Ulnar Neuropathy at the Elbow, an overview

Learning Objectives:

Fascicle – a bundle of axons with a common destination.

Ulnar nerve compression at the elbow is the second most common mononeuropathy seen in the electrodiagnostic laboratory. Because of the way the fascicles are arraigned the clinical and the electrodiagnostic findings can be puzzling and complex.

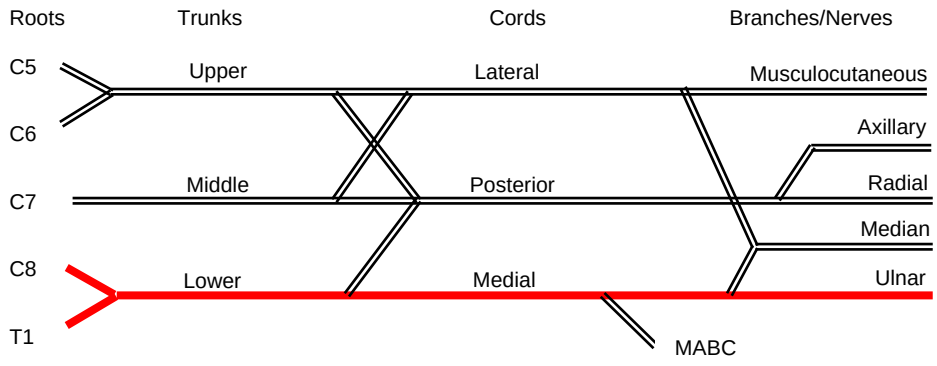
In this paper will review ulnar nerve anatomy, clinical features of ulnar neuropathy at the elbow (UNE), differential diagnosis, nerve conduction findings, techniques and case studies. The reader will gain insight to this common entrapment as well as the importance of the nerve conduction studies used to confirm the diagnosis of UNE.

Anatomy of the Ulnar Nerve:

Understanding ulnar nerve anatomy is important to help sort out the various conditions in that make up the differential diagnosis, whether it is a cervical radiculopathy or brachial plexopathy.

Medial Antebrachial Cutaneous nerve supplies sensation to the medial forearm.

The ulnar nerve, a mixed nerve, arises from cervical roots C8-T1, continuing through the lower trunk and medial cord. Unlike the median and radial nerve the motor and sensory portions of the ulnar nerve travel together through the brachial plexus. The ulnar nerve is essentially an extension of the medial cord.
The medial brachial and the medial antebrachial cutaneous nerve come directly off the medial cord and the MABC is an important nerve when separating brachial plexus lesions with ulnar nerve lesions.



There are no ulnar nerve innervations in the upper arm. At the elbow the ulnar nerve continues through the retroepicondylar groove which is

formed by medial epicondyle of the humerus and the olecranon process of the ulna. This is the most common of the compression sites.

Figure 19.2 in Preston and Shapiro has a very good picture of the ulnar anatomy at the elbow. See page 292.

Slightly distal to the elbow, the ulnar nerve dives beneath a tendon that connects the heads of the flexor carpi ulnaris muscle, known as the humeral-ulnar aponeurosis (HUA) or cubital tunnel. This is the second most common entrapment site of the ulnar nerve at the elbow.

In this area, the ulnar nerve gives off branches to the FCU and the flexor digitorum profundus muscles.

The ulnar nerve continues in the forearm, but does not give off any additional muscle branches until the wrist.

Five to eight centimeters proximal to the wrist the dorsal ulnar cutaneous sensory branch comes off to supply sensation to the dorsal medial hand, dorsal fifth and dorsal medial fourth digits. A little more distally the palmar cutaneous sensory branch exits to supply sensation to the proximal medial palm.

At the level of the wrist, the ulnar nerve enter Guyon's canal. In the canal the ulnar nerve divides into the deep palmar motor branch and the superficial sensory branch. At the end of Guyon's canal, motor fibers for the hypothenar muscles are given off. Finally, after the canal, the superficial sensory branch to the palmar 5th and medial palmar 4th digits and the palmar motor branches are given off. Ulnar nerve compression at Guyon's canal will be addressed in a subsequent paper.

Clinical Features of Ulnar Neuropathy at the Elbow

There is a great deal of variability of the signs and symptoms depending on the location and severity of the compression. Early in the course of the compression, symptoms include sensory loss and paresthesias over digits 4 and 5. In more advanced cases, weakness of the interosseous muscles of the hand becomes apparent and the patient may complain of worsened grip and clumsiness. Pain in the region of the elbow also is common, although not universal. Involvement of ulnar innervated forearm muscles leads to weakness in finger and wrist flexion. A positive Tinel's sign (pain with tapping over the nerve) in the region of the elbow also may be present.

Subluxation is a partial dislocation of bones that leaves them misaligned but still in some contact with each other

Ulnar neuropathy at the elbow can be broken into two distinct sites of compression.

1. The most common location is the nerve at the epicondylar groove. This specific problem is often attributed to prolonged inadvertent compression of the nerve by leaning on the elbows while at a desk or table. Repeated subluxation of the nerve with elbow flexion over the medial epicondyle also may contribute. Studies show this location accounts for 62% - 69% of the elbow compressions.
2. Entrapment of the nerve as it enters the cubital tunnel is the next most common site. The cubital tunnel consists of the two heads of

the flexor carpi ulnaris muscle and the aponeurosis between them. In some individuals, this tunnel is small and compression of the nerve occurs with repeated elbow flexion. Studies show this location accounts for 23% - 28% of the elbow compressions.

Differential Diagnosis

Remember the median *motor* fibers to the hand share the same pathways with the ulnar nerve through the brachial plexus, Lower trunk and Medial Cord.

Median and Ulnar Sensory fibers are, however, separate

The differential diagnosis for ulnar neuropathy at the elbow includes:

a. Ulnar neuropathy at the wrist – ulnar neuropathy at the wrist will spare the dorsal ulnar cutaneous nerve, so if the patient has intact sensation to the medial dorsal portion of their hand, consider a lesion at the wrist instead of the elbow.
b. Medial cord/Lower trunk plexopathies – lower trunk or medial cord lesions would include median motor signs (e.g. weakness on thumb abduction) and medial forearm sensory loss. If the patient has these symptoms, consider a plexopathy lesion. If index finger extension is spared you would tend to think lower trunk, not medial cord.
c. C8-T1 radiculopathy – C8-T1 radiculopathies would include neck pain and median motor symptoms (e.g. weakness on thumb abduction and flexion)

Nerve Conduction Findings

Although it appears straight forward, the electrophysiological findings vary and can be confusing because of the fascicular arraignment inside the nerve. We sometimes see the dorsal ulnar cutaneous branch may paradoxically escape injury with lesions at the elbow. The fibers to the first dorsal interosseous (FDI) seem more susceptible to injury than those to the abductor digiti minimi (ADM). Different fascicles may exhibit different pathophysiology, with conduction block affecting fibers to the FDI while those to the ADM display a pure axon loss picture.
For these reasons careful nerve conduction studies of the ulnar nerve are required.

Standard low filter settings for SNC are 20 or 30 Hz and the standard high filter setting is 3kHz. Set the Sweep speed at 1 or 2 ms/div. and sensitivity to 10 or 20 µV/div to start.

Full technique descriptions follow the introductions:

1. Ulnar sensory study digit V – wrist at 11-13 cm is standard. Many laboratories use antidromic stimulation, while others prefer orthodromic stimulation. While the actual technique is not important it is necessary to be consistent. Use standard sensory amplifier and stimulator settings as noted.
2. Median sensory study Digit II or III – wrist at 12-14 cm is considered standard for comparison. Many laboratories use antidromic stimulation, while others prefer orthodromic

stimulation. While the actual technique is not important it is necessary to be consistent. Use standard sensory amplifier and stimulator settings as noted.

