Clinical Reasoning: A 54-year-old woman with hand dysesthesia

Many dimensions to a common problem

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SECTION 1

A 54-year-old woman with chronic renal failure due to diabetes and on maintenance hemodialysis presented to the Neurodiagnostic Laboratory of our hospital with cramp-like dysesthetic symptoms involving the palms of both her hands. For the past 6 months, she noticed predominantly right-handed numbness which was maximum over the fingertips and worst early in the morning. Massage and hand movements would relieve the early morning symptoms for short periods of time. There was associated mild difficulty in performing fine motor tasks.

Medical history revealed 30 years of type II diabetes mellitus, recently needing control with subcutaneous insulin. The latest HbA1C was 6.6%. She was a nonsmoker and did not abuse alcohol. Serum calcium and phosphate were normal and creatinine 700 μmol/L.

Clinical examination revealed an arteriovenous (AV) fistula over the left forearm. Upper limb examination showed absent Tinel's and Phalen's sign bilaterally. The thenar and hypothenar eminences were preserved in bulk, with power of the abductor pollicis brevis (APB) and abductor digiti minimi normal on both sides. There was mildly reduced perception to superficial touch (using a cotton swab) and vibration (126 Hz tuning fork) over the distal extremities, and deep tendon reflexes were reduced in the lower extremities.

Questions for consideration:

1. What is the differential diagnosis of upper limb sensory disturbance in a patient with chronic renal failure and diabetes?
2. What investigations would you do?

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SECTION 2

Upper limb sensory disturbance mainly occurring over the palms with some asymmetry in a patient with renal failure and diabetes would first suggest a possible diagnosis of carpal tunnel syndrome (CTS) or cervical radiculopathy. A diagnosis of cervical radiculopathy is unlikely due to the absence of neck pain. A metabolic length-dependent polyneuropathy would be unusual due to the dominant upper limb symptoms, though needs to be considered in view of the mild sensory loss involving the distal lower extremities and the absent ankle jerks.

Our patient presented with 2 of the 3 primary symptoms of CTS: paresthesias of the palms maximal in the early morning with relief by shaking and movements.[1] A median nerve distribution of sensory symptoms, though regarded as a primary symptom, is known to be an indicator of advanced median nerve compression.[2] Although Tinel's and Phalen's tests are negative in our patient, it is known that these tests are not sensitive or specific for CTS.[3]

There are several factors in our patient that increase the risk for CTS. Diabetes mellitus is associated with an increased incidence of CTS, with up to 8% of diabetic patients being symptomatic.[4] Dialysis-related amyloidosis, changes in the nerve fluid homeostasis, and nerve ischemia from the AV fistula all contribute to further increased CTS risk.[5]

Electrophysiologic studies play an important role as first line investigation in the detection and classification of CTS. Nerve conduction studies (NCS) help to identify involvement of sensory or motor fibers and also determine whether the underlying pathophysiology is predominantly demyelinating, axonal, or mixed, in addition to indicating severity of disease. The table shows the NCS report.

Question for consideration:

1. Does this electrodiagnostic study support a diagnosis of CTS?

Table Nerve conduction study results

	Right	Left
Hand skin temperature, °C	32.2	32
Sensory nerve conduction		
Median (digit 3) orthodromic		
Sensory peak latency (3.6 ms)	4.55	3.50
Sensory amplitude (6 μV)	9.6	10.1
Sensory conduction velocity (47 m/s)	34.5	47.6
Ulnar (digit 5) orthodromic		
Sensory peak latency (3.3 ms)	3.00	3.00
Sensory amplitude (4 μV)	5.5	6.2
Sensory conduction velocity (45 m/s)	50.0	52.4
Ulnar–median sensory conduction velocity (8 m/s)	15.5	4.8
Motor nerve conduction		
Median–abductor pollicis brevis		
Motor distal latency (3.9 ms)	5.65	4.70
Motor amplitude (4.6 mV)	5.9	6.0
Motor forearm conduction velocity (40 m/s)	40.7	42.8
Motor inching across carpal tunnel (intersegmental latency differences)		
4 cm proximal to wrist crease (4.85 ms)		
3 cm proximal to wrist crease		0.40
2 cm proximal to wrist crease		0.00
1 cm proximal to wrist crease		0.25
At wrist crease		0.45
1 cm distal to wrist crease		0.35
2 cm distal to wrist crease		1.30
3 cm distal to wrist crease		0.05
Ulnar–abductor digiti minimi		
Motor distal latency (3.1 ms)	3.2	3.0
Motor amplitude (7 mV)	8.8	7.5
Motor forearm conduction velocity (40 m/s)	43.8	46.8
Motor conduction velocity across elbow (50 m/s)	52.3	56.8
Second lumbrical interossei latency difference (0.6 ms) (2L-INT)	0.70	0.10
Sural nerve		
Peak latency (3.5 ms)	3.30	3.80
Amplitude (8 μV)	7.7	6.3
Conduction velocity (38 m/s)	38.8	32.7

Our laboratory normal values are given in parentheses.

