OMICS Journal of Radiology
ISSN: 2167-7964

Soldatos, OMICS J Radiology 2012, 1:1
DOI: 10.4172/2167-7964.1000e102

Editorial Open Access

High-Resolution MR Neurography: Application in Peripheral Nerve Disease

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Editorial

Although the evaluation of peripheral neuropathies has traditionally relied on clinical examination and electrodiagnostic studies, there has been an increasing demand from treating physicians for information about the injury type, location of injured nerve stumps, presence or absence of neuroma and underlying etiology of neuropathy, particularly in cases where surgical intervention is contemplated. In this setting, magnetic resonance (MR) imaging of peripheral nerves, also referred to as MR Neurography, has been gaining increasing popularity, because of advances in MR hardware and the development of new imaging techniques. The implementation of 3 Tesla MR Scanners, in particular, has offered higher resolution and contrast imaging of peripheral nerves, which has in turn provided exquisite anatomic and lesion conspicuity [1].

In current clinical practice, MR Neurography may be applied to: a) confirm clinical suspicion of peripheral neuropathy, by directly showing the nerve abnormality or regional muscle denervation changes, b) assess the extent of the abnormality in nerve injuries, or the disease load in diffuse peripheral nerve lesions, such as hereditary neuropathies and neurofibromatosis, c) depict lesions causing nerve entrapment or impingement [2,3], d) exclude peripheral neuropathy by showing normal nerves and regional muscles, e) detect incidental lesions in the region of interest that mimic neuropathy symptoms [4] and f) provide imaging guidance for perineural medication injections.

Typically, MR Neurography techniques utilize a combination of fat-saturated T2-weighted (T2W), short inversion time recovery (STIR), or T2 spectral adiabatic inversion recovery turbo spin-echo (T2 SPAIR TSE) images for the detection of the nerve signal, contour and size changes, as well as T1-weighted (T1W) spin-echo or fluid-attenuated long inversion recovery (FLAIR) images for the anatomic assessment of the involved areas, based on the abundant intra- and perineural fat. In cases of suspected tumor or infection, pre- and post-contrast fat-suppressed T1W images are additionally acquired.

Axial T1W and fat-suppressed T2W images serve as the mainstay in MRN interpretation for prudent assessment of peripheral nerve imaging characteristics, such as signal intensity, course, caliber, fascicular pattern, size, and perineural fibrosis or mass lesions [5]. Normal peripheral nerves demonstrate intermediate signal intensity, similar to skeletal muscle on T1W images and intermediate to minimally increase on T2W images, and exhibit smooth course without focal deviations, uniformly sized fascicles, which are also isointense to skeletal muscles, clean surrounding perineural fat planes, and caliber similar to the adjacent arteries, which gradually decrease proximally to distally. In cases of neuropathy, the signal intensity of the nerve increases abnormally, approaching the fluid-like signal intensity of the adjacent vessels on T2W images. Additionally, the abnormal nerve may demonstrate a) focal or diffuse enlargement, featuring size greater than the adjacent artery, b) enlargement or disruption of single or multiple fascicles, c) focal or diffuse deviations or discontinuity, d) enhancement, which is present in tumors and infections, e) enhancement of perineural fat planes. Apart from the aforementioned direct nerve-related features, secondary skeletal muscle signal intensity changes can indicate or further confirm peripheral neuropathy. Skeletal muscles may show acute denervation changes (edema-like signal) as early as 24 hours from the onset of neuropathy, sub-acute changes (edema-like SI and minimal fatty replacement) weeks to months after injury, as well as chronic changes (fatty replacement and atrophy), months to years after nerve injury. When direct nerve-related findings are subtle or absent, secondary muscle signal intensity changes could be considered highly indicative of neuropathy when they demonstrate regional nerve distribution,

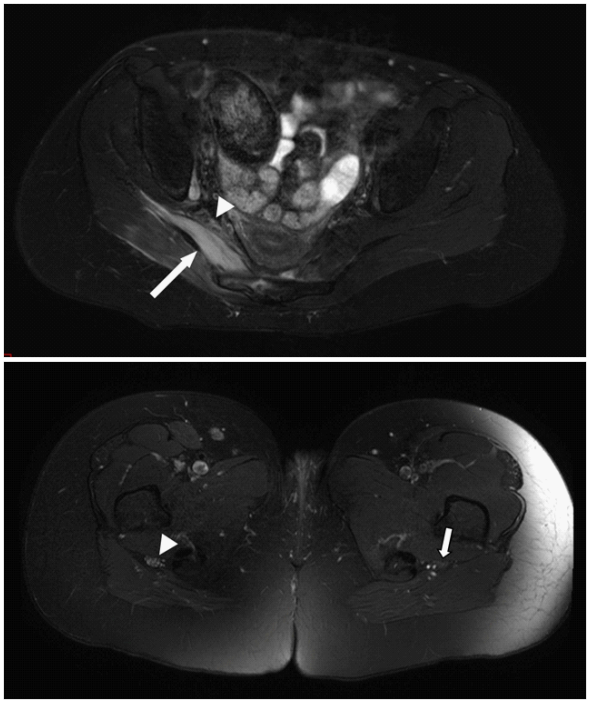

Figure 1: MR Neurography of the pelvis in a 65-year-old female with post-traumatic right gluteal pain. Axial T2 SPAIR image (A) through the pelvis demonstrates edema of the right piriformis muscle (arrow). Note the slightly hyperintense ipsilateral sciatic nerve (arrowhead) in its segment prior to entering the sciatic foramen. In a respective image (B) at a lower level, the sciatic nerve (arrowhead) is enlarged, and features hyper intense fascicles [7]. The contralateral sciatic nerve (arrow) is normal. This was a case of piriformis syndrome.

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Received January 28, 2012; **Accepted** February 01, 2012; **Published** February 06, 2012

Citation: Soldatos T (2012) High-Resolution MR Neurography: Application in Peripheral Nerve Disease. OMICS J Radiology. 1:e102. doi:10.4172/2167-7964.1000e102

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they are diffuse rather than focal, and there is no fascial and subcutaneous edema to suggest infectious or traumatic myopathy.

In our institution, MR Neurography has been established as anintegral component of the diagnostic algorithm in both neurology and nerve injury patients [6] (Figure 1). We expect that the method will gain even more clinical utility in the following years, as clinicians discover its usefulness and MR hardware and imaging techniques evolve.

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