Standard low filter setting for MNC is 2 Hz and the standard high filter setting is 10 kHz. Set the Sweep speed at 2 or 5 ms/div. and sensitivity to 2 or 5 mV/div to start.

3. Ulnar motor study to the hypothenar muscle is a standard. Place the arm at 90º and carefully examine both below and above the elbow. Be sure the below elbow stimulation is not more than 3 cm distal to the medial epicondyle as the nerve buries quite deep there. A more proximal stimulation (i.e. axilla may be necessary as well) Use standard motor amplifier and stimulator settings as noted. Abnormalities to look for are as follows:
    a. An above elbow (AE) to below elbow (BE) segment greater than 10 m/s slower than the below elbow to wrist segment.
    b. A decrease CMAP amplitude from BE to AE greater than 20%; suggests conduction block or temporal dispersion indicative of focal demyelination. Assuming anomalies such as Martin-Gruber anastamosis are not present.
    c. A significant change in CMAP configuration at the AE site compared to the BE site. Again, assuming anomalies are not present.
    d. Antidromic sensory nerve action potential (SNAP) recordings may be useful, especially in patients with only sensory symptoms. However, SNAP studies have pitfalls and limitations, so use caution if slowing of the sensory CV is your only abnormality.

Make sure to measure at least 10 cm across the elbow, but less than 13 cm. By using at least 10 we minimize measurement mistakes, and by keeping it relativity short there is less risk of masking a focal abnormality.

4. Median motor study to the thenar muscles is a standard and will be used as a comparison. Use standard motor amplifier and stimulator settings as noted.
5. Additional studies if above are equivocal or as the clinical picture dictates.
    a. Motor studies to the first dorsal interosseous. Due to differential fascicular involvement, fibers to the FDI may show abnormalities not evident when recording from the abductor digiti minimi. Perform this study using the same stimulation sites as the study to the ADM. (see case study later in this paper)
    b. Inching study to look for changes in the latency, CMAP amplitude, area or configuration over precisely measured 1 or 2 cm increments from BE to AE. Latency changes in isolation are significant, but it is more convincing if the abnormality involves both a change in latency and a change in either amplitude, area, or configuration.
    c. Comparing the BE to AE segment with the AE to axilla segment is useful when there is wallerian degeneration and the distal low CMAP amplitude hinders localization.
    d. When the dorsal ulnar sensory study shows reduced SNAP

Remember to keep the limb temperature in the reference range as your lab protocols dictate. Remember a cool extremity can slow conduction velocity and could mimic an abnormality.

If you have an ulnar neuropathy at the elbow, the F-wave latency from the ADM may be prolonged simply because it passes the lesion, not once, but twice.

amplitude it helps confirm a lesion at the elbow as this nerve is spared in wrist lesions. Caution should be exercised however, as the DUC sensory study can be normal in elbow lesions because of differential fascicular involvement.

e. Recording the medial antebrachial cutaneous nerve is useful to exclude lesions of the lower trunk and medial cord, if clinically indicated.

6. F-waves can be performed; however they are of little value when the lesion is at the elbow.
7. Needle EMG as performed by the physician is useful to gauge severity when the clinical signs indicate.

Specific Nerve Conduction Techniques

Ulnar nerve (C8-T1, lower trunk, medial cord)

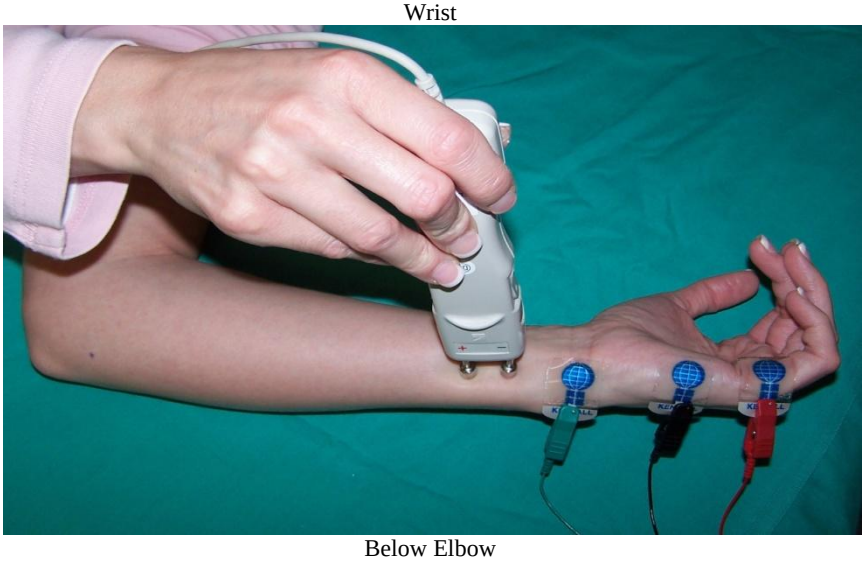
We place the elbow at 70-90° to pull the nerve taut, thus making the skin measurement best match the nerve length.

Ulnar motor study to the ADM

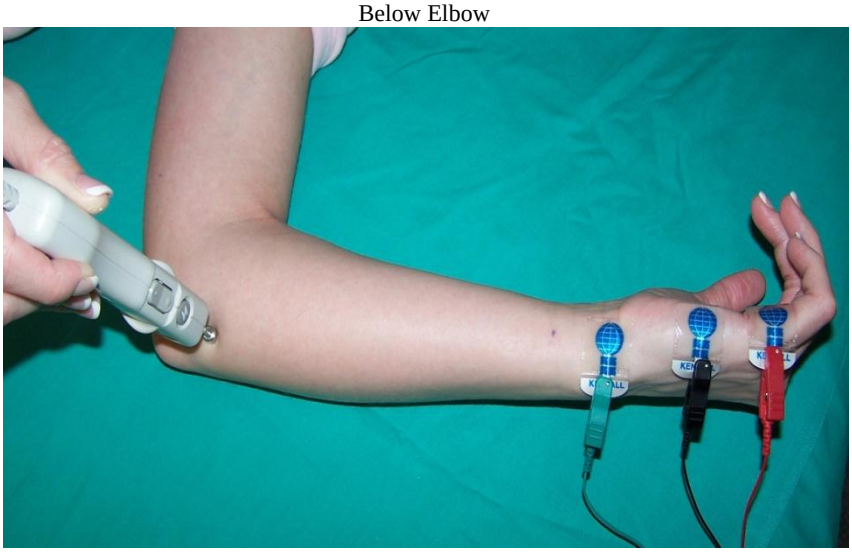
Patient Position:	Supine, or on their side with arm supinated and abducted 70-90 degrees
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed on the belly of the Abductor Digiti Minimi (ADM) ½ distance between the distal wrist crease and the base of the fifth digit
Reference:	Placed on the proximal phalanx of the fifth digit
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	(cathode distal)
Wrist:	Applied 2 cm proximal to the distal wrist crease, anterior to the flexor carpi ulnaris tendon
Below elbow(BE):	Applied 2-4 cm distal to the ulnar groove on the medial side of the forearm
Above elbow(AE):	Applied at least 10 cm proximal to the below elbow site on the medial aspect of the arm
Measurements:	Between the active recording electrode and wrist following a straight line Wrist to BE following contour of the medial aspect of the arm Between BE and AE though the ulnar groove following contour of the medial aspect of the arm Latency and amplitude for CMAP recordings

