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CASE SERIES

Diagnostic Imaging of Peripheral Neuropathies Due to Entrapment & Trauma: A Case Series

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ABSTRACT

Background: Peripheral neuropathies are group of disorder which affects nerves due to various etiologies. Diagnostic imaging helps and play a major role in diagnosing the peripheral neuropathies. Early timely diagnosis of nerve injury is very important in taking treatment decisions. Imaging main role is to diagnose nerve injury/involvement, cause of compression and pathologies mimicking nerve involvement.

Aims & Methods: This case series aims to discuss various entrapment peripheral neuropathies & Role of imaging with different modalities.

Result & Interpretation: Ultrasound is emerging as a great tool in diagnosing nerve pathologies. It is easily available, cheap, cost effective and best screening tool. Magnetic resonance neurography (MRN) studies help in deeper nerve pathologies, and affected muscle details.

KEYWORDS

• Entrapment • Nerves • Neuropathies • Magnetic Resonance Neurography (MRN) • High Resolution Ultrasound (HRUS)

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INTRODUCTION

Peripheral neuropathies are group of disorder which affects nerves due to various etiologies. Diagnostic imaging helps and play a major role in diagnosing the peripheral neuropathies. Early and timely diagnosis of nerve injury is very important in taking treatment decisions. Imaging main role is to diagnose nerve injury/ involvement, cause of compression and pathologies mimicking nerve involvement. This case series aim is to discuss various entrapment peripheral neuropathies and role of imaging with different modalities. Ultrasound is emerging as a great tool in diagnosing nerve pathologies. It is easily available, cheap, cost effective and best screening tool. Magnetic resonance neurography (MRN) studies help in deeper nerve pathologies, and affected muscle details.

CASE DISCUSSIONS

Case 1: A patient, aged 24 years presented in Orthopaedics Department with difficulty in lifting the front part of left foot and was dragging the foot on ground walking. He was hence referred to Radiology department for USG evaluation of left foot drop. The USG of left leg revealed a well defined cystic lesion along the peroneal muscle in lateral aspect of knee and suspicion of superficial peroneal nerve perineural cyst was raised (*Figure 1B*). MRI of left knee with MR neurography was performed and confirmed the diagnosis. MRI revealed a well-defined thin walled loculated cyst along the course of superficial peroneal nerve adjacent to head of fibula and at the level of cyst superficial peroneal nerve was not separately visualized likely compressed. Denervation edema of peroneus muscle in lateral compartment of lower leg was also seen (*Figure 1C & D*).

Patient was operated and findings were matched. Cyst was removed.

After 1year patient again presented with same complaints in orthopaedic department and referred to us for USG. USG reveals well defined cystic lesion along the course of peroneal nerve and another cystic lesion with septation is lateral aspect of knee adjacent to above mentioned cyst (*Figure E*). MRI was performed again thin walled loculated cyst seen along the course of superficial peroneal nerve and diagnosis of recurrent peroneal cyst was made with denervation edema in antero-lateral compartment of lower leg (*Figure 1A*).

Patient refused further surgical intervention and continues to be on follow up.

Case 2: 43 year old patient from Saudi Arabi country presented to the orthopaedics department with complaints of tingling and pain in the right hand since few months. Patient had a trauma history on the right elbow few

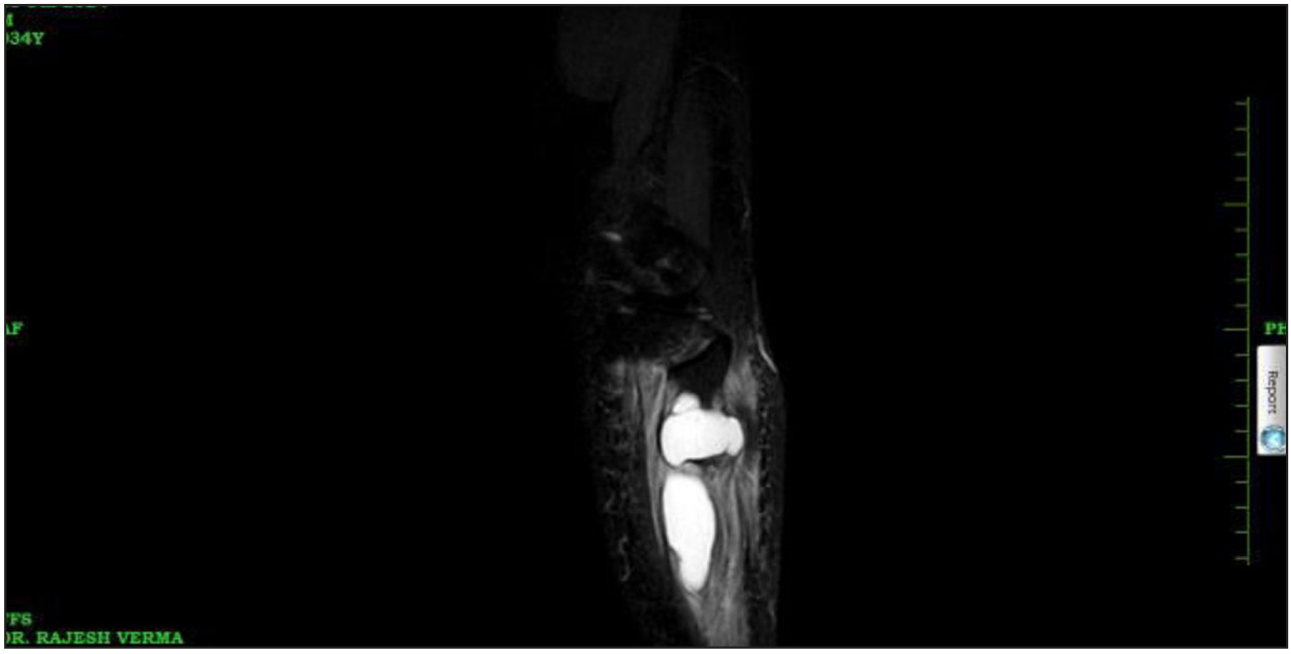


Figure 1A: On MR neurography two cystic lesions appearing hyper-intense are seen along lateral aspect of knee and another seen along peroneal nerve

