Original Research Article

High-resolution ultrasound and magnetic resonance neurography in peripheral nerve pathologies

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Abstract

Background: Peripheral nerve pathologies are commonly encountered by surgeons. They depend primarily on the information gained by non-anatomical tests like clinical examination, neurophysiological assessment and on clinical history for the assessment and management of such patients. The present study was conducted to compare high-resolution ultrasound (HRUS) and magnetic resonance neurography (MRN) in peripheral nerve pathologies. **Materials & Methods:** 65 patients diagnosed with peripheral nerve pathologies of both genders underwent high-resolution ultrasound using HRUS imaging with 14 MHz linear transducer (Siemens S2000) and Siemens MAGNETOM 3 or 1.5T MR. Image interpretation was done using a scoring system (score 0–3 confidence level) to assess for nerve continuity/discontinuity, increased nerve signal/edema, fascicular change, caliber change, and neuroma/mass lesion. coil depending upon the size of the region scanned and various sequences. **Results:** Out of 65 patients, males were 40 and females were 25. The mean sensitivity of MRI was 94.2% and USG was 82.5%, specificity was 68.3% and 100%, PPV was 95.5% and 100% and NPV was 58.1% and 46.2% respectively. Out of 15 cases of nerve discontinuity, MRI assessed 10 and USG 15 accurately. Out of 12 cases of increased nerve signal, MRI detected all correct and USG detected 8 correct. Out of 17 fascicular change, MRI detected 13 and USG all 17 correct. 10 cases of caliber change, MRI detected 5 and USG 10 correctly and 8 cases of mass lesions, MRI detected 7 and USG 8 correctly. The difference was significant (P< 0.05). **Conclusion:** HRUS showed high accuracy and is a powerful tool that may be used as the first-line imaging modality for the evaluation of peripheral nerve pathologies.

Keywords: Peripheral nerve pathologies, MRI, HRUS

Introduction

Peripheral nerve pathologies are commonly encountered by surgeons. They depend primarily on the information gained by non-anatomical tests like clinical examination, neurophysiological assessment and on clinical history for the assessment and management of such patients. It is possible to get spatial information, related to the exact site and nature of pathology as well as the surrounding structures, which is crucial for further management[1].

Nerves generally run along borders of other structures, especially between different muscle groups. It is important to have a practiced survey pattern for each nerve using landmarks and borders that one can follow every time[2]. If one loses the nerve while tracing it, the survey needs to be started again from the beginning. Movement of limb helps to differentiate nerve from tendons, whereas colour doppler helps to differentiate nerves from vessels. Lymph nodes are spherical and show a fatty hilum and can be easily differentiated from nerves by their shape and inability to trace them in longitudinal axis[3].

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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[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. MRI is expensive, sometimes not comfortable for the patient, not dependent on the operator, and has a high spatial resolution[5]. The present study was conducted to compare high-resolution ultrasound (HRUS) and magnetic resonance neurography (MRN) in peripheral nerve pathologies.

Materials & Methods

The present study was conducted among 65 patients diagnosed with peripheral nerve pathologies of both genders. All were informed regarding the study and their written consent was obtained.

Demographic data such as name, age, gender etc. was recorded. All underwent high-resolution ultrasound using HRUS imaging with 14 MHz linear transducer (Siemens S2000) and Siemens MAGNETOM 3 or 1.5T MR. Image interpretation was done using a scoring system (score 0–3 confidence level) to assess for nerve continuity/discontinuity, increased nerve signal/edema, fascicular change, caliber change, and neuroma/mass lesion. Highest confidence level was denoted by score 3 and lowest by score 1. MRN was done using body coil depending upon the size of the region scanned and various sequences. All images were scanned by experienced radiologists. Results were statistically analyzed.

Results

Table 1:Distribution of patients

Total- 65		
Gender	**Males**	**Females**
Number	40	25

Table 1 shows that out of 65 patients, males were 40 and females were 25.

Table 2: Accuracy of imaging modality

Statistics	MRI		USG	
	Value	95% CI	Value	95% CI
Sensitivity	94.2%	80.4-98.7%	82.5%	64.5-92.4%
Specificity	68.3%	42.6-94.2%	100%	52.8-100%
PPV %	95.5%	84.2-96.4%	100%	-
NPV %	58.1%	26.5-80.4%	46.2%	26.4-93.5%

Table 2, Fig 1 show that mean sensitivity of MRI was 94.2% and USG was 82.5%, specificity was 68.3% and 100%, PPV was 95.5% and 100% and NPV was 58.1% and 46.2% respectively.