Calculations: Motor conduction velocity wrist to BE and wrist to AE

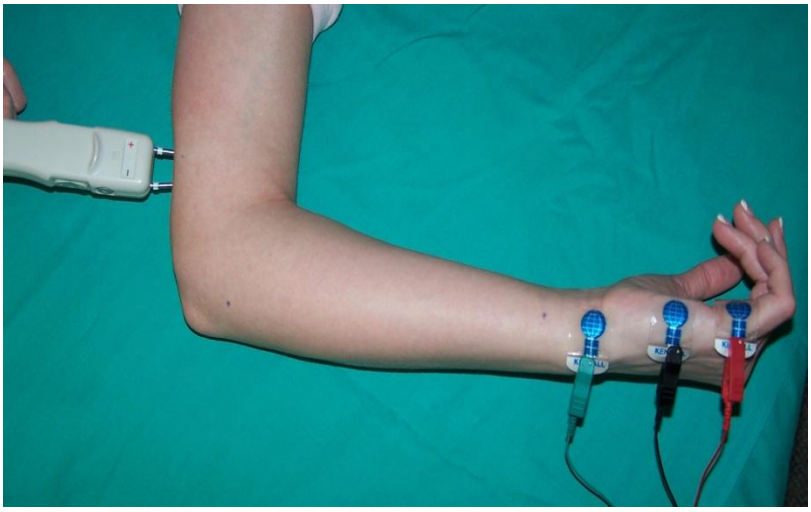
Wrist



Below Elbow



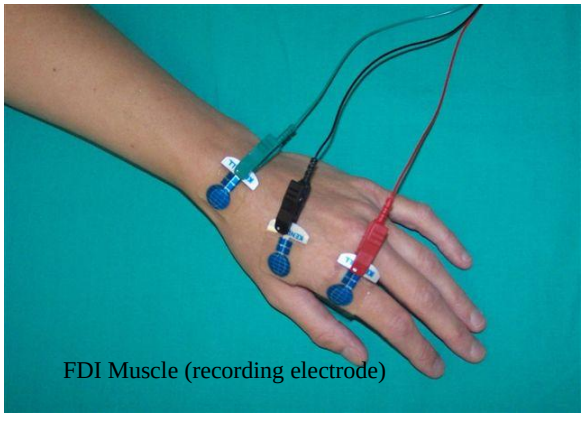
Above Elbow



Ulnar motor study to the FDI

In Buschbacher he leaves the reference electrode on the knuckle of the fifth digit, or where we place it for the ADM recording. This possibly gives a better onset and higher amplitude. Be consistent with your lab's normal values.

Patient Position:	Supine, or on their side with arm supinated and abducted 70-90 degrees
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed on the belly of the First dorsal interosseous (FDI) in the web space between the thumb and forefinger. Have the patient make a peace sign.
Reference:	Placed on the proximal phalanx of the digit II
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	(cathode distal)
Wrist:	Applied 2 cm proximal to the distal wrist crease, anterior to the flexor carpi ulnaris tendon
Below elbow(BE):	Applied 2-4 cm distal to the ulnar groove on the medial side of the forearm
Above elbow(AE):	Applied at least 10 cm proximal to the below elbow site on the medial aspect of the arm
Measurements:	Between the active recording electrode and wrist following a straight line Wrist to BE following contour of the medial aspect of the arm Between BE and AE though the ulnar groove following contour of the medial aspect of the arm Latency and amplitude for CMAP recordings
Calculations:	Motor conduction velocity wrist to BE and wrist to AE (or BE to AE)



FDI Muscle (recording electrode)

Wrist

Below Elbow

Above Elbow

The amplitude of antidromic recordings tend to be larger, but they tend to have more motor artifact that can obscure the waveforms. This is even more pronounced as we move to proximal recordings, as in the BE and AE sites.

Antidromic sensory study to the fifth digit

Patient Position:	Supine, or on their side with arm supinated and abducted 70-90 degrees
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Ring electrode placed on the midportion of the proximal phalanx of the 5th finger
Reference:	Ring electrode placed on the midportion of the middle phalanx of the 5th finger
Ground:	Placed between the stimulating and recording electrodes

Reduced amplitude at the wrist does not localize a lesion, but slowed CV from BE to AE does show the focus.

Stimulation:	(anode is 2.5 cm proximal to cathode)
Wrist:	Applied 2 cm proximal to the distal wrist crease anterior to the flexor carpi ulnaris tendon – many labs record only from the wrist
Below elbow(BE):	Applied 2-4 cm distal to the ulnar groove on the medial side of the forearm
Above elbow(AE):	Applied at least 10 cm proximal, but not more than 13 cm to the below elbow site on the medial aspect of the arm
Measurements:	Between active recording electrode and wrist Latency and amplitude for SNAP
Calculations:	Conduction velocity, from baseline, of the Wrist – BE and the BE – AE segments

Remember the amplitude of antidromic sensory responses may drop as much as 50% as you move proximal because of phase cancellation.

Phase cancellation occurs because the different fibers travel at different speeds, so over the long distance the repolarization of the fast fibers cancel some of the slow fibers.

Ulnar sensory – antidromic

Wrist

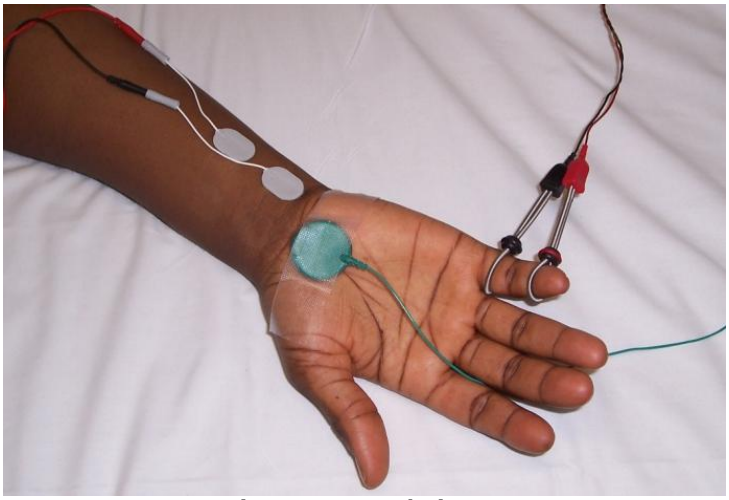
Below elbow

Above elbow

Orthodromic sensory study to the wrist

Orthodromic stimulation gives lower amplitude than the equivalent antidromic recording. In theory this is because the recording electrodes over the wrist are farther from the actual nerve than recording electrodes over the digit.

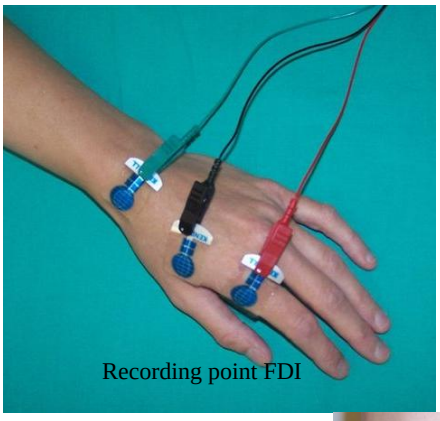
Patient Position:	Supine with arm supinated and extended at side
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed 11 cm proximal to the stimulating cathode in the wrist crease anterior to the flexor carpi ulnaris tendon
Reference:	Placed 3 or 4 cm proximal to the active recording electrode along the ulnar nerve
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	
Cathode:	Applied with a ring electrode on the proximal phalanx of the 5th digit
Anode:	Applied with a ring electrode on the distal phalanx, 3cm from the cathode
Measurements:	Between active recording electrode and cathode Latency and amplitude
Calculations:	None required

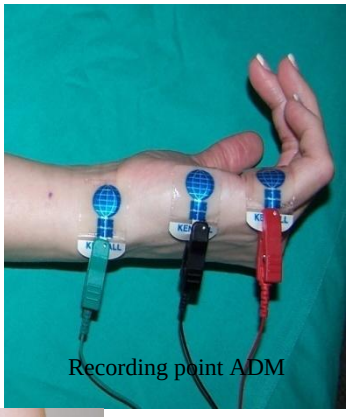


Ulnar sensory – orthodromic

Inching technique

Patient Position:	Supine, or on their side with arm supinated and abducted 70-90 degrees
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed on the belly of the ADM ½ the distance between the distal wrist crease and the base of the fifth digit, or the FDI in the web space between the thumb and forefinger.
Reference:	Placed on the proximal phalanx of the fifth digit
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	(cathode distal)
	Start at the "zero" mark in the epicondylar groove and make a mark, then mark 3, 2 cm increments both proximal and distal to this "zero" mark. Stimulate these 7 positions, starting distal and moving proximal.
Measurements:	Look for segmental changes in latency or amplitude that is asymmetrical as compared to the others segments.


