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Case Series

Radiology Section

High Resolution Ultrasound in Entrapment Neuropathies of Ulnar Nerve- A Case Series

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ABSTRACT

Ulnar nerve is one of the terminal branches of the medial cord of brachial plexus. Owing to its superficial location and unprotected course ulnar nerve is susceptible to physical impingement at specific sites. Although clinical and electrophysiological assessment can diagnose ulnar neuropathy and site of compression, they do not provide aetiological information which is important for management. High Resolution Ultrasonography (HRUS) is a non invasive imaging tool that has been used widely to evaluate peripheral nerves. In the present case series, HRUS imaging findings in seven distinct cases of entrapment of ulnar nerve or its branches are presented. In cases 1, 2, 3 and 4, ulnar nerve was entrapped at the elbow; by synovial thickening due to degeneration, claw osteophyte arising from ulna, synovial cyst and epineural ganglion cyst respectively. In cases 5 and 6, ulnar nerve was entrapped at the wrist by a pisotriquetral ganglion cyst and an ulnar artery pseudoaneurysm respectively. In case 7, the Dorsal Cutaneous Branch (DCB) of ulnar nerve was entrapped over the Extensor Carpi Ulnaris (ECU) tendon. In all the aforementioned cases, HRUS accurately identified the site of entrapment, the status of ulnar nerve and the underlying cause of entrapment, which was subsequently confirmed surgically. The non invasive, inexpensive and accurate qualities make HRUS a potential first line imaging tool in the evaluation of entrapment neuropathies of superficial nerves.

Keywords: Cubital tunnel, Extensor carpi ulnaris, Guyon's canal

INTRODUCTION

The ulnar nerve arises from the medial cord of the brachial plexus. It receives innervations from spinal nerves C8 and T1 with a variable contribution from C7. It provides motor innervation to the Flexor Carpi Ulnaris (FCU), hypothenar muscles, 3rd and 4th lumbricals. The ulnar nerve has a superficial course in the arm and passes through two fibro-osseous tunnels; the cubital tunnel at the elbow and the Guyon's canal at the wrist, where it is susceptible to entrapment [1]. Imaging is required to identify the cause of entrapment at these sites, which is of paramount importance in the management. High Resolution Ultrasonography (HRUS) offers a widely available, cost-effective, tool with excellent soft-tissue resolution to evaluate the ulnar nerve at these sites [1,2].

