Magnetic resonance neurography

Magnetic resonance neurography (MRN) is the direct imaging of nerves in the body by optimizing selectivity for unique MRI water properties of nerves. It is a modification of magnetic resonance imaging. This technique yields a detailed image of a nerve from the resonance signal that arises from in the nerve itself rather than from surrounding tissues or from fat in the nerve lining. Because of the intraneural source of the image signal, the image provides a medically useful set of information about the internal state of the nerve such as the presence of irritation, nerve swelling (edema), compression, pinch or injury. Standard magnetic resonance images can show the outline of some nerves in portions of their courses but do not show the intrinsic signal from nerve water. Magnetic resonance neurography is used to evaluate major nerve compressions such as those affecting the sciatic nerve (e.g. piriformis syndrome), the brachial plexus nerves (e.g. thoracic outlet syndrome), the pudendal nerve, or virtually any named nerve in the body. A related technique for imaging neural tracts in the brain and spinal cord is called magnetic resonance tractography or diffusion tensor imaging.

Interventional magnetic resonance (MR) neurography is a minimally invasive technique that affords targeting of small nerves in challenging areas of the human body for highly accurate nerve blocks and perineural injections. This cross-sectional technique uniquely combines high tissue contrast and high-spatial-resolution anatomic detail, which enables the precise identification and selective targeting of peripheral nerves, accurate needle guidance and navigation of the needle tip within the immediate vicinity of a nerve, as well as direct visualization of the injected drug for the assessment of appropriate drug distribution and documentation of the absence of spread to confounding nearby nerves [1)].

History

We have made cross-sectional image “neurograms” in which peripheral nerve has a greater signal intensity than that of other tissue. Neurographic images of the rabbit forelimb were obtained using a spin-echo magnetic resonance imaging (MRI) technique that combines fat suppression and diffusion weighting. After fat suppression the nerve shows up in relative isolation and is brighter than the surrounding tissue due to its longer T2 relaxation time of approximately 50 ms compared to approximately 27 ms for muscle. The addition of pulsed gradients for diffusion weighting of the MR signal further enhances the intensity of the nerve signal relative to that of surrounding muscle tissue. The greater diffusional anisotropy of nerve tissue (D parallel/D perpendicular = 3.1) compared to that of muscle (D parallel/D perpendicular = 1.9) allows further enhancement of the nerve by a subtraction of two diffusion-weighted images, one with the gradients oriented parallel and one with the gradients oriented perpendicular to the nerve orientation. We show that by manipulation of the MRI parameters, either echo time or pulsed gradient strength, the nerves can be made to show up as the most intense feature. This verifies the feasibility of generating three-dimensional “neurographic” images, analogous to angiograms, but which demonstrate the peripheral nerve tracts in apparent isolation [2)].

1)

Fritz J, Dellon AL, Williams EH, Belzberg AJ, Carrino JA. 3-Tesla High-Field Magnetic Resonance Neurography for Guiding Nerve Blocks and Its Role in Pain Management. Magn Reson Imaging Clin N Am. 2015 Nov;23(4):533-545. doi: 10.1016/j.mric.2015.05.010. Epub 2015 Aug 20. Review. PubMed PMID: 26499273.

2)

Howe FA, Filler AG, Bell BA, Griffiths JR. Magnetic resonance neurography.Magn Reson Med. 1992

Dec;28(2):328-38. PubMed PMID: 1461131.