Recording point FDI


Recording point ADM

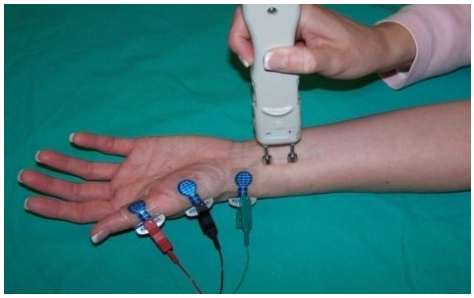
Stimulation points

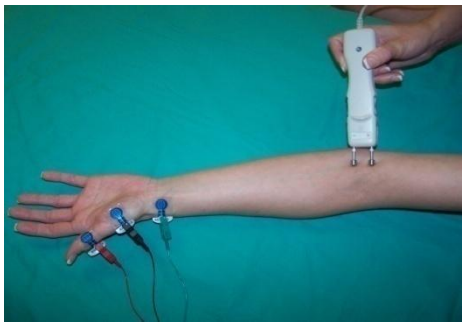
Median nerve (C6-T1, all trunks, lateral and medial cords)

Median motor study to the APB

The median nerve is used as a comparison study.

Patient Position:	Supine with arm supinated and extended at side
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed over the belly of the Abductor Pollicis Brevis (APB), ½ distance between metacarpophalangeal (MCP) joint of thumb and midpoint of the distal wrist crease
Reference:	Placed on the distal phalanx of the thumb
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	(cathode distal)
Wrist:	Applied 2 cm proximal to the distal wrist crease between the flexor carpi radialis (FCR) and the palmaris longus (PL) tendons
Elbow:	Applied at the elbow crease, just medial to biceps tendon
Measurements:	Between active recording electrode and wrist Between wrist and elbow Latency and amplitude for CMAP recordings
Calculations:	Conduction velocity wrist to elbow

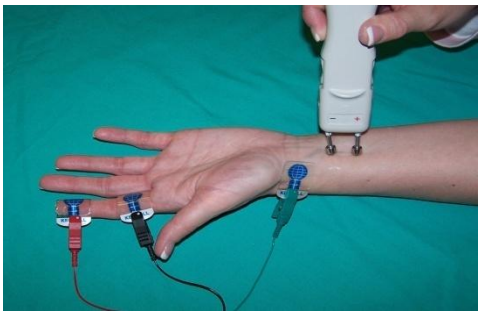




Antidromic sensory study to the index finger

If a patient has a CTS as well as an UNE, validate the CTS by performing a sensory comparison study to the radial nerve, thus eliminating confusion with an abnormal ulnar sensory.

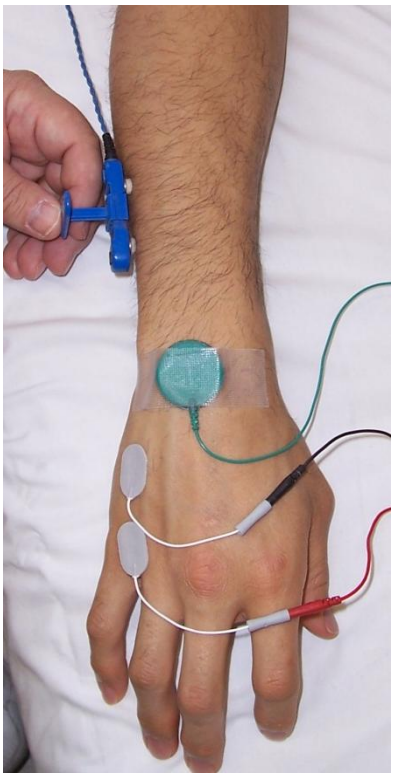
Patient Position:	Supine with arm extended at side
Skin Prep:	Wipe with alcohol, temperature check
Recording site:	
Active:	Ring electrode placed on midportion of the proximal phalanx of the index finger
Reference:	Ring electrode placed on the midportion of the middle phalanx of the index finger
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	(anode is 2.5 cm proximal to cathode)
Wrist:	Applied 2 cm proximal to the distal wrist crease between the flexor carpi radialis (FCP) and palmaris tendons (PL)
Measurements:	Between active recording electrode and wrist Latency and amplitude for SNAP
Calculations:	Sensory conduction velocity



Dorsal ulnar cutaneous nerve (C8-T1, lower trunk, medial cord)

You would think the DUC would be abnormal in lesions at the elbow, but because of the fascicular arraignment it is often spared.

Patient Position:	Supine with arm pronated and extended at side
Skin Prep:	Clean area with alcohol, temperature check
Recording site: Active:	In the web space between the 4th and 5th metacarpal.
Reference:	3-4 cm distal
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	10 cm proximal along the ulna bone. Anatomically the nerve curves around the ulna so the best response may be found on either side of the ulna.
Measurements:	Between active recording electrode and wrist Latency and amplitude for SNAP
Calculations:	None required, although some may calculate the CV from cathode to recording electrode. Side-to-Side comparison is often necessary

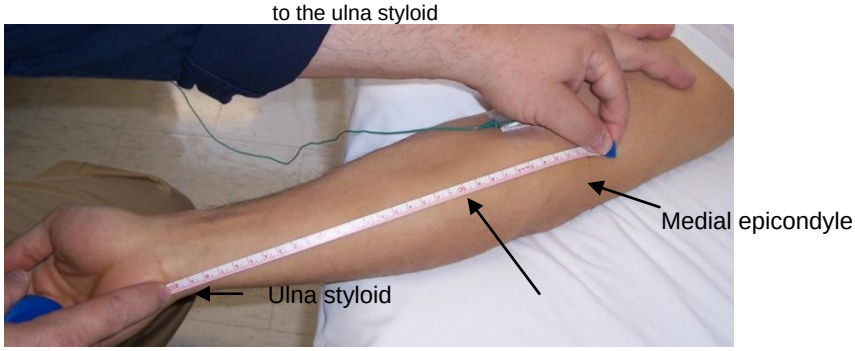


Medial antebrachial cutaneous nerve (C8-T1, lower trunk, medial cord)

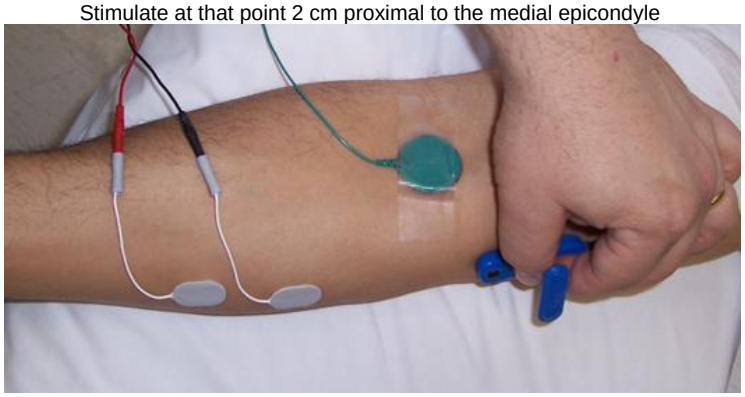
Some believe the MABC is a difficult nerve to record, but after a little practice it becomes easier. One key is using a light touch with low intensity. Pressing hard or strong stimulation activates the median and/or the ulnar nerves, which, because they are mixed nerves, will obliterate your response with motor artifact.