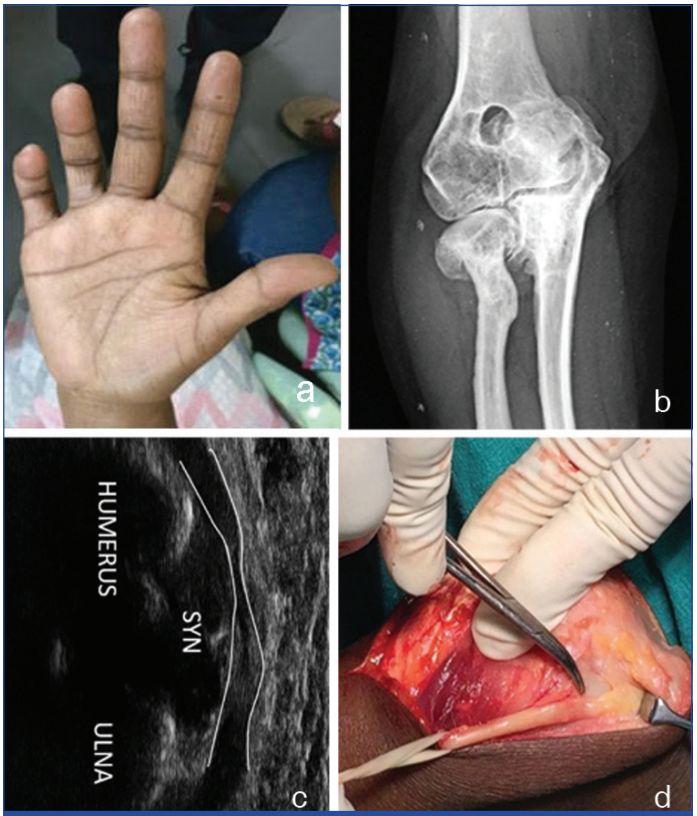
CASE SERIES

Case 1

A 50-year-old female presented with tingling, numbness and progressive clawing of last two digits of the right hand for three months. She sustained trauma to the elbow a few years agothat resulted in a moderate restriction of elbow extension. Patient was not a diabetic. Clinical examination did not reveal any anaesthetic patches over the skin or palpable nerves in the involved hand to suggest leprosy, butshowed a linear scarover the medial aspect of elbow, severe atrophy of the hypothenar muscles and clawing of the 4th and 5th digits. An electrophysiologic study showed reduced Compound Muscle Action Potential (CMAP), distal motor latency and reduced velocity in the ulnar nerve at the level of injury at elbow.

Preliminary radiograph of the elbow revealed a post-traumatic deformity of the proximal end of radius and olecranon process of ulna with osteoarthritic changes at the elbow joint. HRUS showed a thickened hypoechoic ulnar nerve posterior to the medial epicondyle, Cross-Sectional Area (CSA) was 12 mm^2. A focal area of extrinsic compression of the nerve by thickened synovium at the elbow joint. On dynamic flexion, there was worsening of the nerve compression by the synovial tissue [Table/Fig-1a-d].

Patient underwent surgical synovial debridement of the joint with anterior transposition of the ulnar nerve following which the patient's symptoms resolved completely.



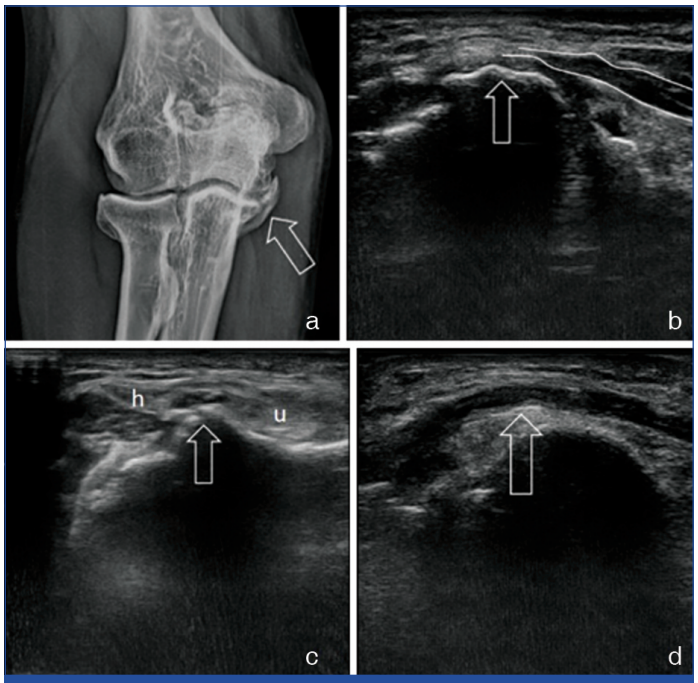
[Table/Fig-1a-d]: Synovial thickening causing right ulnar nerve entrapment in case 1; a) ulnar Claw hand; b) Anteroposterior radiograph of right elbow showing old traumatic deformity involving radial head and ulnar olecranon process with osteoarthritic changes; c) Longitudinal sonogram image over medial aspect of elbow showing hypoechoic synovial thickening (syn) seen focally compressing the ulnar nerve (white outlines) posterior to medial epicondyle; d) Intraoperative photograph showing thickened ulnar nerve proximal to site of compression.

Case 2

A 65-year-old male presented with tingling and numbness in the of last two digits of his right hand for six months. There was no history of trauma to the elbow. Patient was not a diabetic. On clinical examination, there were no hypoaesthetic or anaesthetic patches over the skin or clinically palpable nerves. Dynamic

evaluation of elbow revealed mild restriction in elbow extension. An electrophysiologic study showed features of ulnar nerve injury at the level of elbow.