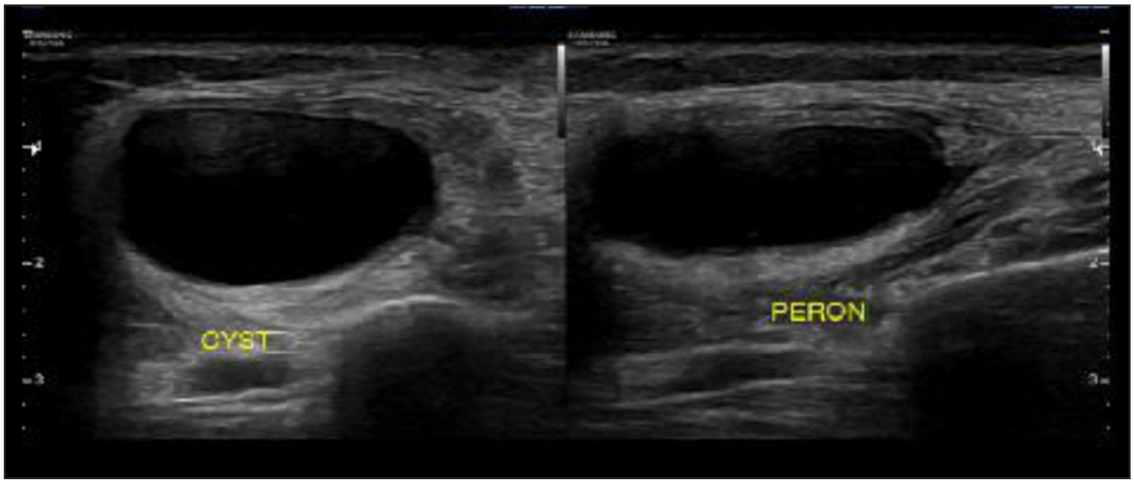


Figure 1B: On USG well defined two cystic lesions seen along lateral aspect of knee and another seen along peroneal nerve

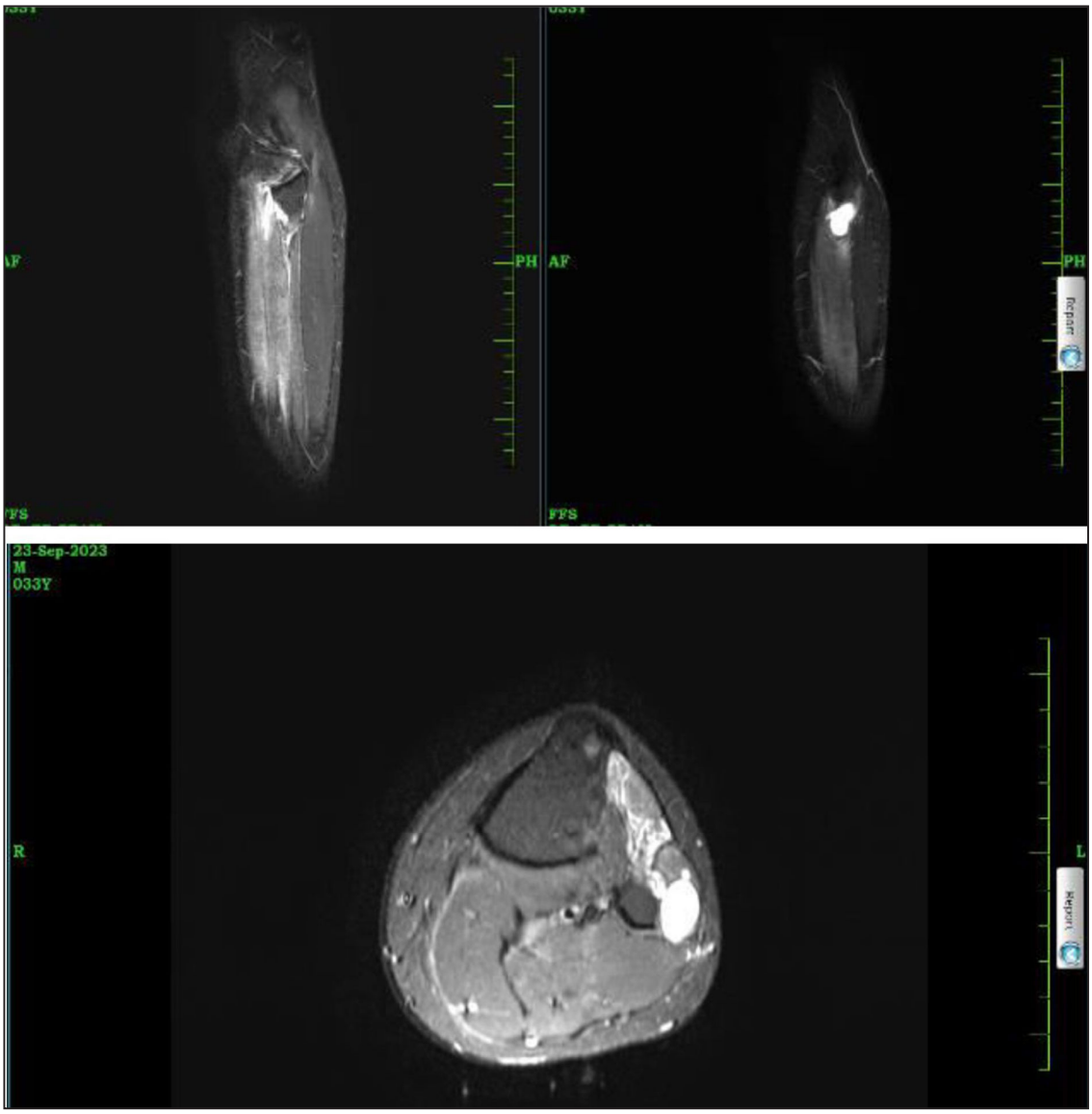


Figure 1C & D: On MR neurography of leg, axial and coronal Figures respectively, cyst along superificial peroneal nerve is seen appearing hyperintense and surrounding denervation muscle edema

