ISSN: 0975-1556

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2022; 14(1); 609-613

Original Research Article

A Prospective Study Assessing the Accuracy of Diagnostic Imaging in Evaluating Peripheral Nerve Pathologies: Comparative Study

Baidya Nath Singh[1], Ishan Tiwari[2]

[1]Associate Professor, Department of Radiology, SSIMS Medical College, Bhilai, Chhattisgarh, India.

[2]Assistant Professor, Department of Radiology, SSIMS Medical College, Bhilai, Chhattisgarh, India

Received: 18-9-2021 / Revised: 15-10-2021 / Accepted: 30-11-2021
Corresponding author: Dr. Baidya Nath Singh
Conflict of interest: Nil

Abstract

Background: Magnetic resonance imaging (MRI) has been used extensively in revealing pathological changes in the central nervous system. However, to date, MRI is very much underutilized in evaluating the peripheral nervous system (PNS). This underutilization is generally due to two perceived weaknesses in MRI: first, the need for very high resolution to image the small structures within the peripheral nerves to visualize morphological changes; second, the lack of normative data in MRI of the PNS and this makes reliable interpretation of the data difficult.

Materials and Methods: This prospective study was done Department of Radiology, SSIMS Medical College, Bhilai, Chhattisgarh, India for 12 months. using HRUS with 14 MHz linear-transducer and 1.5T MR in cases referred for the assessment of peripheral nerve pathologies.

Results: The overall accuracy of MRN was 89.3% (negative predictive value [NPV]: 57.1%, positive predictive value [PPV]: 95%) and that of HRUS was 82.9% (NPV: 42.8, PPV: 100).

Conclusion: HRUS is a powerful tool that may be used as the first-line imaging modality for the evaluation of peripheral nerve pathologies, and a better means of evaluation of peripheral nerves with submillimeter caliber.

Keywords: peripheral nerve, HRUS, pathologies.

Introduction

Metabolic In order to execute commands from the central nervous system (CNS) (consisting of the brain and spinal cord), humans need the peripheral nervous system (PNS) to provide a communication route from their "external devices" such as sensory organs or muscles to the brain. Thus, these peripheral nerves are designed to travel between the brain, through the spinal cord, and eventually to the organs outside of the cranial space or spinal canal[1].

Peripheral nerves are well-organized tubular structures running from the spinal cord/brain to the cranial tissues and the extremities. For simplification, this review

will omit the cranial nerves. The spinal cord extends the nerve fibers from its ventral column, called ventral roots (primarily motor nerve fibers), and from its dorsal column, called dorsal roots (primarily sensory nerve fibers). Ventral and dorsal roots meet together and are encased by epineurial tissues right before they exit the spinal canal at the neural foramen. These nerves from different levels of the neural foramen are intermingled to form either the brachial plexus in the neck or lumbosacral plexus in the lower back and branched into peripheral nerves in the extremities, such as the ulnar, median, radial, femoral, and sciatic nerves. [1].

Peripheral nerve pathologies are commonly encountered by clinicians in practice. They rely primarily on the information gained by non-anatomical tests like clinical examination, neurophysiological assessment, and on clinical history for the evaluation and management of these cases. With the use of imaging, it is possible to get spatial information, regarding the exact site and nature of pathology as well as the surrounding structures, which is crucial for further management. [2] HRUS and magnetic resonance neurography (MRN) are now considered complementary to clinical and neurophysiological assessment for neuropathies and depending on the clinical question, appropriate choice needs to be made. [3,4] Both the modalities are unique in their respective ways, with HRUS being more comfortable for the patient, cheap, easily available, provides higher image resolution than MR but has a steep learning curve and is highly operator dependent.[5,6].

Peripheral nerve injury has a high prevalence, affecting about 3% in the trauma population, whose trauma often is caused by motor vehicle accidents.[6] There are three major types of peripheral nerve injuries described by Seddon [7] and Sunderland [8] neurapraxia, axonotmesis, and neurotmesis.Neurapraxia is primary demyelination with a reversible conduction block in myelinated nerve fibers. Axonotmesis results in axonal degeneration. Because the neuronal cell body is not damaged, the axon can regenerate at a very slow rate (about 1 mm per day). The distal end of the axon separated from the cell body undergoes Wallerian degeneration. The neurotmesis is a mixture of demyelination and axon loss with disruption of endoneurium, perineurium, or epineurium. When endoneurium is damaged, the axon may regrow; however, poor growth is expected in those nerves with perineurial damage. When the epineurium is damaged, usually there will be no regrowth.[9].