Radiograph of the elbow showed degenerative changes at the elbow joint with a large smooth claw osteophyte arising from medial aspect of ulna. The HRUS showed a large osteophyte causing severe compression of ulnar nerve in the cubital tunnel (CSA 4 mm^2), with proximal thickening (CSA 10 mm^2) and hypoechogenicity [Table/Fig-2a-d]. In addition, HRUS also showed marked atrophy with fatty changes within the muscle belly of FCU. Patient underwent anterior transposition of ulnar nerve, which relieved his symptoms significantly.



[Table/Fig-2a-d]: Claw osteophyte causing right ulnar nerve entrapment in case 2; a) Anteroposterior radiograph of right elbow showing degenerative changes in elbow with a large claw osteophyte along the medial aspect (block arrows); b) Longitudinal sonogram over medial aspect of elbow showing hypoechoic claw osteophyte compressing the ulnar nerve (white outlines); c) Transverse sonogram at the cubital tunnel, showing compression of ulnar nerve (block arrow) by the osteophyte in the cubital tunnel between humeral (h) and ulnar (u) heads of Flexor Carpi Ulnaris (FCU); d) Longitudinal sonogram at the level of medial epicondyle showing thickened, hypoechoic ulnar nerve proximal to site of compression.

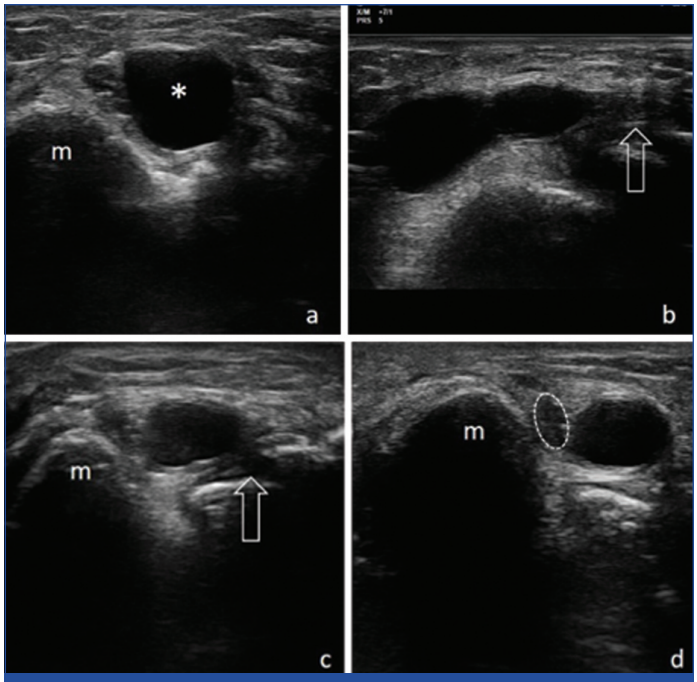
Case 3

A 58-year-old female presented with tingling and numbness in the little finger of right hand for three months. She had no history of trauma to the elbow or restriction of elbow movements. Patient was not a diabetic. Clinical examination did notreveal any hypoaesthetic or anaesthetic patches over the skin or palpable nerves in the involved hand to suggest leprosy. There was no other significant abnormality. The electrophysiologic study, showed signs of slow motor conduction velocity with mildly reduced Sensory Action Potential (SNAP) in the ulnar nerve.

The HRUS revealed a well-defined anechoic lobulated cystic lesion measuring 15×8 mm at the level of right elbow joint with a beak-like extension into the joint space posteriorly. The ulnar nerve was compressed between the cyst and the bony medial epicondyle [Table/Fig-3 a-d]. A provisional diagnosis of synovial cyst was given on sonography. Patient underwent surgical decompression and was symptom free thereafter.