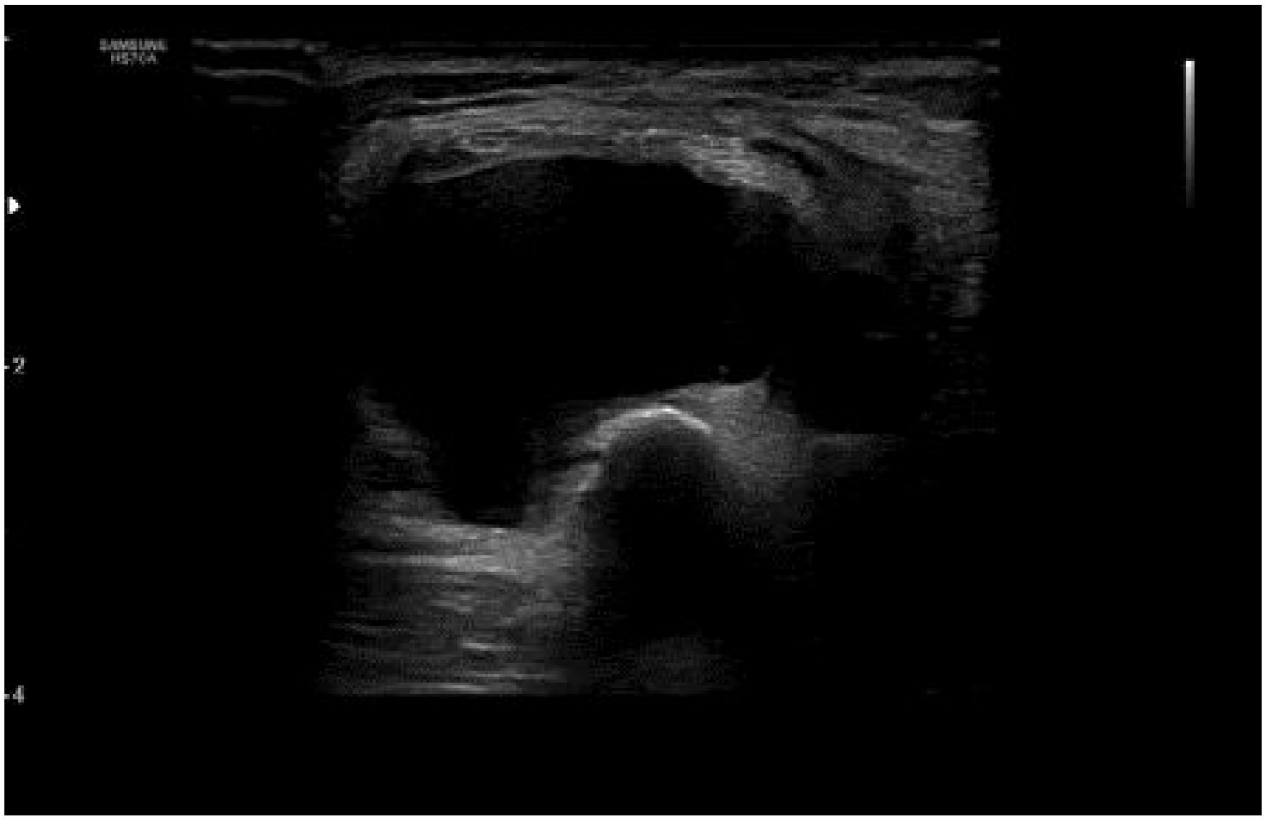


Figure 1E: USG Figure of leg, showing large cystic lesion along the surperficial peroneal nerve

months back. Suspicion of right ulnar nerve injury was made which was confirmed on MRI in the radiology department. The MRI revealed ulnar nerve lying antero-medially at the level of elbow with empty cubital tunnel and ulnar was observed to the thickened and showing increased signal on T2/PD SPAIR Figures suggesting ulnar nerve injury (*Figure 2*)

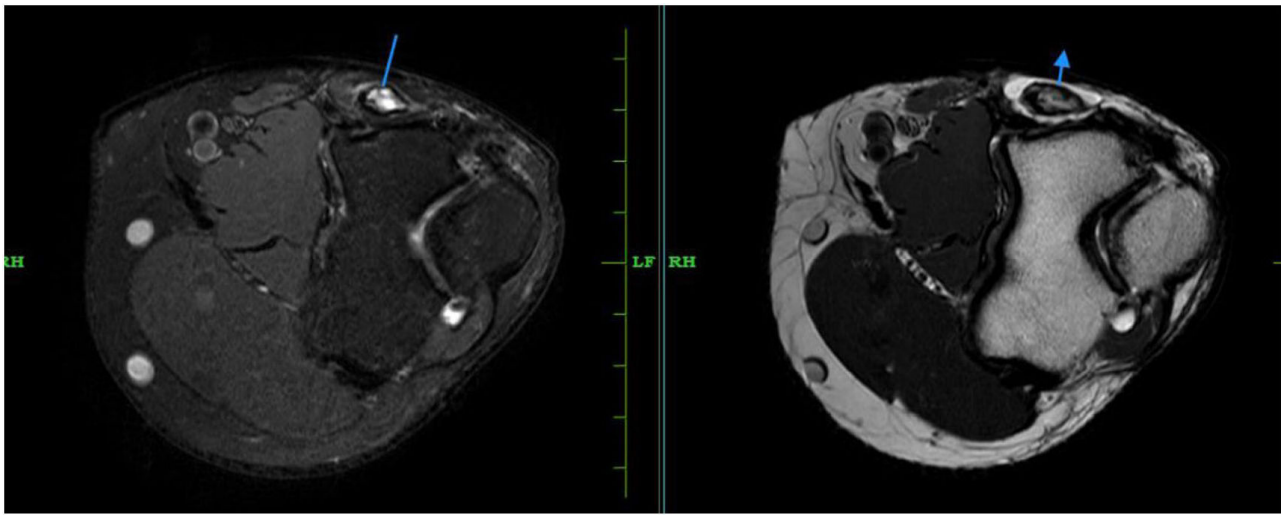


Figure 2: On axial PDFS & T2 MRI Figures of elbow ulnar nerve (blue line and arrow) shows increased signal and appears thickened suggesting ulanar nerve injury

Patient was suggested for surgery. Hence, ulnar nerve transposition was undertaken after which the patient was relieved of the tingling and the pain.

Case 3: Child of 14 years, male, presented with weak hand grip to the Neurology department giving a history of a holy tread tied in the early years of life leading to compression on wrist.

The patient was brought by the family with the above complaints. The neurologist suspected nerve compression due to foreign body (holy thread), causing impaction and compression on wrist. USG was performed in the radiology department showing bulky median nerve with loss of fascicular patterns (*Figure 3A*). MRI of right wrist was performed revealing bulky median nerve with loss of fascicular pattern at the site of scar region with altered signal suggesting neuroma in continuation (*Figure 3B,C*). Proximal and distal median nerve appears normal. Parents were counselled for surgery. Neurolysis of neuroma was done. Patient recovered post surgery and being followed up.

