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EDITORIAL

Magnetic resonance neurography: is it so complicated that it needs a touch of genius?

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Key Points

- *Neuropathy imaging is not that complicated or illusive that it needs a touch of genius.*
- *By gaining MR imaging expertise of peripheral nerve lesions and using knowledge of common clinical patterns and diseases, general radiology practitioners can prudently participate in the multidisciplinary care for appropriate and timely management of peripheral neuropathy patients.*

Imaging of peripheral nerves seems challenging owing to their small calibre, proximity to the vessels, frequent oblique course, and complex anatomy. Magnetic resonance neurography (MRN) is an advancement of MR technique devised specifically to highlight the peripheral nerve anatomy, architecture, and its pathology along its longitudinal axis with superior resolution akin to MR angiography for vessels [1]. Every year almost 5% of the population is affected by peripheral neuropathy with a relatively higher frequency in the elderly. The technique of MRN has vastly improved over the years, largely due to wider availability of higher strength and quality magnet scanners as well as innovations in new sequence developments [2] with time-efficient isotropic 3D (dimensional) imaging producing spin-echo type contrast resolution. MRN has been found to be clinically valuable leading to impact in decision making and treatments for neuropathies due to traumatic injuries, entrapment, neoplasm characterization, and post-operative follow-up [3]. In tertiary care centres like ours, diffusion-weighted imaging is routinely used in conjunction with 3D fat-suppressed MRN that enables the generation of vessel signal suppressed MR neurograms for excellent depiction of nerve pathology.

The term MRN was coined in the early 1990s, and the technique then described primarily included a combination of T1 W and 2D STIR (short tau inversion recovery) images [4, 5]. However, the beginning was not easy with many hurdles. Lower magnetic strength scanners at that time generated poor image resolution, low contrast to noise ratio, inadequate fat- and vascular-signal suppression, and exhibited longer scanning times. The advent of 3-Tesla scanner, improved phased-array surface coils, and parallel imaging have revolutionized the MRN technique [6]. 3-D isotropic technique using 3D-SITR and 3D-PSIF (reversed imaging in steady state free precession), and diffusion tensor imaging (DTI) when used in combination with axial T1W and axial T2 SPAIR or T2 Dixon imaging provides comprehensive evaluation of the regional neuromuscular structures aiding in both qualitative and quantitative assessments. Qualitative assessment like any other organ system includes evaluation of peripheral nerve contour, calibre, signal, fascicular disruption, and intralesional fat, etc. Quantitative assessment involves evaluation of parameters like fractional anisotropy (FA),apparent diffusion coefficient (ADC), and contrast enhancement [7].

MRN technique has immensely benefited the neuropathy patients, e.g. preoperative determination of the Sunderland injury grade, distinguishing diabetic amyotrophy from radiculopathy, detecting diffuse neuropathy condition like Charcot Marie tooth disease or chronic demyelinating polyneuropathy, characterizing nerve tumour as benign or malignant, finding exact site of nerve entrapment or demonstrating the post-tunnel release re-entrapment, and in addition,

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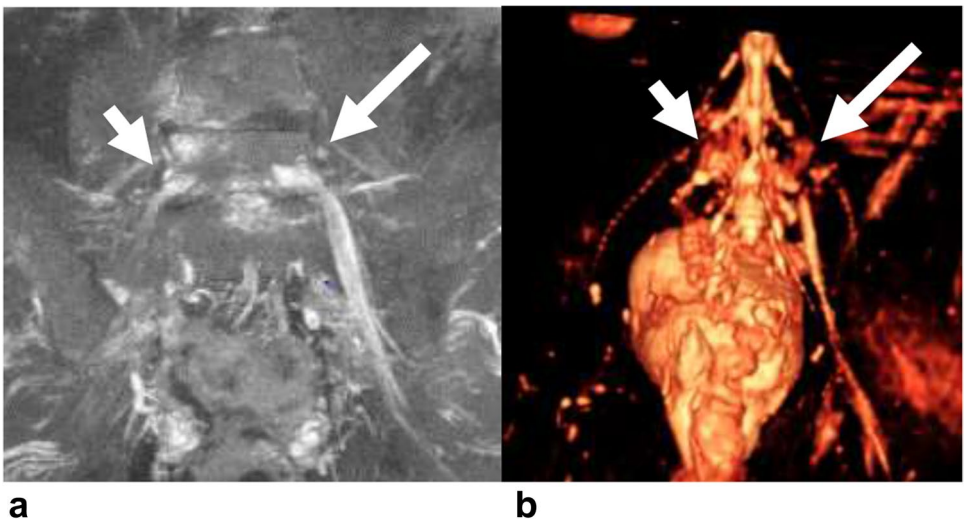