Case 4

A 52-year-old male presented with severe tingling and numbness in the little and ring fingers of his right hand for the last six months. He also noticed worsening of symptoms during prolonged flexion of the elbow. He had no history of trauma to the elbow and no restriction of joint movements. Patient was not a diabetic. Clinical examination did not reveal any hypo or anaesthetic patches on skin or clinically palpable nerve thickening to suggest leprosy. The electrophysiologic study showed significantly decreased motor conduction velocity with decreased SNAP in the ulnar nerve.



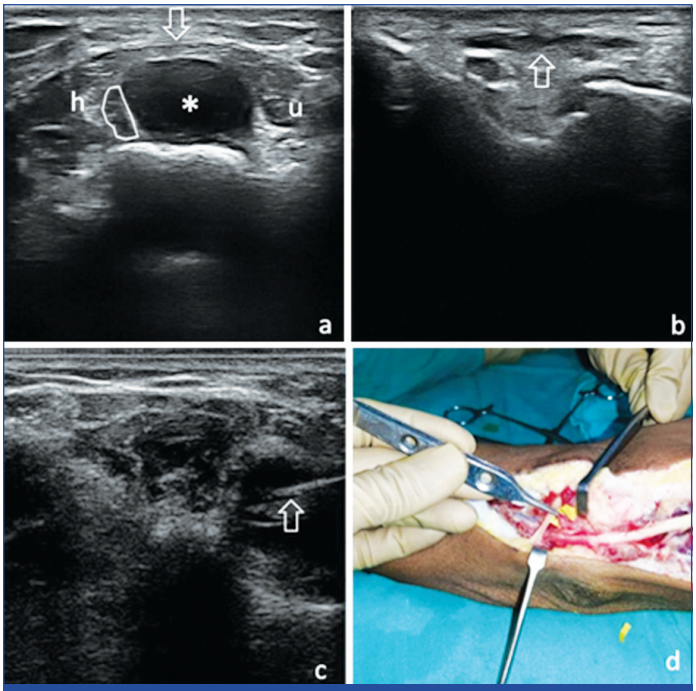
[Table/Fig-3a-d]: Synovial cyst causing right ulnar nerve entrapment in case 3; a) Transverse sonogram image at the medial epicondyle (m) showing an anechoic cyst (asterisk) abutting the ulnar nerve behind the medial epicondyle (m); b) Longitudinal sonogram over medial aspect of elbow showing the cyst is lobulated with a neck (block arrow) that is extending into the elbow joint; c) Transverse sonogram at the medial epicondyle, also showing the neck (block arrow) extending into the elbow joint; d) Transverse sonogram at the medial epicondyle with arm in flexion showing the ulnar nerve (white oval) entrapped between the medial epicondyle and cyst.

The HRUS showed an anechoic ellipsoid cystic lesion measuring 10×11×6 mm in size in the distal cubital tunnel, abutting and compressing the ulnar nerve. The cyst did not show any extension into the joint space. On colour doppler evaluation, the cyst showed no internal vascularity [Table/Fig-4]. Incidentally, HRUS also demonstrated an Anconeus epitrochlearis muscle [Table/Fig-4d]. Based on the sonographic findings, a diagnosis of epineural ganglion cyst was suggested. Patient underwent ultrasound guided cyst decompression by fenestration using an 18 G needle. A 3 mL of gelatinous material was aspirated from the cyst, resulting in near total collapse of the cyst. However, the patient's symptom continued to persist and by exclusion, the same was attributed to the presence of anomalous anconeus muscle compressing the ulnar nerve. Subsequently, surgical dissection of the muscle was performed and his symptoms improved after surgery.