Patient Position:	Supine with arm supinated and extended at side
Skin Prep:	Clean area with alcohol, temperature check
Recording site:	
Active:	Placed 10 cm along a line extending from 3 cm proximal to the medial epicondyle to the ulnar styloid
Reference:	Placed 3-4 cm distal along the nerve course
Ground:	Placed between the stimulating and recording electrodes
Stimulation:	At the tip of the measurement point 3 cm above the medial epicondyle. Use a soft touch; too much pressure or too much stimulus will cause extensive motor artifact.
Measurements:	Between active recording electrode and wrist Latency and amplitude for SNAP
Calculations:	None required, although some may calculate the CV from cathode to recording electrode.

Place the active electrode 10 cm along the straight line from 2cm proximal to the medial epicondyle to the ulna styloid



Stimulate at that point 2 cm proximal to the medial epicondyle



Case Study 1:

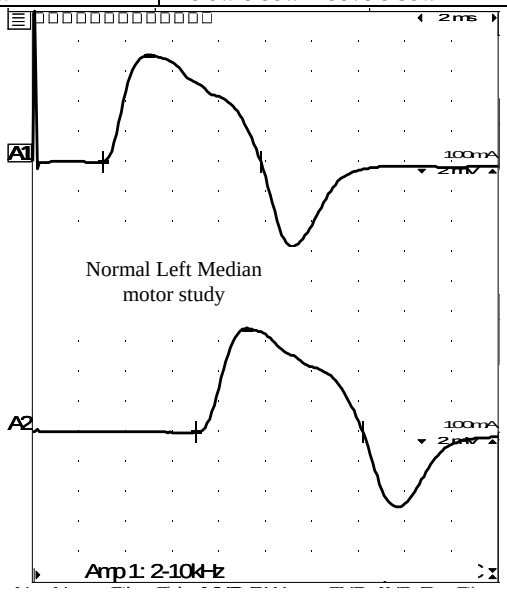
Age:	27	Temperatures:
Gender:	Female	Left wrist: 31.5°C

For your convenience values outside the normal range are **bolded**. Normal values for this age are stated below the tables. Note: Normal waveform screen shots of the left radial SNC and the right ulnar SNC were omitted for space considerations.

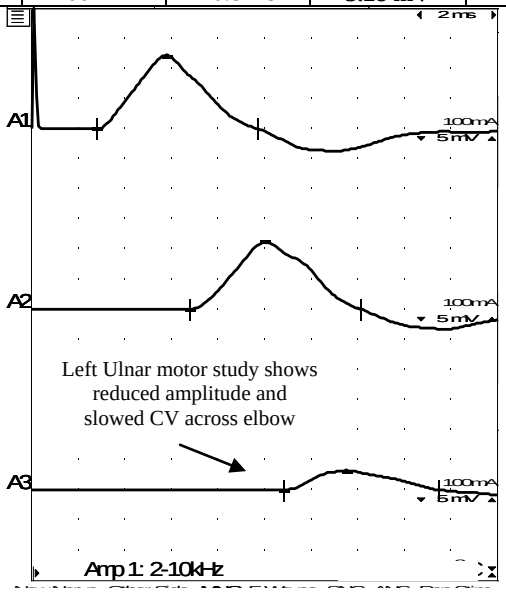
REASON FOR STUDY: Patient with numbness and tingling in the 4th and 5th fingers of the left hand. There is no neck pain. Evaluate for underlying neuropathic process.

Motor Nerve Conduction:

Nerve and Site	Segment	Distance	Latency	Amplitude	Conduction Velocity
Left Median	Rec: APB				
Wrist	Abductor pollicis brevis-Wrist	60 mm	3.0 ms	7.14 mV	
Elbow	Wrist-Elbow	230 mm	7.0 ms	7.00 mV	57.5 m/s
Left Ulnar	Rec: ADM				
Wrist	ADM-Wrist	60 mm	2.8 ms	12.33 mV	
Below elbow	Wrist-Below elbow	220 mm	6.8 ms	11.22 mV	55.0 m/s
Above elbow	Below elbow-Above elbow	100 mm	10.8 ms	**3.28 mV**	**25.0 m/s**

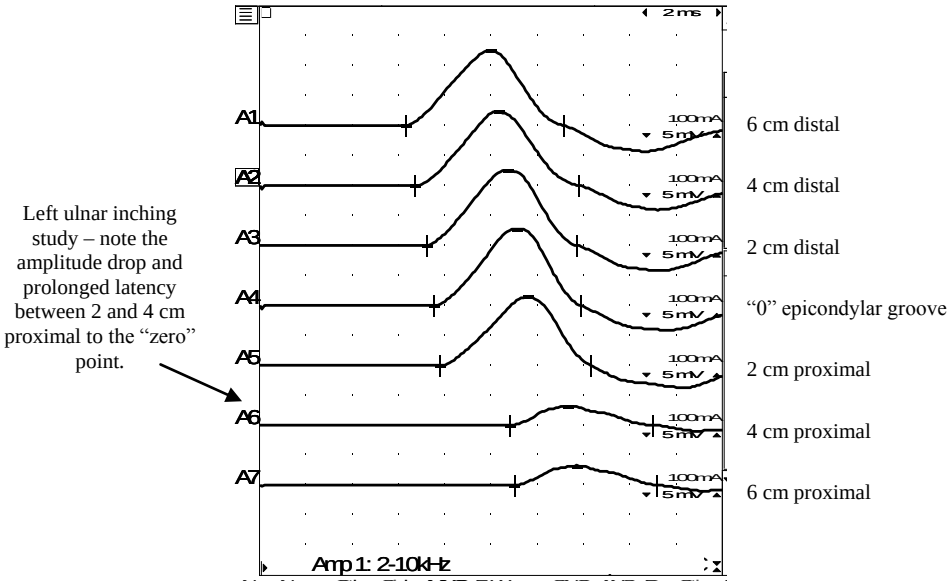


Normal Left Median motor study



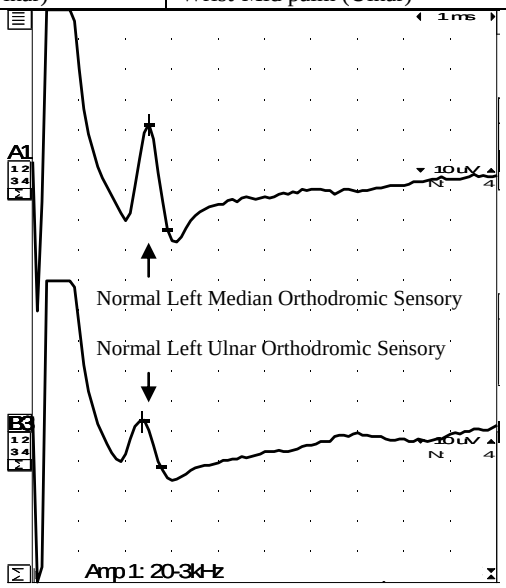
Left Ulnar motor study shows reduced amplitude and slowed CV across elbow

