggestive of nerve pathology include changes in nerve signal and morphology, with affected fascicles commonly becoming hyperintense and thickened, resulting in focal or diffuse nerve enlargement (Figure 1). Associated muscle denervation may also be observed, with affected muscles becoming hyperintense and edematous in the acute and subacute phases of denervation, and subsequently atrophic during the chronic phase. Associated findings depend on the cause of nerve pathology, and may be related to trauma, entrapment/compression, neoplasm, demyelinating disease, infection, ischemic, toxic, and metabolic etiologies[1,4,5].

While normal nerves do not enhance following the administration of contrast, acutely inflamed nerves enhance, as do a variety of neural and perineural mass lesions[3].

Diffusion tensor imaging in the setting of pathology may demonstrate deviations from expected normal patterns. Due to their architecture, nerves are highly anisotropic, and pathologic processes tend to disrupt this normal architecture and decrease the degree of anisotropy, resulting in decreased fractional anisotropy and often increased mean diffusivity. Fiber tract mapping may demonstrate areas of disruption or deviation in the expected path of the affected nerve[1,2].

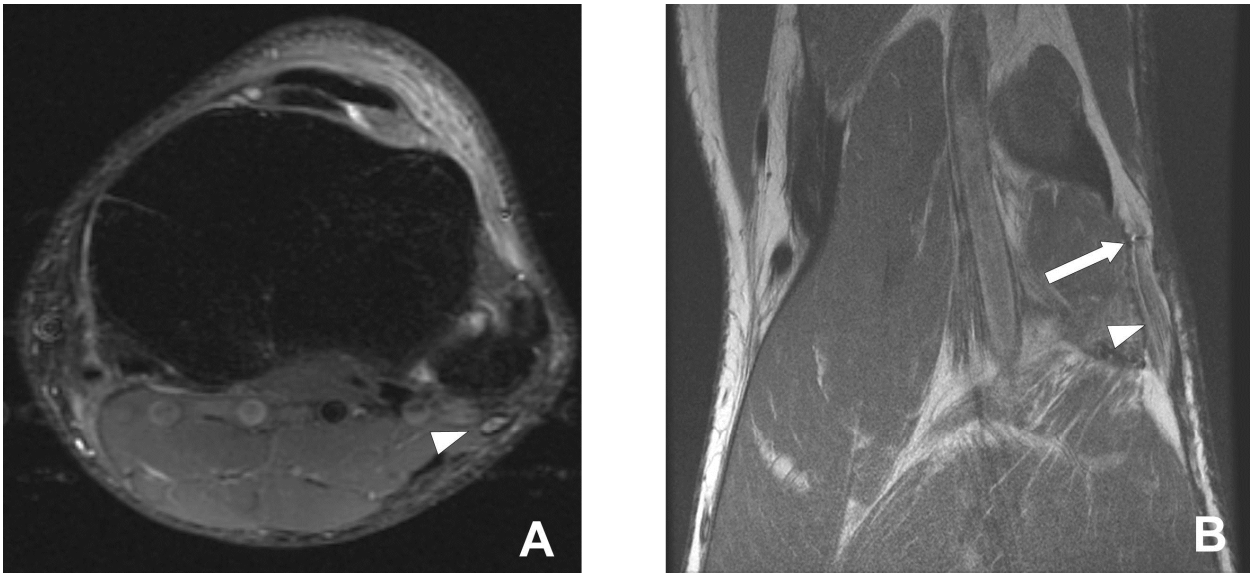

Figure 1: Axial inversion recovery (A) image demonstrates hyperintensity and thickening of the common peroneal nerve (white arrowhead) in a 45 year-old man presenting with pain and numbness radiating to the foot following proximal tibiofibular joint reconstruction. Coronal proton density weighted image (B) demonstrates focus of susceptibility related to suture (white arrow) entrapping the common peroneal nerve (white arrowhead), which is hyperintense and thickened.

References:

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