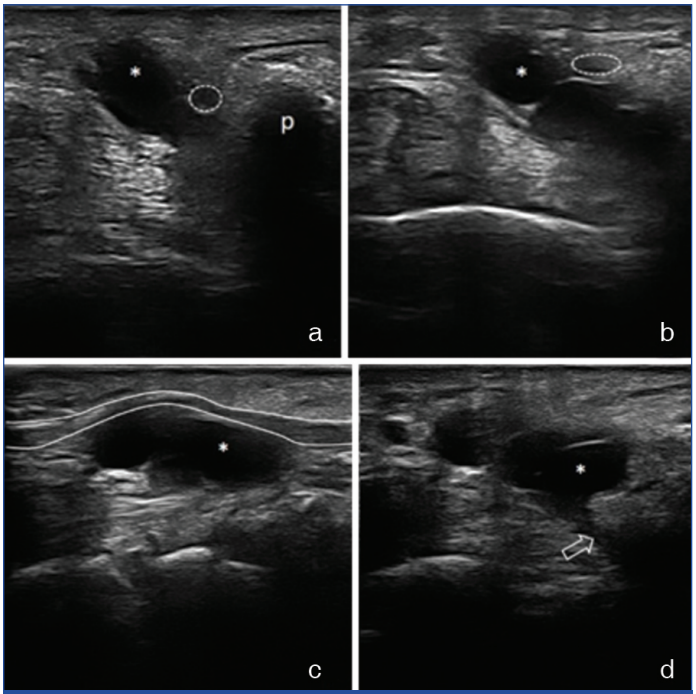
Case 5

A 30-year-old male presented with a firm swelling on the ulnar side of the volar aspect of his left wrist associated with tingling and numbness in the little and ring fingers. On examination, there was a firm, immobile swelling at the wrist. Palpation and mild compression of the lesion resulted in sharp radiating pain to the fingers. The left ulnar nerve at elbow was not thickened clinically.

The HRUS revealed an anechoic ellipsoid cystic lesion measuring 16x6 mm in the Guyon's canal compressing (CSA 2 mm^2) and displacing the ulnar nerve anteriorly. The cyst showed a narrow 2 mm neck extending into the pisotriquetral joint [Table/Fig-5]. Colour doppler of the cyst showed no internal vascularity. Based on the ultrasound findings, a diagnosis of pisotriquetral joint ganglion cyst was considered. Patient underwent surgical cyst decompression following which his symptoms improved.



[Table/Fig-4a-d]: Epineural ganglion cyst causing right ulnar nerve entrapment in case 4; a) Transverse sonogram at the cubital tunnel showing an anechoic cyst (asterisk) compressing the ulnar nerve. Osborne's fascia (block arrow) shown between the humeral (h) and ulnar (u) heads of FCU; b) Transverse sonogram at the medial epicondyle showing the Anconeusepitrochlearis muscle (block arrow); c) Transverse sonogram showing the tip of an 18 G needle within the cyst (block arrow). Postaspiration showing reduced cyst size; d) Intraoperative photograph showing anconeusepitrochlearis muscle.

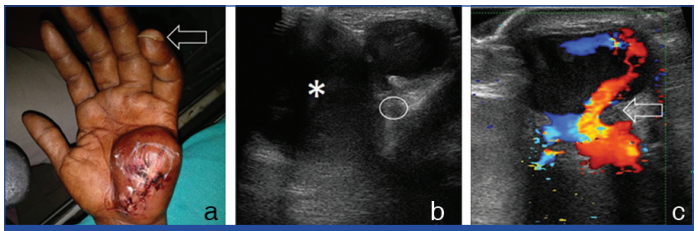


[Table/Fig-5a-d]: Pisotriquetral ganglion cyst causing left ulnar nerve entrapment in case 5; a and b) Transverse sonogram at the Guyon's canal showing an anechoic cyst (asterisk) compressing the ulnar nerve. Pisiform bone (p) can be seen along the medial aspect of canal; c) Longitudinal sonogram at the Guyon's canal showing the lobulated anechoic cyst displacing and compressing the ulnar nerve (white outlines); d) Transverse sonogram showing the neck of the cyst extending into the pisotriquetral joint (block arrow).