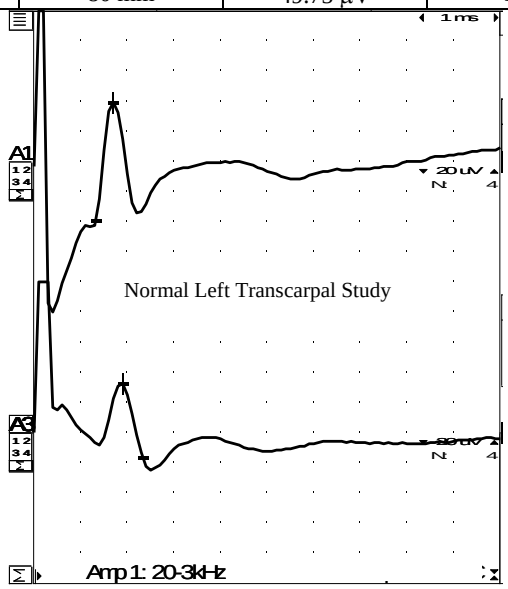
Left Ulnar - Inching	Rec: ADM				
D6	Abductor digiti minimi (manus)-D6		6.3 ms	12.64 mV	
D4	D6-D4		6.7 ms	12.42 mV	
D2	D4-D2		7.2 ms	12.54 mV	
P	D2-P		7.5 ms	12.90 mV	
P2	P-P2		7.8 ms	11.47 mV	
P4	P2-P4		10.8 ms	**3.24 mV**	
P6	P4-P6		11.0 ms	**3.24 mV**	
	D6-P6	120 mm			**25.5 m/s**



Sensory Nerve Conduction:

Nerve and Site	Segment	Distance	Amplitude	Peak Latency
Left Median (orthodromic)	Rec: Wrist			
Digit II (index finger)	Wrist-Digit II (index finger)	130 mm	35.35 µV	2.5 ms
Left Ulnar (Orthodromic)	Rec: Wrist			
Digit V (little finger)	Wrist-Digit V (little finger)	110 mm	15.63 µV	2.4 ms
Left Transcarpal, Med-Uln Comparison				
Mid palm (Median)	Wrist-Mid palm (Median)	80 mm	79.20 µV	1.7 ms
Mid palm (Ulnar)	Wrist-Mid palm (Ulnar)	80 mm	49.75 µV	1.9 ms





Left Radial (Antidromic)	Rec: Snuffbox			
Forearm	Anatomical snuff box-Forearm	100 mm	35.28 µV	2.0 ms
Right Ulnar (Orthodromic)	Rec: Wrist			
Digit V (little finger)	Wrist-Digit V (little finger)	110 mm	17.33 µV	2.4 ms

Normal values:			
Median MNC	DML: ≤ 4.2, Amp: ≥ 4, CV ≥ 49	Median SNC	Peak Lat: ≤ 3.2, Amp: ≥ 12
Ulnar MNC	DML: ≤ 3.8, Amp: ≥ 6, CV ≥ 49, CV across elbow may slow ≤ 10	Ulnar SNC	Peak Lat: ≤ 2.8, Amp: ≥ 10
		Palmar diff	≤ 0.4

NERVE CONDUCTION STUDIES:

1. Motor conduction study of the left ulnar nerve revealed normal distal latency and amplitude. There was an amplitude drop of 71% upon stimulation above the elbow with marked slowing of conduction velocity across the elbow. An inching study of the left ulnar nerve revealed a 79% amplitude drop with a 3 ms delay between the epicondylar groove and 2 cm proximal to the groove. Motor conduction study of the left median nerve was within normal limits.

2. Sensory nerve conduction studies of the left median, left radial and both ulnar nerves were within normal limits. The ulnar sensory nerve amplitude was symmetric upon side to side comparison.

DISCUSSION:

There is electrical evidence to suggest the presence of a left ulnar neuropathy that localizes to the region of the retroepicondylar groove. The segmental slowing in conduction velocities and partial conduction block suggests a focus of demyelination, which usually corresponds to a good prognosis for recovery. The symmetry in ulnar sensory amplitudes and the lack of denervation changes on needle exam argue against axonal loss injury. This is an example of sparing to some fascicles (the fascicles going to the sensory innervations) while others are affected (the fascicles going to the ADM).

Case Study 2:

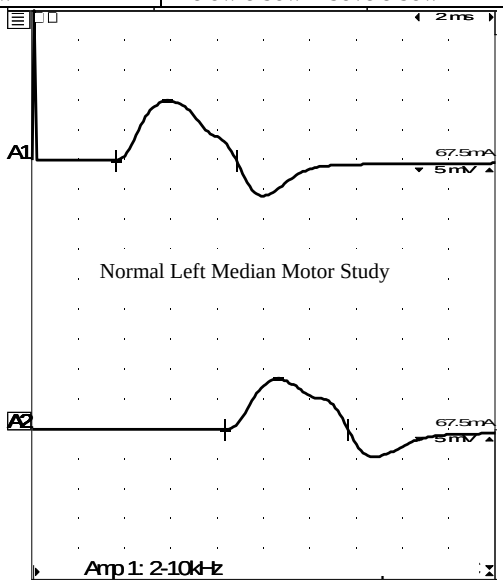
		Temperatures:
Age:	63	Right wrist: 33°C
Gender:	Male	Left wrist: 33°C

For your convenience values outside the normal range are **bolded**. Normal values for this age are stated below the tables.

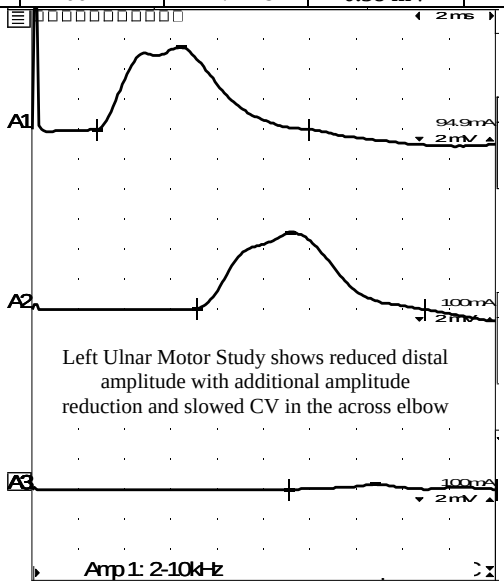
REASON FOR STUDY: Numbness in the fifth digit in the left hand for the past three months. Symptoms began in the tip of the fifth digit and have spread to the left wrist. He denies left hand weakness. He also notes tingling in the left shoulder that does not radiate further down the arm. He denies neck pain, symptoms involving the right hand or the feet. His exam today shows weakness in ulnar distribution bilaterally. This study is to evaluate for a left ulnar mononeuropathy versus a left lower cervical radiculopathy.