Case 4: A patient of 35 year presented in Orthopaedics department with weakness in grip and pain and needle sensation in hand. On NCV and clinical examination median nerve involvement was suspected and patient referred to our department for further evaluation with MRI right wrist. On MRI hyperintensity and enlargement of

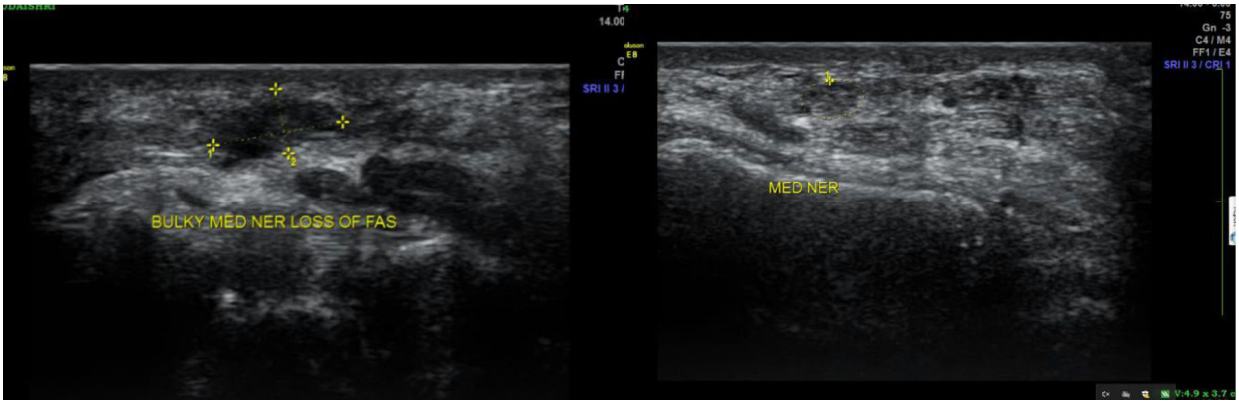


Figure 3A: On ultrasound Figures median nerve appears bulky with loss of fascicular pattern

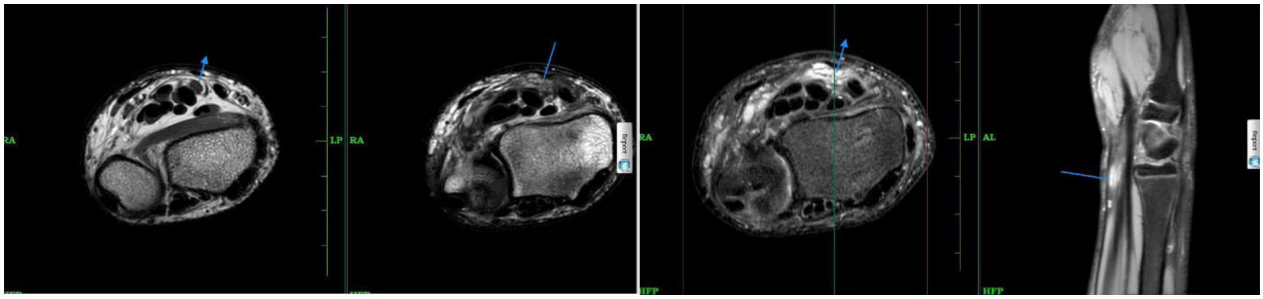


Figure 3B

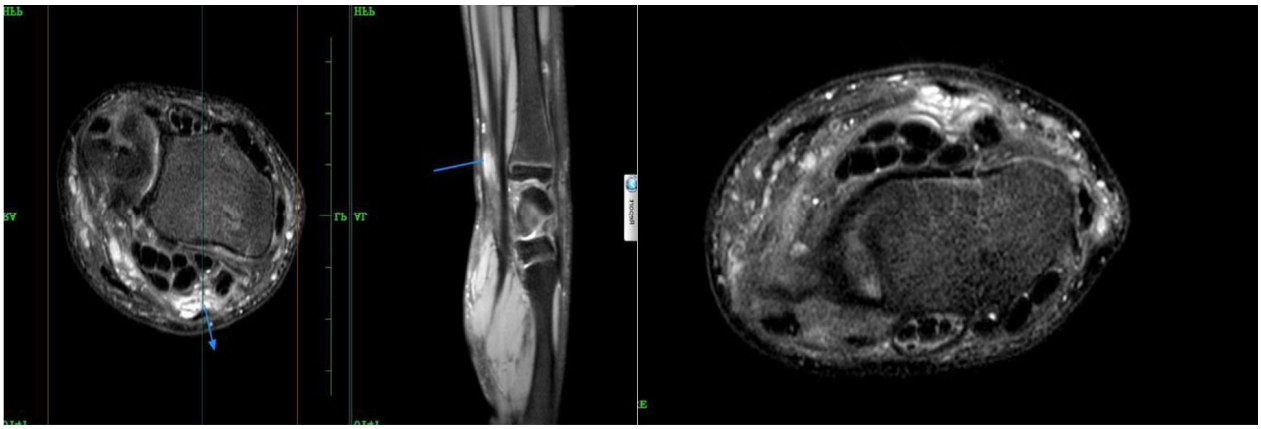


Figure 3C

Figure 3B & C: Axial and sagittal MRI Figures of wrist shows bulky median nerve with loss of fascicular pattern at scar site with increased signal, suggesting neuroma in continuation

median nerve is seen with volar bowing of flexor retinaculum at the level of pisiform and flattening is noted at the level of hook of hamlet with mild edema with loss of fat is noted within the carpal tunnel in association with flexor retinaculum thickening at the level of hook of hamate and just proximal to it in volar aspect which suggested carpal tunnel syndrome (*Figure 4*).

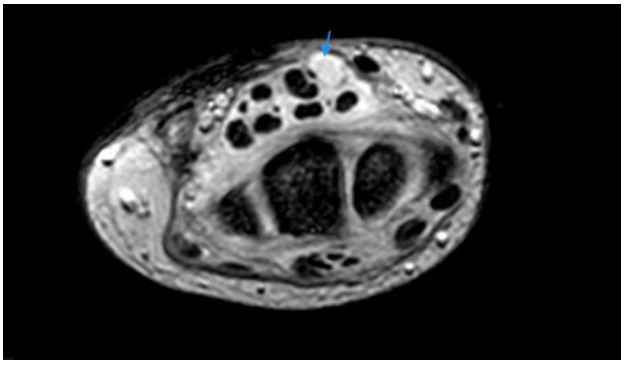


Figure 4: In MRI axial Figures of wrist there is increase signal and enlargement of median nerve

Patient was counselled and explained and further managed with non-invasive treatment.