MRI is expensive, sometimes not comfortable for the patient, not dependent on the operator, and has a high spatial resolution. The aim of our study was to compare accuracy of HRUS and MRN for detecting various types of peripheral nerve pathologies, to choose the correct investigation to facilitate prompt patient management.

Materials and Methods:

A prospective study was conducted in the Department of Radiology, SSIMS Medical College, Bhilai, Chhattisgarh, India for 12 months.

Methodology

The study performed using HRUS imaging with 14 MHz linear transducer (Siemens Juniper) and Siemens Essenza 1.5T MR (Siemens Healthcare, Erlangen, Germany) in cases referred for peripheral nerve pathologies. Ethical committee approval and prior patient consent were obtained. Highest confidence level was denoted by score 3 and lowest by score 1. The confidence level for each of these findings compared for both the modalities using the *z*-test and *p*-value was calculated. Patients with polyneuropathies, MR contraindication, claustrophobia, and imaging of brachial/lumbar plexus were

excluded. Sampling Perfection with Application optimized Contrasts using different flip angle Evolutions for submillimeter resolution of nerves, and 3D diffusion weighted PSIF) were obtained. MRs was reported by two radiologists who were unaware of US findings. Radiologists were blinded to nerve conduction velocity (NCV), electromyography (EMG), and clinical details. Studies were conducted in close time intervals to exclude any error or difference in findings due to interval change in lesion characteristics. We determined the accuracy, sensitivity, and specificity of these modalities against the diagnostic standard determined by surgical and/or histopathological evaluation, if not performed then clinical and/or electrodiagnostic evaluation.

Results:

The overall accuracy of MRN (**Table 1**) was 89.3% (negative predictive value [NPV]: 57.1%, positive predictive value [PPV]: 95%) and that of HRUS was 82.9% (NPV: 42.8, PPV: 100). Confidence level (**Table 2**) for detecting nerve discontinuity and change in nerve caliber.

Sixty patients (39 males, 21 females), with the mean age of 40 years and a total of 75 nerves were evaluated using HRUS and MRN, against diagnostic standard determined by surgical (33.0%), histopathological (9.2%), clinical (5.1%), and/or electrodiagnostic evaluation (52.7%). The nerves involved included median (9), ulnar (8), radial (7), anterior interosseous (2), posterior interosseous (2), sciatic (3) common peroneal (6), sural (3), tibial (4), and others (3) like one each of spinal accessory, posterior, and medial cutaneous nerve of the forearm.

Table 1: The overall accuracy of MRN

	MRI		US	
Statistic	**Value**	**95% CI**	**Value**	**95 % CI**
Sensitivity	**90.23%**	**79.99-81.63%**	**82.89%**	**61.32–90.12 %**
Specificity	**60.12%**	**26.28–95.99%**	**100.00%**	**62.67–100.00 %**
Positive predictive value	**95.00%**	**82.72–96.21%**	**100.00 %**	
Negative predictive value	**51.34%**	**23.82–84.89%**	**47.18%**	**34.18–62.11 %**
Accuracy	**82.73%**	**77.91–94.62%**	**88.92%**	**70.18–93.81 %**

Abbreviations: CI, confidence interval; MRN, magnetic resonance neurography; US, ultrasound.

Table 2: Confidence level for various parameters on MRI and US

	n	**MRI**	**US**	***p*- Value**
Nerve discontinuity	**10**	**7 (70.0%)**	**10 (100.0%)**	**0.005[a]**
Increased nerve signal	**13**	**16 (100.0%)**	**8 (69.2%)**	**0.003[a]**
Fascicular change	**18**	**21 (88.9%)**	**18 (100.0%)**	**0.234**
Caliber change	**14**	**9 (57.1%)**	**14 (100.0%)**	**0.005[a]**
Neuroma/mass lesion	**9**	**6 (88.9%)**	**9 (100.0%)**	**0.378**

Abbreviations: MRI, magnetic resonance imaging; US, ultrasound. [a]*p*-Value <0.05, statistically significant.

Discussion:

Our study has shown the overall accuracy of MRN was 89.3% (negative predictive value [NPV]: 57.1%, positive predictive value [PPV]: 95%) and that of HRUS was 82.9% (NPV: 42.8, PPV: 100). Confidence

level for detecting nerve discontinuity and change in nerve caliber.