Motor Nerve Conduction:

Nerve and Site	Segment	Distance	Latency	Amplitude	Conduction Velocity
Left Median	Rec: APB				
Wrist	Abductor pollicis brevis-Wrist	60 mm	3.6 ms	9.95 mV	
Elbow	Wrist-Elbow	250 mm	8.3 ms	8.56 mV	53.1 m/s
Left Ulnar	Rec: ADM				
Wrist	ADM-Wrist	60 mm	2.8 ms	**5.53 mV**	
Below elbow	Wrist-Below elbow	225 mm	7.1 ms	5.09 mV	52.3 m/s
Above elbow	Below elbow-Above elbow	100 mm	11.1 ms	**0.38 mV**	**25.2 m/s**



Normal Left Median Motor Study



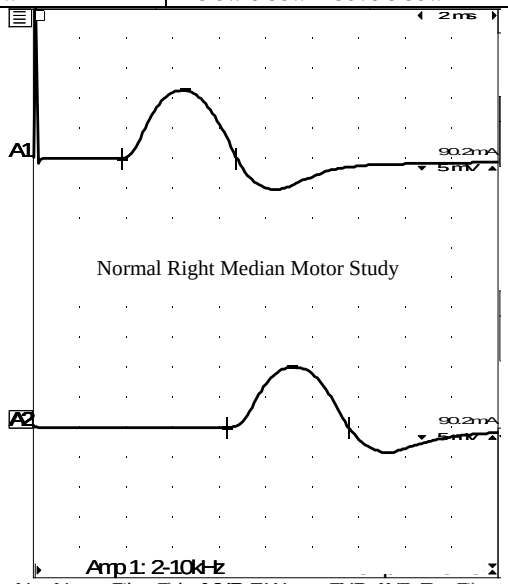
Left Ulnar Motor Study shows reduced distal amplitude with additional amplitude reduction and slowed CV in the across elbow

Right Median Rec: APB

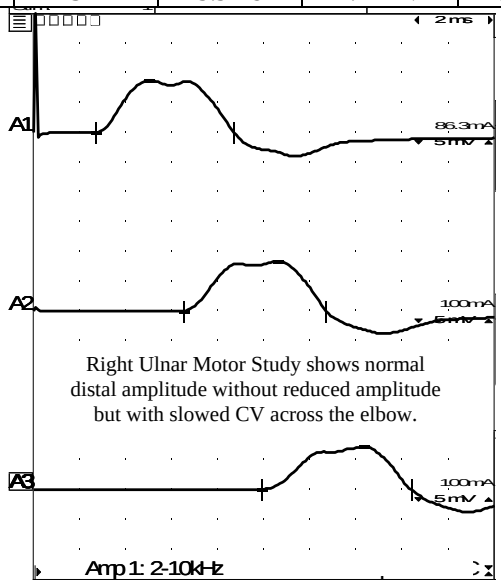
Wrist	Abductor pollicis brevis-Wrist	60 mm	3.8 ms	11.43 mV	
Elbow	Wrist-Elbow	245 mm	8.3 ms	10.25 mV	54.4 m/s

Right Ulnar Rec: ADM

Wrist	ADM-Wrist	60 mm	2.7 ms	8.82 mV	
Below elbow	Wrist-Below elbow	205 mm	6.5 ms	8.35 mV	53.9 m/s
Above elbow	Below elbow-Above elbow	115 mm	9.9 ms	7.21 mV	**33.8 m/s**



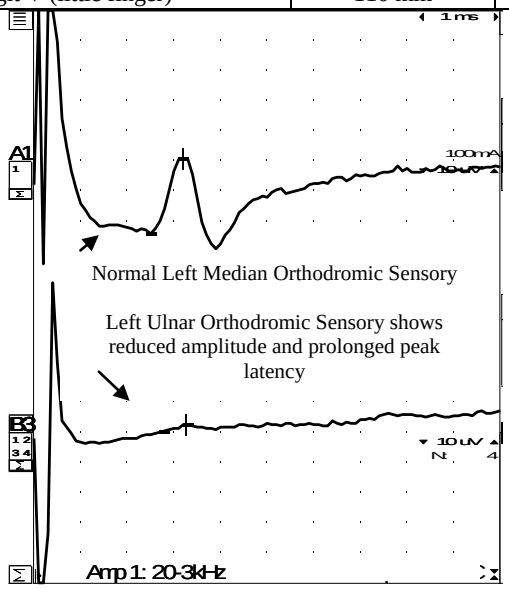
Normal Right Median Motor Study



Right Ulnar Motor Study shows normal distal amplitude without reduced amplitude but with slowed CV across the elbow.

Sensory Nerve Conduction:

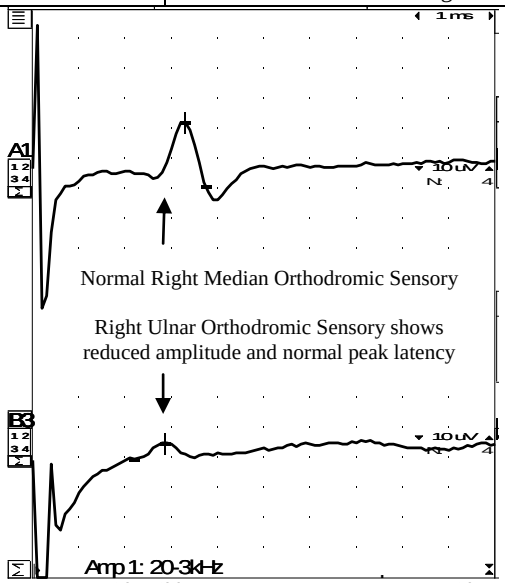
Nerve and Site	Segment	Distance	Amplitude	Peak Latency
Left Median (Orthodromic)	Rec: Wrist			
Digit II (index finger)	Wrist-Digit II (index finger)	130 mm	25.55 µV	3.2 ms
Left Ulnar (Orthodromic)	Rec: Wrist			
Digit V (little finger)	Wrist-Digit V (little finger)	110 mm	**2.27 µV**	**3.3 ms**

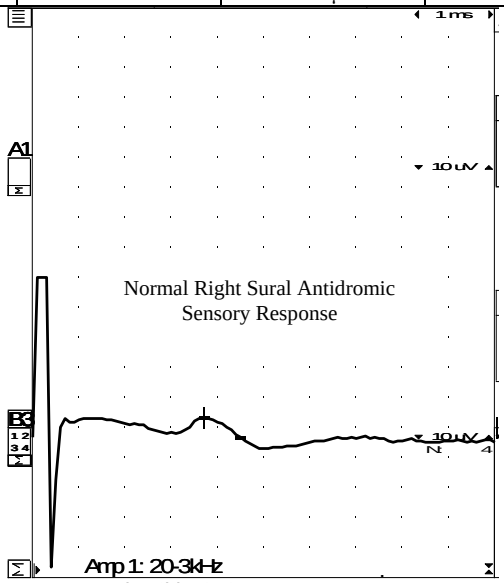


Normal Left Median Orthodromic Sensory

Left Ulnar Orthodromic Sensory shows reduced amplitude and prolonged peak latency

Right Median (Orthodromic)		Rec: Wrist		
Digit II (index finger)	Wrist-Digit II (index finger)	130 mm	21.93 µV	3.3 ms
Right Ulnar (Orthodromic)		Rec: Wrist		
Digit V (little finger)	Wrist-Digit V (little finger)	110 mm	**5.43 µV**	2.9 ms
Right Sural (Antidromic)		Rec: Lat. Mall		
Lower leg	Lateral malleolus-Lower leg	140 mm	6.84 µV	3.7 ms





Normal values:

Median MNC	DML: ≤ 4.2, Amp: ≥ 4, CV ≥ 49	Median SNC	Peak Lat: ≤ 3.2, Amp: ≥ 12
Ulnar MNC	DML: ≤ 3.8, Amp: ≥ 6, CV ≥ 49, CV across elbow may slow ≤ 10	Ulnar SNC	Peak Lat: ≤ 2.8, Amp: ≥ 10
		Sural SNC	Peak Lat: ≤ 4.2, Amp: ≥ 5

NERVE CONDUCTION STUDIES:

1. Motor conduction studies of both median nerves are normal. The left ulnar motor conduction revealed low amplitude with conduction block upon proximal stimulation and conduction velocity slowing across the elbow. The right ulnar motor conduction was of normal distal latency and amplitude, however, there was conduction velocity slowing across the elbow.