Case 6

A 50-year-old male presented with a slow growing pulsatile swelling along the hypothenar aspect of his left hand following a penetrating injury few months ago. Swelling was associated with tingling and numbness in the little finger. Patient gives a history of surgical procedure during which the lesion bled heavily and procedure was abandoned. Clinical examination showed clubbing of little finger with clawing. On palpation, the swelling was firm with a palpable thrill.

HRUS showed a large bilobed anechoic lesion compressing the ulnar nerve in its inferior aspect in Guyon's canal with mildly thickened (CSA 5 mm^2) and hypoechoic ulnar nerve proximal to the swelling [Table/Fig-6a-c]. On colour doppler study, the lesion showed turbulent flow within with a typical Yin yang pattern suggestive of a pseudoaneurysm. Patient underwent emergency operative treatment, with excision of pseudoaneurysm, ulnar artery ligation and capsular repair. Patient made a complete neurologic recovery.

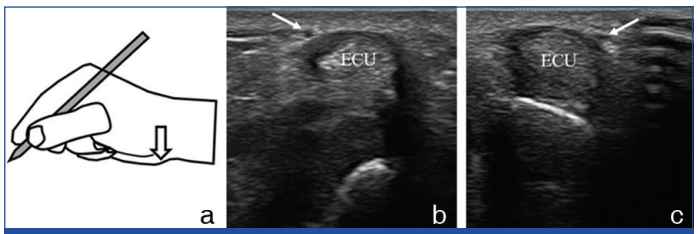


[Table/Fig-6a-c]: Ulnar artery pseudoaneurysm causing left ulnar nerve entrapment in case 6; a) Image showing pulsatile mass overlying skin discoloration the hypothenar eminence. There is clubbing and mild clawing of the little finger (block arrow); b) Transverse sonogram at the Guyon's canal showing an anechoic bilobed cyst (asterisk) in close proximity to the ulnar nerve (white outline); c) Transverse colour Doppler image slightly more distally showing the neck of the pseudoaneurysm with colour flow into the lesion and the ulnar nerve entrapped at the neck (block arrow).

Case 7

A 21-year-old female presented with pain radiating to the dorsal aspect of her little finger of right hand while writing. Clinical examination and electrophysiological studies were normal.

The HRUS showed thickening of the extensor retinaculum around the Extensor Carpi Ulnaris (ECU) tendon with thickening of the overlying Dorsal Cutaneous Branch (DCB) of ulnar nerve [Table/Fig-7]. On dynamic imaging with pronation and supination of hand, the DCB could be seen snapping over the extensor retinaculum. These changes could be attributed to the friction generated by the pressure over the volar aspect of wrist due to excessive writing. Patient was managed conservatively and suggested to use a splint and with this her symptoms reduced.



[Table/Fig-7a-c]: Dorsal Cutaneous Branch (DCB) of ulnar nerve entrapment and snapping in case 7; a) Diagram showing site of pressure (block arrow) over the ulnar aspect of hand in writing position; b) Transverse sonogram over the ECU tendon, showing a thickened DCB branch of ulnar nerve (white arrow) over the tendon in supination; c) Transverse sonogram over the ECU tendon, showing the anteriorly snapped thickened DCB branch of ulnar nerve (white arrow) in pronation.

DISCUSSION

The diagnosis of peripheral entrapment neuropathy is suspected clinically based on the duration, pattern and distribution of symptoms along a particular nerve [1]. Electrodiagnostic studies confirm the neuropathy and can localise the site more precisely than clinical examination. However, both clinical examination and Electroneuromyography (ENMG) studies do not provide any information regarding the underlying cause of neuropathy [2]. Due to this limitation, imaging in entrapment neuropathy is now performed to support and confirm the diagnosis.

For imaging peripheral nerves, either Magnetic Resonance Imaging (MRI) or HRUS can be used. The HRUS scores over MRI as it is inexpensive, quicker, safer and offers the highest spatial resolution [1]. The limitations of HRUS are the operator dependence and a learning curve.