Fig. 1 Left lower back and buttock pain after recent sudden exertion. MR imaging of lumbar spine revealed L5-S1 osteophytes and disc bulge (not shown). **(a)** Grey scale and **(b)** colour heat map MR neurography of lumbosacral plexus using 3D STIR sequence with maximum intensity projection revealed focal constriction and torsion of left L5 nerve with proximal and distal enlargement and asymmetric hyperintensity and yellow colouration (large arrows) compared to normal right L5 nerve root (small arrows). The patient improved gradually following CT-guided left L5 perineural injection of anaesthetic and steroid

determining the regional muscle denervation changes, etc. [6–9].

The major question in vogue is whether such concepts of MRN can be applied to the routine practice by general radiologists or is it still a forte of the nerve imaging sub-specialists? The authors strongly believe that in lieu of availability of abundant literature, conventional radiologists can adapt the interpretation principles in their practices. 3D imaging is also becoming routine on 1.5 T and 3 T scanners. Main hurdle seems to be the lack of interest and efforts needed in gaining clinical and imaging knowledge by radiologists in the domain of peripheral neuropathy. While ultrasound is popular, especially in European countries for peripheral nerve imaging, it requires operator expertise, and deeper nerves are challenging to interrogate. Using conventional high-resolution multiplanar MR imaging, finding the precise site of injury, grading nerve injury to aid pre-operative assessment for the nerve surgeon, characterizing nerve tumours, detecting lesions, such as multi-loculated elongated intraneural ganglion, classic honeycomb pattern of a perineurioma, or hourglass constriction of severe entrapment is not that difficult. MRN though has the added advantage of displaying these pathologies in the long-axis adding to the diagnostic confidence level of the reader, e.g. for finding nerve torsion (Fig. 1) [9]. In fact, pudendal, superficial peroneal and smaller sensory nerves like lateral or medial antebrachial cutaneous and radial sensory nerves are best seen on axial 2D imaging, though MRN is ideally suited for fine craniofacial nerves like for facial, lingual, or occipital pain using 3D PSIF or 3D DESS MR imaging.

To describe findings seen in MRN, structured reporting is ideally used, as shown by Chhabra et al in dedicated books on MRN and musculoskeletal MRI structured evaluation. General practitioners can adopt similar practice for detailed description of MR imaging findings in their reports. The reader should treat peripheral neuromuscular structures as another organ system in question in the field of view, i.e. assess neuromuscular signal, size, contour, and intra-lesional haemorrhage and fat. One should also determine and report the possible aetiology of neuropathy, e.g. entrapment or injury rather than just calling the nerve hyperintense and possible neuropathy. In future, standardized lexicon development, such as neuropathy score reporting and data system, may facilitate more standardized reporting like BIRADS. Further refinement and improved post-processing of techniques of diffusion-weighted imaging will help its widespread application, since these images are very sensitive for qualitative assessment of neuropathy and, in addition, generate quantification parameters as described above.

Thus, neuropathy imaging is not that complicated or illusive that it needs a touch of genius. By gaining MR imaging expertise of peripheral nerve lesions and using knowledge of common clinical patterns and diseases, general radiology practitioners can prudently participate in the multidisciplinary care for appropriate and timely management of peripheral neuropathy patients. Such an approach can tremendously benefit their clinical care with potential positive outcomes and prognosis.

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Methodology • Editorial

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