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SECTION 3

NCS show evidence of bilateral median neuropathy at the wrist.

Neurophysiologic studies on the right showed prolongation of the median peak sensory latency and motor distal latency. Additionally, there is a significant difference in sensory conduction velocities on internal comparison studies between the median and ulnar nerves in the palm using a fixed distance, with median nerve conduction velocity being considerably slower than ulnar. The second lumbrical to interossei motor test (2L-INT) shows prolonged latency to the second lumbrical muscle in comparison to the second interossei on stimulating the median and ulnar nerve, at identical distances from the recording electrode, at the wrist.

Neurophysiologic studies on the left showed a prolonged median motor latency to APB. Segmental stimulation (inching technique) of the median nerve across the carpal tunnel shows an abrupt change in the latency to the APB 2 cm distal to the wrist crease, hence localizing the site of slowing possibly to the carpal tunnel outlet. The sensory peak latency, sensory amplitude, and sensory conduction velocity in the palm on internal comparison between the median and ulnar and the 2L-INT showed no abnormality.

CTS is associated with neurophysiologic abnormalities, which are initially predominantly demyelinating. Sensory values are often initially assessed, as the majority of median nerve fibers at the wrist are sensory. Median nerve sensory potentials across the wrist are widely taken as the most sensitive and earliest abnormality in CTS, with prolongation of the peak latency, drop in conduction velocity, or (least reliably) a drop in sensory nerve action potential. In those with mild CTS, there are several other special sensory electrodiagnostic studies which are sensitive and specific for CTS. These include orthodromic palmar stimulation, median sensory short segment stimulation across the wrist, median-ulnar sensory latency difference to the fourth digit, and median-radial latency difference to the first digit.[6] The 2L-INT is similarly sensitive to sensory techniques due to early involvement of lumbrical motor fibers.[1]

Even though less sensitive than other neurophysiologic methods, APB motor nerve stimulation plays an important role in the documentation of motor fiber involvement. Motor nerve conduction studies assessed include prolongation in distal latency or decrease in compound muscle action potential from the APB.

There are several scales used to assess the severity of CTS, based on the extent of involvement of the sensory and motor nerve fibers. Our laboratory convention is to grade CTS into mild (abnormal sensory or 2L-INT), moderate (sensory and motor abnormality), or severe (absent motor/sensory responses).

Our case demonstrates a moderate grade CTS on the right, and shows the typical abnormalities seen on NCS in CTS.

However, on the left, the unusual finding of isolated abnormal distal APB latency with normal APB compound muscle action potential amplitude needs further consideration. All sensory nerve conduction values and 2L-INT were normal and thus unusual for typical CTS.

Our case, in addition, shows the presence of a mild sensory neuropathy as evidenced by borderline abnormal sural nerve amplitudes with mildly reduced conduction velocity. This is a typical finding in longstanding diabetic and uremic neuropathy, wherein the distal lower limbs are initially affected.

Question for consideration:

1. What are the possible causes for this isolated median motor nerve conduction abnormality on the left and what further investigations are possible?

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SECTION 4

Pure motor CTS is unusual as the increased intracarpal tunnel pressure underlying CTS tends to affect sensory fibers far earlier than motor fibers. This can be explained by the intraneural topography wherein most of the nerve fibers are sensory, and being superficially located is more vulnerable to extraneural pressure. The fascicles that subserve motor functions to the thenar muscles and lumbricals are more centrally placed, with those destined to supply the thenar eminence more rostral.[7]

Our case therefore suggests a primarily central, more volar-radial location of pathology since motor fibers to the APB are positioned in this region. The lumbrical motor fibers, which lie separate and are more dorsal, were not involved as the 2L-INT test was normal.

Alternatively, the recurrent branch of the median nerve, which contains motor fibers to the thenar eminence and which arises at the level of the terminal bifurcation of the median nerve, may occasionally exit the carpal tunnel through a separate opening in the carpal ligament and be subjected to isolated compression. NCS, using inching technique, can differentiate between these 2 sites of APB pathway abnormality but is technically difficult due to the abrupt diversion that this motor branch takes.