Case 5: A young patient of 21 year presented in Orthopaedics department with h/o foot drop. On detail history there was a history of trauma, after which the symptoms started initially pain and then leads to foot drop. Clinical examination, was done and patient referred to radiology department for further evaluation with ultrasound of left knee. On USG, left common peroneal nerve at the site of injury, at knee level is thickened and shows anechoic cystic areas which raised the suspicion of neuroma formation (*Figure 5*). Findings are explained to the patient and counselled for surgery however patient was not willing for the invasive procedure so non-invasive treatments were done.

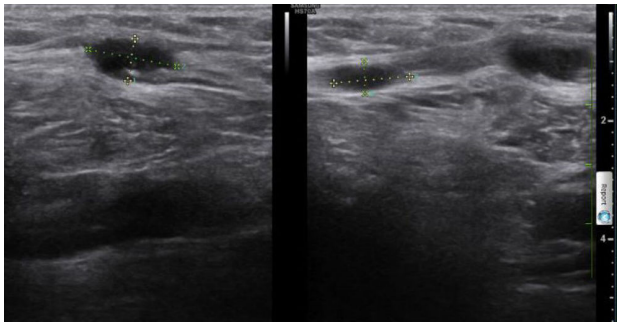


Figure 5: On ultrasound Figure of knee, well defined cystic lesion is seen in course of left common personeal nerve, likely favours neuroma formation

Case 6: A young male patient of 34 year presented in Orthopaedics department with h/o pain and intolerance to old. Clinical examination, was done and patient referred to radiology department for further evaluation with MRI of left wrist. On MRI well defined lobulated soft tissue mass lesion showing tortous tubular low signal intensities within it, in volar aspect of 2nd, 3rd and 4th intermetacarpal spaces extending dorsally between adjacent intermetacarpal spaces and anteriorly exteding into the adjacent flexor retinaculum and encasing medial tendon flexor digitorum profundus. Similar tortous tubular fusiform soft tissue lesions are seen superficial to the flexor digitorum superficialis tendon and hypothenar muscles and encasing medial tendon of flexor digitorum superficialis. Dilated tortous tubular vessels are also seen in adjacent subcutaneous plane. Findings are suggestive of low flow vascular malformation (*Figure 6*).

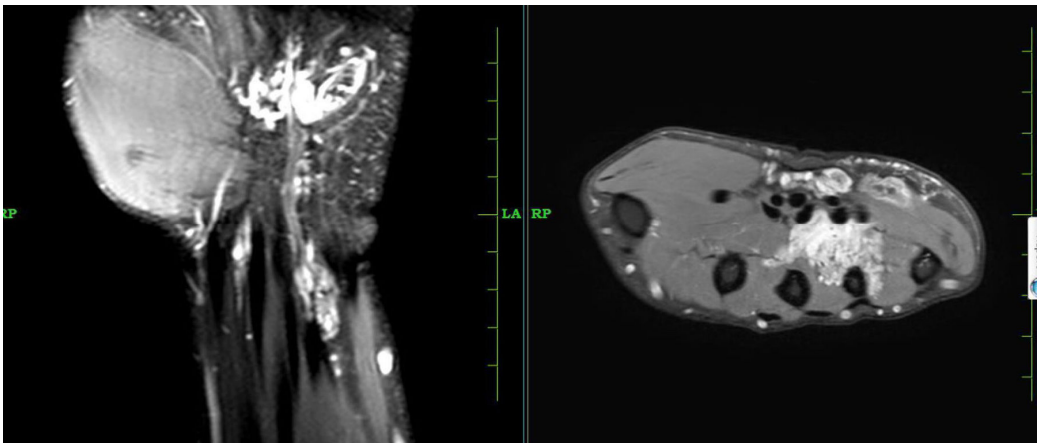


Figure 6: On MRI Figures of wrist coronal and axial Figures shows tortuous tubular fusiform soft tissue lesions showing increased signal favour low flow vascular malformation

Case 7: A patient of 47 year presented in Orthopaedics department with h/o swelling in left ankle. On clinical examination, swelling was painless and soft slightly mobile. Patient referred to radiology department for further evaluation with ultrasound of left ankle. On USG of left ankle, A well-defined lesion was seen along flexor digitorum longus and flexor hallucis longus tendon (*Figure 7A*). MRI of left ankle was done and it reveals, well defined lesion seen postero-medially between the flexor digitorum longus and flexor hallucis longus tendon. Neurovascular bands seen abutting the lesion however no obvious invasion seen-likely benign (DD Schwannoma) *Figure 7B*. Findings are explained to the patient and counselled for surgery and it was removed.

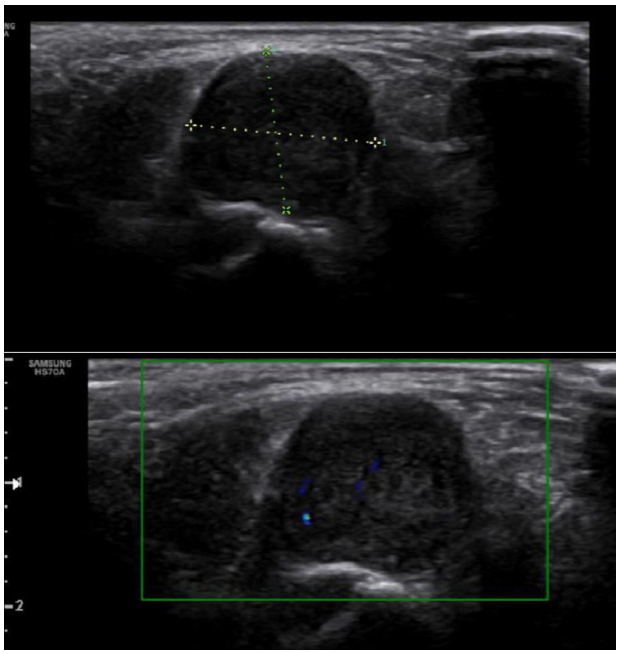


Figure 7A: On MRI of left ankle sagittal and coronal Figures (T2/STIR) shows a hyperintense lesion along flexor digitorum longus and flexor halluces longus tendon abutting neurovascular bundle-likely schwannoma