Evaluation of nerves using ultrasonography was first performed by Solbiati L et al., [3]. Fornage BD were the earliest to describe the

typical sonographic anatomy of peripheral nerves [4]. The evolution in hardware and software technology has allowed the modern high frequency transducers to evaluate peripheral nerves to the fascicular level. This makes HRUS very sensitive and specific in identifying lesions in peripheral neuropathies [5].

On HRUS normal peripheral nerve in short axis appears as an oval or round structure with a cluster of hypoechoic fascicles surrounded by hyperechoic internal perineurium resulting in "honeycomb" pattern [6,7]. In the longitudinal axis, the hypoechoic fascicles run nearly parallel to each otherin a "Fascicular" pattern.

In entrapment neuropathies regardless of site, the entrapped nerve proximal to the site of compression is enlarged, becomes more hypoechoic with partial or complete loss of the fascicular echopattern. These changes are attributed to intraneural venous congestion and oedema. There is an abrupt decrease in calibre at the site of compression. Power doppler evaluation may detect intraneural hyperaemia [8].

Ulnar nerve is the largest unprotected nerve in the body with a predominantly subcutaneous course [7]. It is the second most common nerve involved in entrapment neuropathies [9]. Its anatomical course makes it vulnerable at multiple potential sites of compression or irritation. The first of these potential sites is the bony medial epicondyle,where the ulnar nerve courses in a groove on its hard posterior surface. The second is the cubital tunnel, which is a myofascial tunnel between the humeral and ulnar heads of FCU and the overlying retinaculum (Osborne's fascia). Here, the ulnar nerveis susceptible to compression by osteophytes, loose bodies, synovial thickening and anomalous muscle (anconeus epitrochlearis). The third site is at the wrist, where the ulnar nerve passes through a narrow osteofibrous tunnel, the Guyon's canal, which is bordered by pisiform medially (proximal tunnel), hook of hamate laterally (distal tunnel) with the floor formed by the flexor retinaculum and roof by the palmar carpal ligament. Here, the ulnar nerve can be compressed by ganglion cysts, pseudoaneurysms and fracture fragments [9]. The spectrum of conditions described in our case series was similar to the spectrum described by Agarwal A et al., and Martinoli C et al., [9,10]. In the series of cases presented by Agarwal A et al., they presented three cases of ulnar nerve compression at cubital tunnel due to ganglion cysts, one was a simple ganglion cyst, the second was an infected ganglion cyst and the third was an epineural ganglion cyst. The other causes they described included fracture, impingement due to orthopaedic implant, tardy ulnar nerve palsy due to synovial thickening in rheumatoid arthritis, age related arthritic changes and joint effusion [9]. A very similar spectrum was described by Martinoli C et al., [10]. Their series additionally included space-occupying soft-tissue lesions, like thickened medial collateral ligament, accessory anconeus epitrochlearis muscle and hypertrophied medial head of triceps [10].

In the present case series, author have described seven unique cases of ulnar nerve entrapment which were recognised on clinical examination and by electrophysiological studies. In each of these cases, HRUS was an invaluable tool that confirmed the site and presence of nerve entrapment and also identified the cause of nerve compression accurately, aiding in the presurgical planning and management. Cases 1, 3 and 7 case shows the unique ability of dynamic HRUS to demonstrate compression/friction neuropathies in real time at the sites of entrapment, which gives sonography a distinct advantage over other imaging modalities. The sonographic findings were confirmed on surgery in 5 out of 7 cases. In one case, therapeutic aspiration of a ganglion cyst was also performed using HRUS guidance.

CONCLUSION(S)

The spectrum of pathologies causing entrapment of the ulnar nerve is varied. Clinical and electrodiagnostic studies are capable of confirming the diagnosis and localising the site, but unable to identify the underlying aetiology. HRUS is a safe, quick and inexpensive imaging tool that directly visualises the ulnar nerve, thus, allows the operator to not only identify the site of entrapment, but also the underlying cause. This provides the clinician and operating surgeon a clear and precise road map for the management of the patient.

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