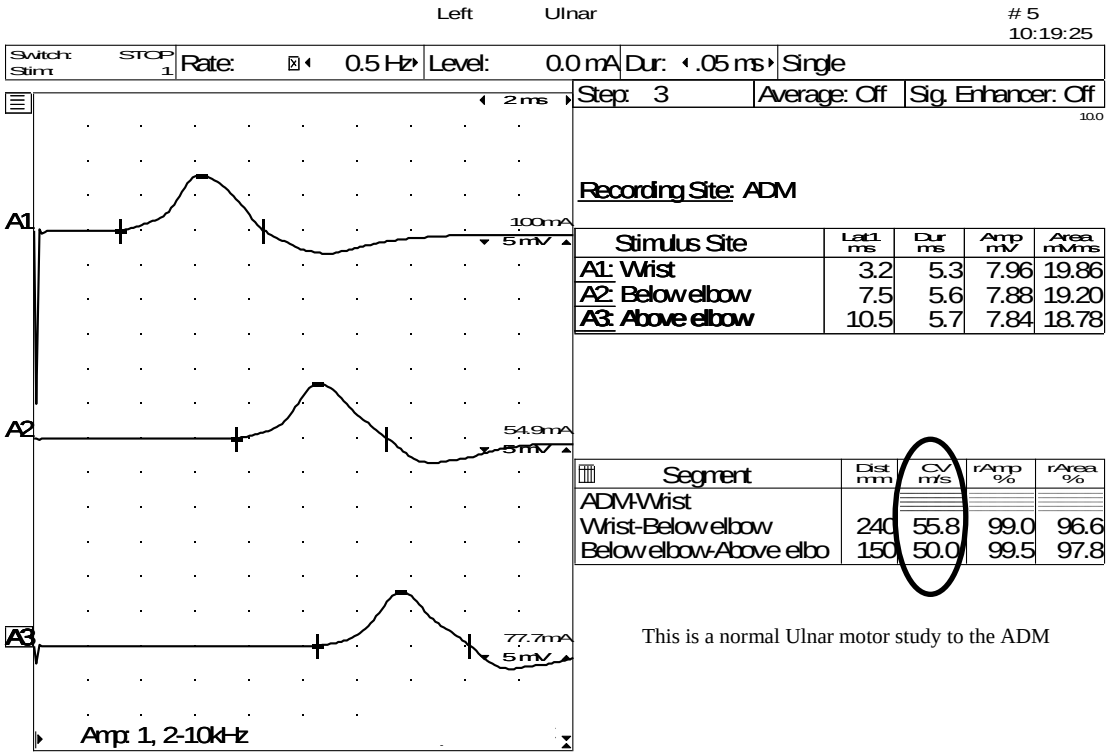
2. Sensory nerve conduction studies of the median nerves were normal on both sides. Sensory conductions of both ulnar nerves were of low amplitude with normal peak latency on the right and prolonged peak latency on the left. Right sural sensory conduction was normal.

DISCUSSION:

There is electrical evidence to suggest the presence of bilateral ulnar neuropathies that localize to the region of the retroepicondylar groove. The segmental slowing in conduction velocities suggests a focus of demyelination, which usually corresponds to a good prognosis for recovery. There is however additional electrical evidence for some degree of axonal loss in the territory of the left ulnar nerve based on the low distal compound muscle action potential amplitude.

Case Study 3:

54 year-old man with left arm pain and numbness in the 4th and 5th digits for several months.

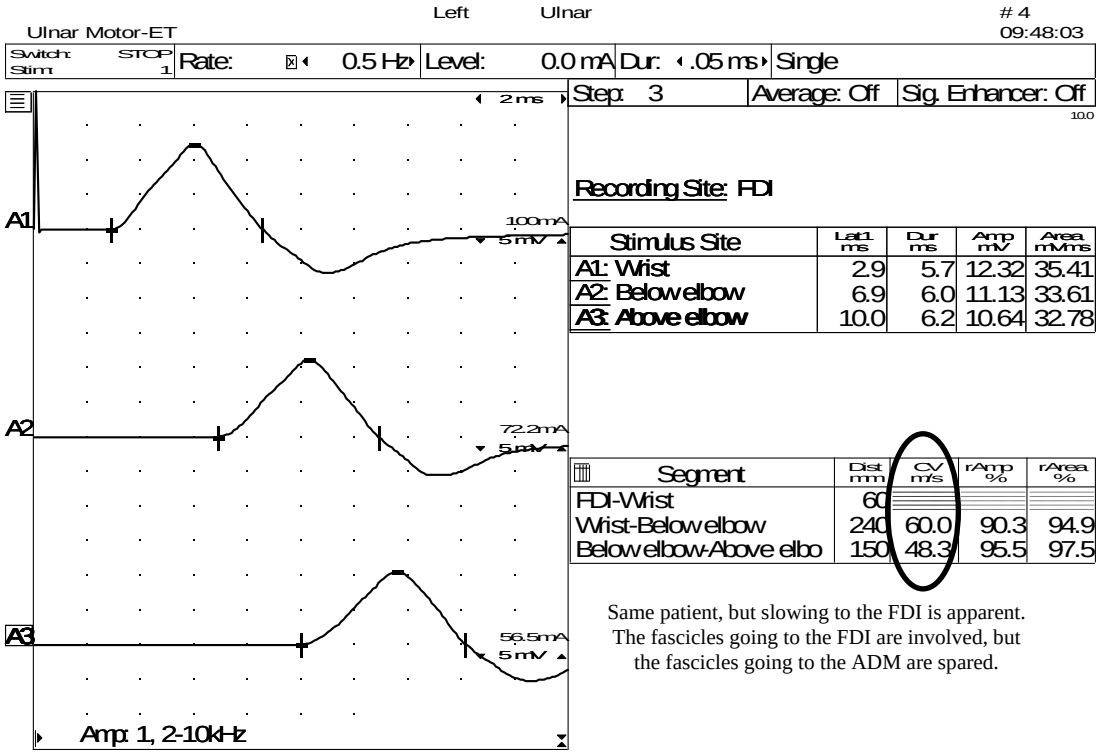


Recording Site: ADM

Stimulus Site	Lat1 ms	Dur ms	Amp mV	Area mVms
A1: Wrist	3.2	5.3	7.96	19.86
A2: Below elbow	7.5	5.6	7.88	19.20
A3: Above elbow	10.5	5.7	7.84	18.78

Segment	Dist mm	CV m/s	rAmp %	rArea %
ADM-Wrist				
Wrist-Below elbow	240	55.8	99.0	96.6
Below elbow-Above elbo	150	50.0	99.5	97.8

This is a normal Ulnar motor study to the ADM



Recording Site: FDI

Stimulus Site	Lat1 ms	Dur ms	Amp mV	Area mVms
A1: Wrist	2.9	5.7	12.32	35.41
A2: Below elbow	6.9	6.0	11.13	33.61
A3: Above elbow	10.0	6.2	10.64	32.78

Segment	Dist mm	CV m/s	rAmp %	rArea %
FDI-Wrist	60			
Wrist-Below elbow	240	60.0	90.3	94.9
Below elbow-Above elbo	150	48.3	95.5	97.5

Same patient, but slowing to the FDI is apparent. The fascicles going to the FDI are involved, but the fascicles going to the ADM are spared.

NCS summary:
SNC – Orthodromic stimulation of the median nerve is normal. Orthodromic stimulation of the ulnar nerve reveals reduced amplitude and normal peak latency.
MNC – The median nerve recording is normal. The ulnar nerve recording from the ADM is normal. Ulnar nerve recording from the FDI reveals slowing across the elbow.

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