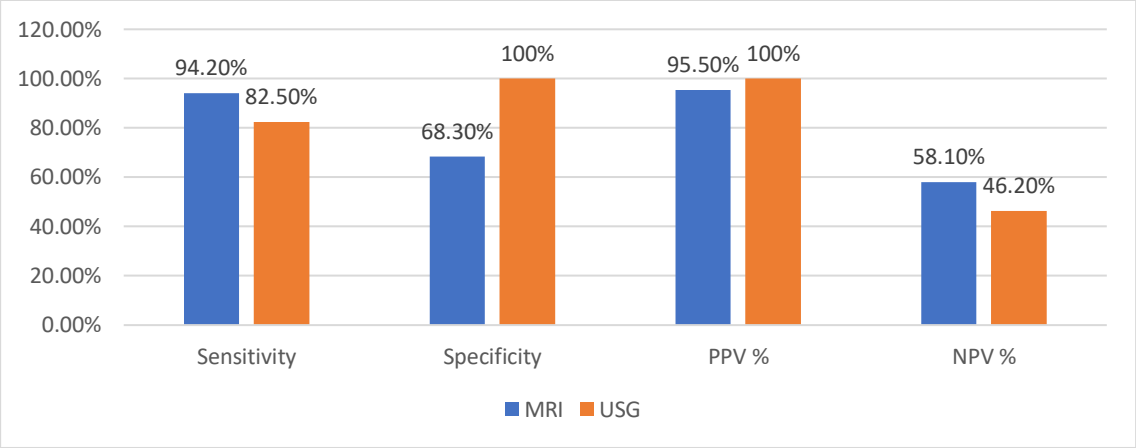

Fig 1:Accuracy of imaging modality

Table 3:Confidence level for various parameters on MRI and USG

Parameters	Number	MRI	USG	P value
Nerve discontinuity	15	10	15	0.01
Increased nerved signal	12	12	8	0.04
Fascicular change	17	13	17	0.15
Caliber change	10	5	10	0.02
Neuroma/ mass lesion	8	7	8	0.16

Table 3 shows that out of 15 cases of nerve discontinuity, MRI assessed 10 and USG 15 accurately. Out of 12 cases of increased nerve signal, MRI detected all correct and USG detected 8 correct. Out of 17 fascicular change, MRI detected 13 and USG all 17 correct. 10 cases of caliber change, MRI detected 5 and USG 10 correctly and 8 cases of mass lesions, MRI detected 7 and USG 8 correctly. The difference was significant ($P< 0.05$).

Discussion

Peripheral nerves are affected by a number of disease processes like trauma, infection, inflammation, benign and malignant tumors, as well as entrapment neuropathies. USG with its high resolution, can detect and characterize these pathologies in a cost-effective manner[6]. The normal nerve, in transverse section, reveals small hypoechoic areas separated by hyperechoic septae, giving a "honeycomb-like" appearance[7]. The hypoechoic areas represent nerve fascicles while the echogenic septae represent interfascicular perineurium. The longitudinal sections also reveal the fascicular architecture, leading to a "bundle of straws" appearance. The nerve is more echogenic as compared to the muscle which shows hypoechoic muscle fiber bundles with intervening echogenic perimysium[8]. The tendon is more echogenic as compared to the nerve and shows a compact arrangement of echogenic fibrils. On dynamic examination, the nerves show sliding movement over the muscles and tendons. An altered movement or contour deformity during movement of the nerve gives us a clue to diagnose pathology[9]. The present study was conducted to compare high-resolution ultrasound (HRUS) and magnetic resonance neurography (MRN) in peripheral nerve pathologies. In present study, out of 65 patients, males were 40 and females were 25. The mean sensitivity of MRI was 94.2% and USG was 82.5%, specificity was 68.3% and 100%, PPV was 95.5% and 100% and NPV was 58.1% and 46.2% respectively. Nischal et al[10] compared the accuracy of HRUS and MRN for detecting various peripheral nerve pathologies, to choose the correct investigation to facilitate prompt patient management. They determined the accuracy, sensitivity, and specificity of these modalities compared with the diagnostic standard determined by surgical and/or histopathological, if not performed then clinical and/or electrodiagnostic evaluation. The overall accuracy of MRN was 89.3% (specificity: 66.6%, sensitivity: 92.6%, negative predictive value [NPV]: 57.1%, positive predictive value [PPV]: 95%) and that of HRUS was 82.9% (specificity: 100%, sensitivity: 80.4%, NPV: 42.8, PPV: 100). The confidence level for detecting nerve discontinuity and change in nerve caliber was found to be higher on ultrasonography than magnetic resonance imaging (MRI) (100 vs. 70% and 100 vs. 50%, respectively). Pathology of submillimeter caliber nerves was accurately detected by HRUS and these could not be well-visualized on MRI.

We found that out of 15 cases of nerve discontinuity, MRI assessed 10 and USG 15 accurately. Out of 12 cases of increased nerve signal, MRI detected all correct and USG detected 8 correct. Out of 17 fascicular change, MRI detected 13 and USG all 17 correct. 10 cases of caliber change, MRI detected 5 and USG 10 correctly and 8 cases of mass lesions, MRI detected 7 and USG 8 correctly. Agarwal et

al[11] reported higher specificity with MRI (86.67 vs. 80%) with higher positive predictive values.

Entrapment or compression neuropathies are often unrecognized cause of pain and neural impairment. The nerves are more prone to compression in specific locations where they course through osteofibrous tunnels. The median nerve in carpal tunnel and the ulnar nerve in Guyon's canal and cubital tunnel are the common sites of entrapment in the upper limb and can be evaluated with USG. Common peroneal nerve near fibular neck and posterior tibial nerve in tarsal tunnel are commonly involved in the lower limb[12].

Conclusion

Authors found that HRUS showed high accuracy and is a powerful tool that may be used as the first-line imaging modality for the evaluation of peripheral nerve pathologies.

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