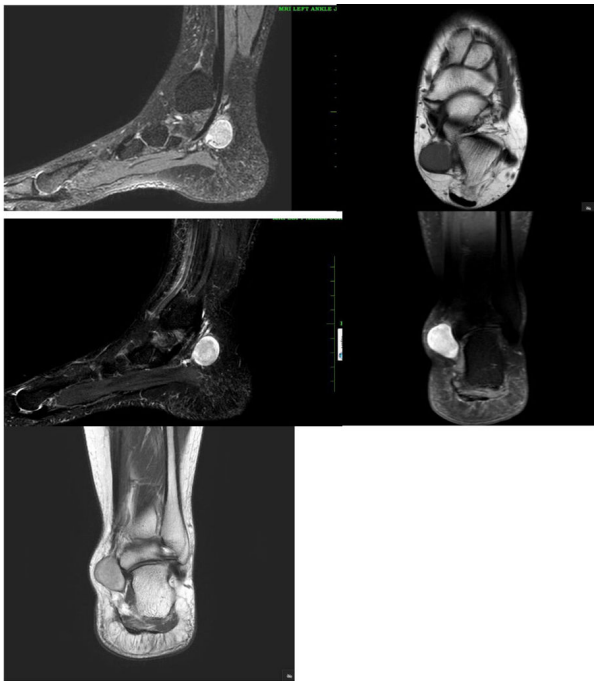


Figure 7B: On MRI of left ankle sagittal and coronal Figures (T2/STIR) shows a hyperintense lesion along flexor digitorum longus and flexor halluces longus tendon abutting neurovascular bundle-likely schwannoma

Case 8: A female patient of 34-year female presented with numbness and tingling sensation in left arm. On detailed history patient revealed H/o trauma and started symptom since then. On clinical examination neurologist suspected nerve injury and sent patient to radiology department for MRI of left elbow and wrist. On MRI wrist hyperintensity in ulnar nerve in guyon's canal was noted and on MRI elbow focal increased signal intensity was seen in ulnar nerve posterior to medial epicondyle (*Figure 8*). Patient was counselled and opted for conservative treatment.

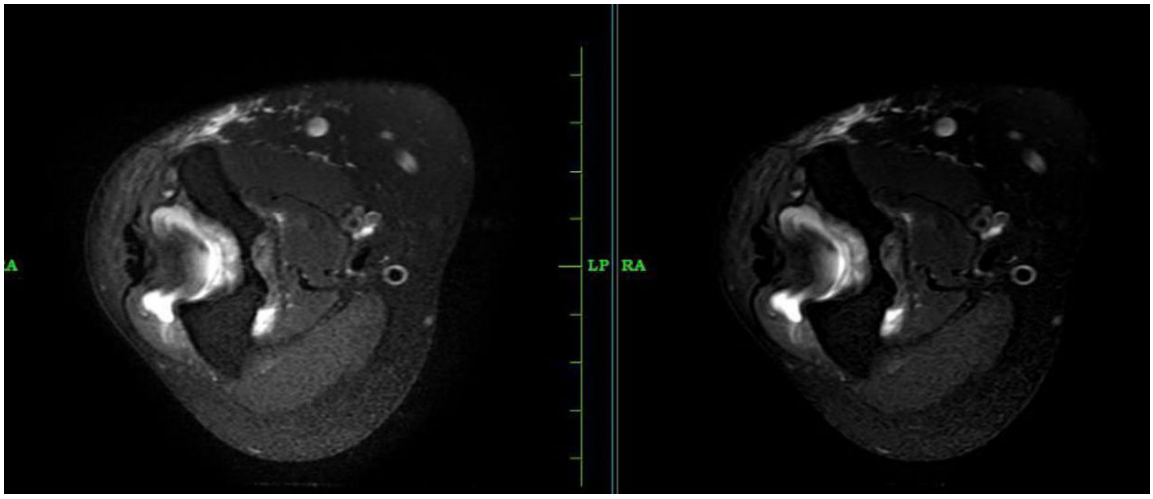


Figure 8: On MRI axial Figures of left elbow shows increase signal in the ulnar nerve posterior to medial epicondyle

Case 9: A young patient of 30 year presented in neurology department with weakness in grip in left hand. No h/o trauma was there. Patient was send to radiology department for MRI left elbow. On MRI Increased signal intensity of ulnar nerve noted in cubital tunnel, however no evidence of discontinuity of nerve fibers noted, could be related to edema in the nerve (*Figure 9*). Patient was managed non-invasively.

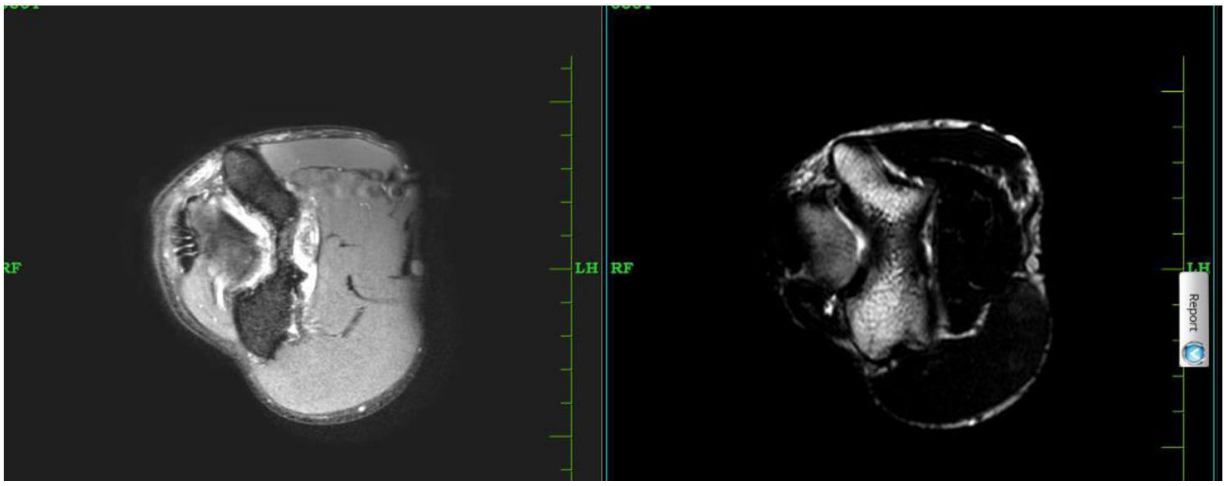


Figure 9: On MRI axial Figures of left elbow shows increase signal in the ulnar nerve in cubital tunnel to medial epicondyle

Case 10: A young patient of 27 year presented in orthopaedic department with weakness in grip in right hand. No h/o trauma was there. Patient was send to radiology department for ultrasound right elbow. On ultrasound of right elbow, right ulnar nerve appears normal upto epicondyle level and appears severely thin distal to it likely due to compression (*Figure 10*). Patient was counselled and advised surgery. Surgery was done and transposition of ulnar nerve was done.