Peripheral nerve imaging is helpful in patients with indeterminate findings on electrodiagnostic studies (especially postoperative patients) and in patients in whom electrodiagnostic studies are not feasible due to inaccessible nerves or with dermatological conditions. [10, 11]

Our study has shown MRN to be more accurate in detecting the peripheral nerve pathologies with higher negative predictive values for diagnosing the lesions. Similar findings were noted in a comparative study published by Agarwal et al, [12] who also reported higher accuracy of MRI over HRUS (93.89 vs. 86.11%) with higher negative predictive value of MRI. The confidence levels to detect pathological characters like caliber change (p = 0.007) and nerve discontinuity (p = 0.009) were higher with HRUS than MRI (100 vs. 50% and 100 vs. 70%, respectively) and found to be statistically significant (p<0.05). Confidence level for detection of focal neuroma formation was high with both (100% for US vs. 88.8% for MRI) with no statistically significant difference. However, MRI detected nerve edema with more confidence in cases, whereas US depicted no abnormality leading to higher rates of pathological diagnosis (p = 0.033). Garg et al9 in their study also evaluated confidence levels for these characteristics and they had a similar impression for detecting nerve discontinuity, neuroma detection, and detection of nerve edema on MRN. However, in their study confidence level was higher for MRN in detecting change in caliber, which can probably be explained due to difference in the frequency of the US probe used in both studies. We used a 14-MHz high-resolution probe and they used 7 to 10 MHz linear array probe. Pathology of submillimeter caliber nerves (i.e., spinal accessory, posterior and medial cutaneous nerve of forearm) was accurately detected on US because of a high-frequency probe that gives submillimeter resolution. These could not be diagnosed on MRI, probably because of wider field of view imaging that made it difficult to evaluate submillimeter caliber nerves.

Conclusion:

HRUS is a powerful tool that may be used as the first-line imaging modality for the evaluation of peripheral nerve pathologies, as it is dynamic, economical, and comfortable for the patients and has high confidence levels to detect pathology with a trained operator.

References:

1. Marieb EN, Hoehn K: Human anatomy & physiology. Pearson Education; 2007.
2. Gagliardo A, Toia F, Maggì F, Mariolo AV, Cillino M, Moschella F. Clinical neurophysiology and imaging of nerve injuries: preoperative diagnostic work-up and post-operative monitoring. PlastAesthet Res 2015; 2:149–155 3.
3. Kwee RM, Chhabra A, Wang KC, Marker DR, Carrino JA. Accuracy of MRI in diagnosing peripheral nerve disease: a systematic review of the literature. AJR Am J Roentgenol 2014;203(6):1303–1309.
4. Brown JM, Yablon CM, Morag Y, Brandon CJ, Jacobson JA. US of the peripheral nerves of the upper extremity: a landmark approach. Radiographics 2016;36(2):452–463 5.
5. Yablon CM, Hammer MR, Morag Y, Brandon CJ, Fessell DP, Jacobson JA. US of the peripheral nerves of the lower extremity: a landmark approach. Radiographics 2016;36(2):464–478.
6. Noble J, Munro CA, Prasad VS, et al.: Analysis of upper and lower extremity peripheral nerve injuries in a population of patients with multiple injuries. J Trauma. 1998; 45(1): 116–22.
7. Seddon H: Three types of nerve injury. Brain. 1943; 66(4): 237–288.

8. Sunderland S: A classification of peripheral nerve injuries producing loss of function. Brain. 1951; 74(4): 491–516.
9. Evans GR: Peripheral nerve injury: A review and approach to tissue engineered constructs. Anat Rec. 2001; 263(4): 396–404.
10. Jablecki CK, Andary MT, So YT, Wilkins DE, Williams FH. AAEM Quality Assurance Committee. Literature review of the usefulness of nerve conduction studies and electromyography for the evaluation of patients with carpal tunnel syndrome. Muscle Nerve 1993;16(12):1392–1414.
11. Dellon AL. Management of peripheral nerve problems in the upper and lower extremity using quantitative sensory testing. Hand Clin 1999;15(4):697–715.
12. Agarwal A, Chandra A, Jaipal U, et al. Can imaging be the new yardstick for diagnosing peripheral neuropathy? A comparison between high resolution ultrasound and MR neurography with an approach to diagnosis. Insights Imaging 2019;10(1):104.