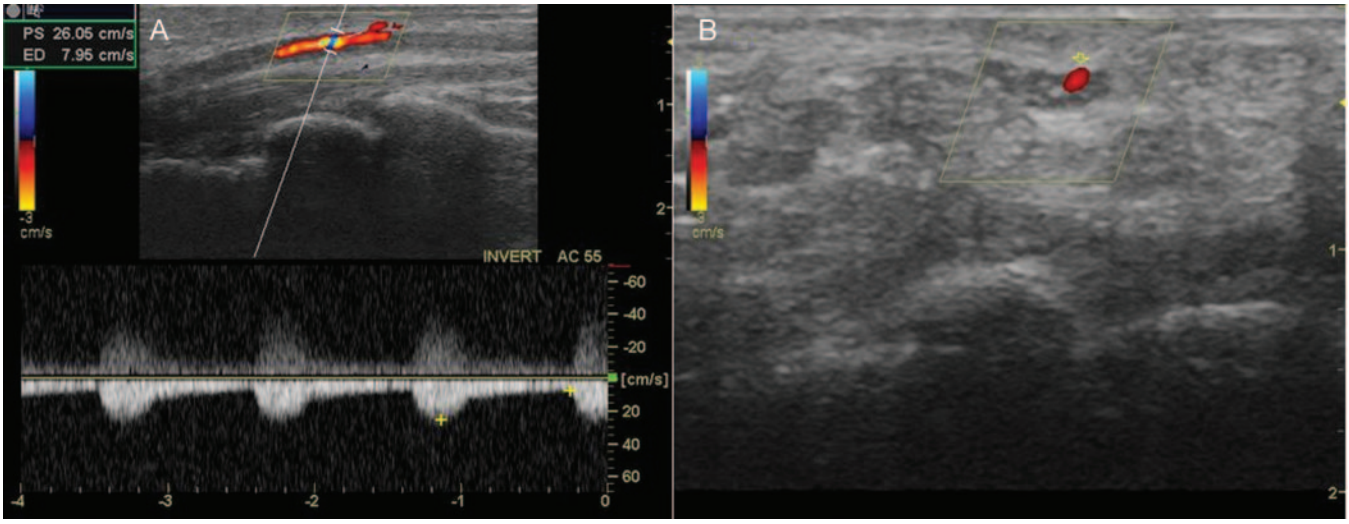
Imaging modalities of peripheral nerves which include high-resolution sonography and MRI are increasingly being used as useful complementary tests in the evaluation of entrapment neuropathies. Both allow direct visualization of the compressed median nerve and other soft tissue structures of the carpal tunnel. The low cost and time requirement of sonography favor its use as the initial imaging modality in evaluating the carpal tunnel.

Duplex ultrasonography was performed on the median nerve, yielding the image shown in the figure and video (on the *Neurology*® Web site at www.neurology.org).

Question for consideration:

1. What is the imaging diagnosis?

Figure **Doppler studies of the left median nerve at the wrist**



(A) Longitudinal section showing arterial blood flow within the nerve and (B) transverse section showing arterial flow at the radial and rostral part of the nerve (oval hypoechoic).

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SECTION 5

The ultrasound image shows the presence of a persistent median artery (maximum diameter 1.7 mm, minimum diameter 1.2 mm), located intraneurally. It is located on the radial and rostral site within the nerve, suggesting close relation to the motor fibers to the abductor pollices brevis. This abnormality could well explain the pure motor CTS.

The median nerve cross-sectional area at the wrist crease is 0.07 cm^2 and the fascicular architecture is relatively maintained.

DISCUSSION Persistent median artery is increasingly being implicated as a cause of CTS. It is often associated with acutely presenting CTS, when associated with thrombosis of the persistent median artery. However, its role as an independent risk factor in the causation of CTS has not been well evaluated.

In a study which evaluated 100 wrists from 50 asymptomatic volunteers, sonographic detection of a persistent median artery could be found in 13 (26%, 10 [20%] unilateral and 3 [6%] bilateral), with a mean diameter of 1.1 mm (range, 0.5–1.7 mm).[9] A median artery above 1.5 mm in diameter was associated with symptoms.[9]

Not much is known about the anatomic variations of this aberrant vessel.[10] It has been increasingly associated with a bifid median nerve, when the vessel is often located in an extraneural site in between the separate nerve bundles. This anomalous vessel can also be situated intraneurally. Detection of persistent median artery may assist in management decisions and surgical planning.

Sonographic detection of atypical vascular structures within the carpal tunnel may be of importance as during surgery, induction of a bloodless operation field using a tourniquet can obscure abnormal vessels leading to postoperative bleeding and ensuing sequelae such as hematoma and fibrosis.

A further consideration would be the need for an epineurectomy, in addition to transverse carpal ligament release in those with an intraneurally situated persistent median artery, since increased pressure could be mainly from within the nerve.

Our patient opted for conservative management and had partial improvement using a wrist splint.

DISCLOSURE

Dr. Vijayan, Dr. Ng, A.K. Therimadasamy, and Dr. Titus report no disclosures. Dr. Wilder-Smith received a travel grant from GlaxoSmithKline French to attend an American Epilepsy Society annual meeting; serves as an Associate Editor of *Neurology Asia*; and serves as director of a diagnostic laboratory which performs the investigations described in this article.

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