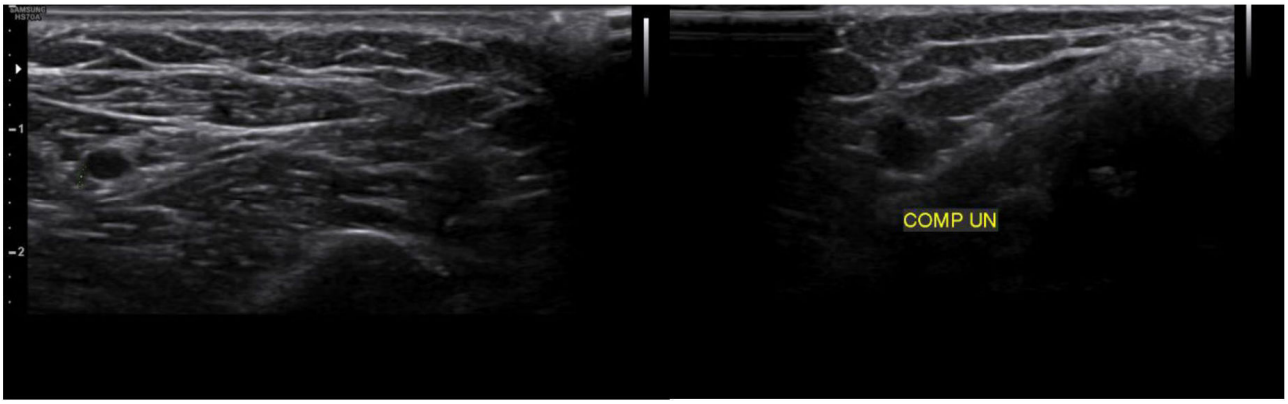


Figure 10: On ultrasound Figures of right elbow, ulnar nerve appears normal upto epicondyle level and severely thin distal to it

Case 11: A female patient of 32-year female presented with trauma in ER department right arm. On detailed history patient revealed numbness and tingling in right arm. On clinical examination the orthopaedician suspected nerve injury and sent patient to radiology department for MRI/CT of right elbow. On CT/MRI elbow Fracture of coronoid process of ulna and Increased signal intensity of ulnar nerve in cubital tunnel and around elbow joint - likely edema (*Figure 11*). Patient was counselled and surgery was advised. Surgery was done.

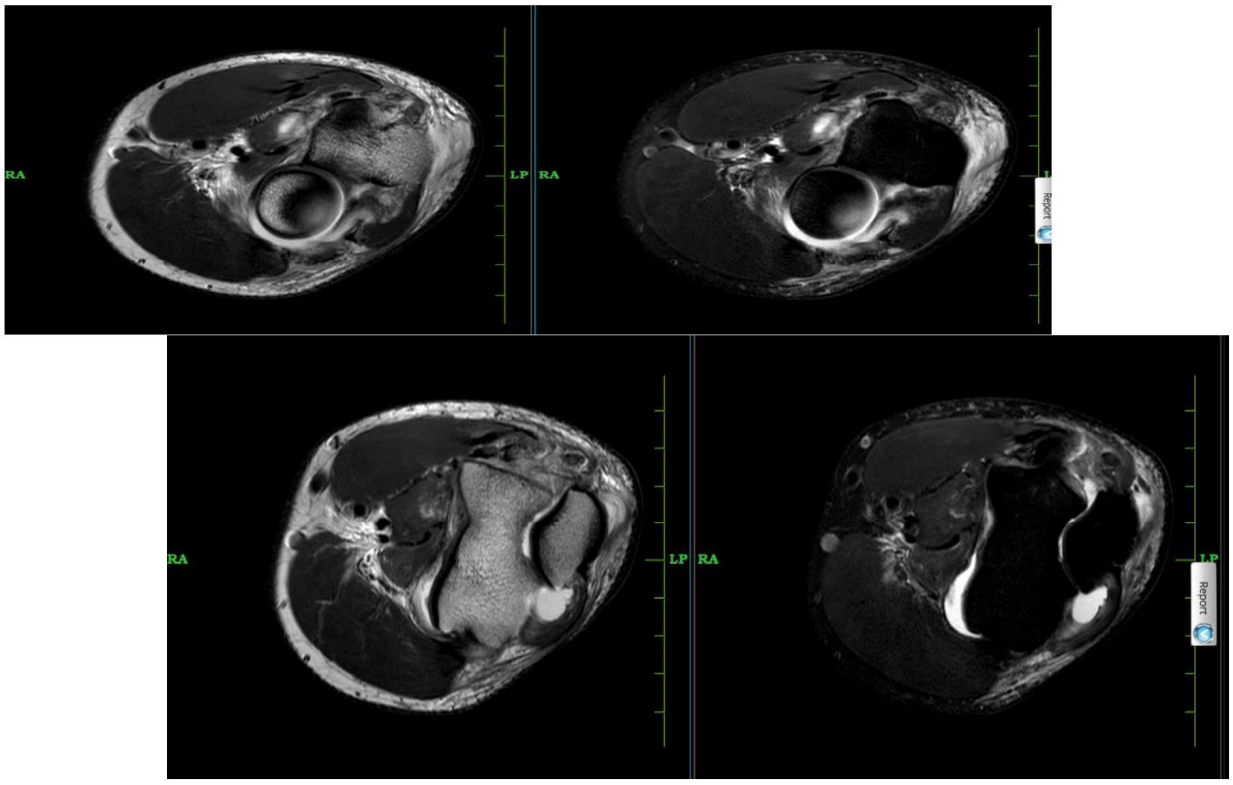


Figure 11: On MRI of right elbow increase signal of ulnar nerve is seen in cubital tunne and around elbow joint

Case 12: A young patient of 27 year presented in orthopaedic department with weakness in grip in right hand. No h/o trauma was there. Patient was send to radiology department for ultrasound right elbow. On ultrasound of right elbow, right ulnar nerve appears normal upto epicondyle level and appears severely thin distal to it likely due to compression (*Figure 12*). Patient was counselled and advised surgery. Surgery was done and transposition of ulnar nerve was done.

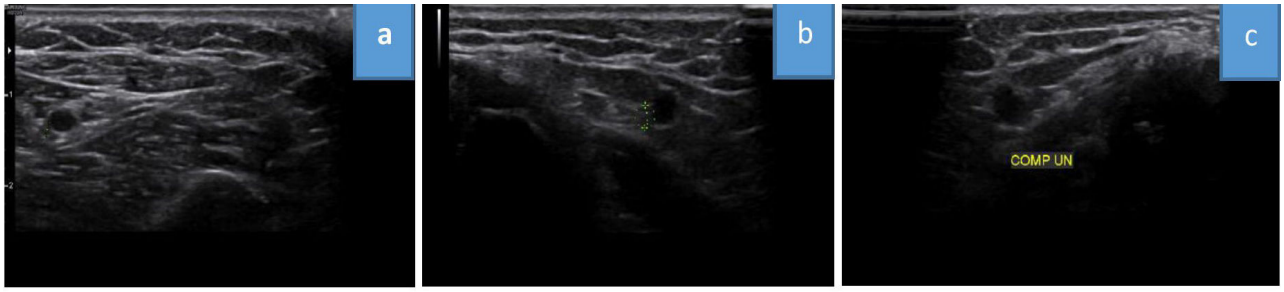


Figure 12: On ultrasound Figures of right elbow, right ulnar verve appears normal upto epicondyle level (b) and appears severely thin distal to it (a,c)

DISCUSSION

Neuropathy is a clinical term presentation of nerve involvement sensory as well as motor. The diagnostic role is to confirm the findings of clinical and nerve conduction study findings. Entrapment of nerve due to trauma, tumor or anomalous muscle. Pre-operative details of extent of involvement of nerve, its pathology and surrounding involvement and associated findings helps surgeon in better decision and outcome. Most common sites where nerve entrapments are commonly seen are carpal tunnel in wrist for median nerve, cubital tunnel at elbow, ulnar groove in Humerus and Guyon's canal at wrist for ulnar nerve.

Imaging with clinical examination and electro diagnostic studies help in diagnosing in nerve pathology and entrapment syndromes. Every modality of imaging has its own role: Plain x-ray film and CT helps in recognizing fracture site in case of trauma or tumor. Ultrasound especially high resolution helps in direct visualization of nerves, compression of nerve, site of nerve injury, tumor and associated findings. MRI and MR neurography helps in detection of nerve pathology as well as associated muscle involvement and soft tissue details, Follow up of nerve recovery. Entrapment of nerves can be due to trauma or compression due to tumor, infection etc.[1,2]

Nerve anatomy Peripheral nerves are collection of nerve fibers contained in a connective tissue sheath known as endoneurium and contain two layers' inner which contain the vessels & small adipose tissues and outer layer. They form a bundle which are covered in connective tissue known as perineurium. Small sensory nerve consists of less fascicles (<3 in number) and large fascicles contain more than 200 fascicles. Functionally nerves are sensory, motor and mixed[3,5]

Imaging in the peripheral nerves:

Diagnostic imaging place a significant role in the evaluation of peripheral neuropathies.

Ultrasounds specifically high frequency and MRI both helps in evaluation of nerve pathologies. Both the modalities have its strength and weaknesses. Ultrasound is safe, cheap and easily available. Localization of nerve can be done which appears hypoechoic and can be trace cranially or caudally, to know the extent of nerve involve. Comparison with contralateral side can be made easily. Doppler evaluation can be done. There is no contraindication. Superficial nerves are well assessed. Ultrasound has high spatial resolution so location of injury, its morphology, extent of injury or impingement can be diagnosed on ultrasound. However, it has its own limitation as information regarding surrounding structure and muscle is not well evaluated on ultrasounds. Nerves on ultrasound appears oval and hypoechoic with hyperechoic supporting tissues. Thickness of nerve is dependent on different factors(Age, gender, weight etc).[7-9]

MRI is the modality and definitive diagnostic tool in case of nerve injury and secondary denervation changes in the muscles. It provides exact location, severity of nerve injury, details of surrounding structures, secondary denervation, provides detail anatomical location pre-operative, post–operative follow ups. Nerves appears hypointense on T1W/ T2W Figures and shows no enhancement on post contrast Figures however MRI neurography are usually performed foe nerve pathology that provides better visualization and details of nerve pathology. It gives detail nerve anatomy, internal architecture, course, size of nerve and extent of injury focal or diffuse

and neuroma-in-continuity, nerve kinking or impingement and end-bulb neuroma and surrounding nerve fibrosis. High signal intensity is seen. Limitation is false positivity due to magic angle artifacts[7,8,9].

CT and X-rays help in diagnosing fracture in case of trauma, any placement of metallic implants.

Classification of Peripheral Nerve Injuries[10,11,12]

Seddon *et al.* classified peripheral nerve injury into grades according to severity in 1943y:

Grade I: Neurapraxia (Demyelination is the character which leads to block along the nerve)

Grade II: Axonotmesis (Axonal injure with Wallerian degeneration, surrounding connective tissue intact)

Grade III: Neurotmesis (Discontinuity of nerve-Partial or Complete)

Limitation is there is no detailed information regarding the detailed anatomy of connective tissue layer which is important in outcome and for surgery.

Later Sunderland classify it further into 5 classes. Sunderland classified seddon classification further into different degrees or levels of injury. However, there is overlap seen in specific to each individual patient.

Seddon Classification	Sunderland Classification
Grade I: Neurapraxia	First degree
Grade II: Axonotmesis	Second and third degree
Grade III: Neurotmesis	Third, Fourth and fifth degree

CONCLUSIONS

In Peripheral nerve neuropathies diagnosis imaging plays a great role, ultrasound can be used as a screening tool as easily available and cheaper. Also major patients have claustrophobic so it can be a great tool of screening. MR Neurography provides more detail of nerve injury, its extent and surrounding structure.

Conflict of Interest: None

Funding: None

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