And I Thought Electrodiagnosis of Ulnar Neuropathies was Easy!

Kathleen Galloway MPT, DSc, ECS
Belmont University
Ed Schrank, MPT, DSc, ECS
Shenandoah University

Credit to:
Omejic & Podnar: Proposal for electrodiagnostic evaluation of patients with ulnar neuropathy at the elbow
Mark E. Landau, William W. Campbell: Clinical Features and Electrodiagnosis of Ulnar Neuropathies

Speaker Bios

- Dr. Ed Schrank
- Dr. Kathleen Galloway
- Dr. Todd Telemeco – pinch hitting for Dr. Galloway

METHODIST UNIVERSITY

DOCTOR OF PHYSICAL THERAPY

Bibliography

Go to: www.Zotero.org
Search: Ulnar Neuropathy CSM 2018

You can download the citation list to your own Zotero library.

Or follow this link:
https://www.zotero.org/groups/2074454/ulnar_neuropathy_csm_2018

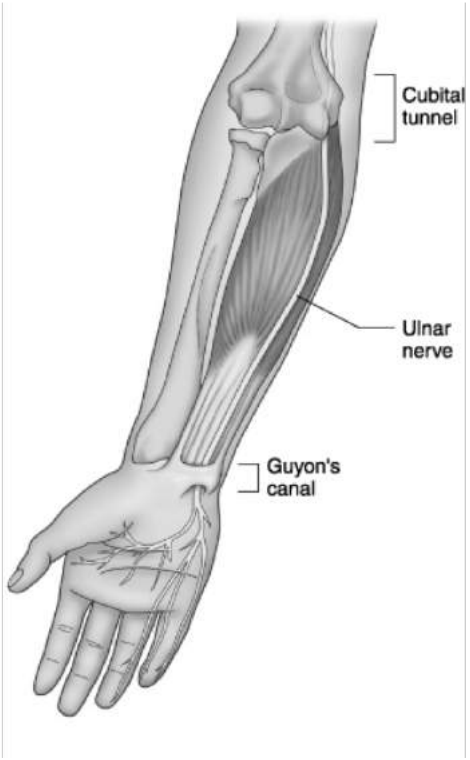
Learning Objectives

- At the conclusion of this session, the attendee should be able to:

1. List the 4 locations of ulnar neuropathy at the elbow (UNE) and know the two most prevalent locations.
2. Understand the anatomic factors that account for susceptibility of the ulnar nerve to injury at the elbow.
3. List the recommendations of the AAEM practice parameter on UNE.
4. Describe one technique learned today to improve your diagnostic accuracy on UNE.

Introduction

- UNE????
- Second most frequent UE compression neuropathy
- Incidence rate
  - 20.9 cases/100,000 persons/yr



Surgeons: Fear the Ulnar Nerve

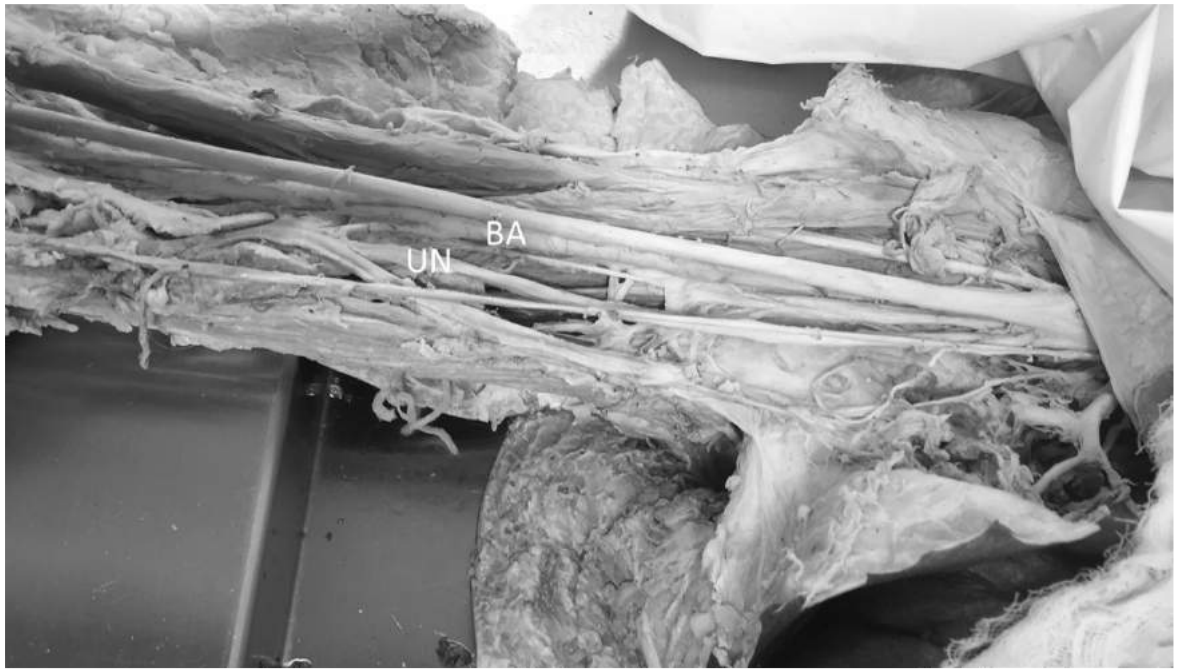
Roadmap

- Part 1
  - Anatomy review
  - Clinical features
  - Terminology
  - Etiology
- Part 2
  - AANEM Practice Parameter
  - The 2 x 4cm inching study
  - Fatal flaws
  - Cases
  - Suggested Approach

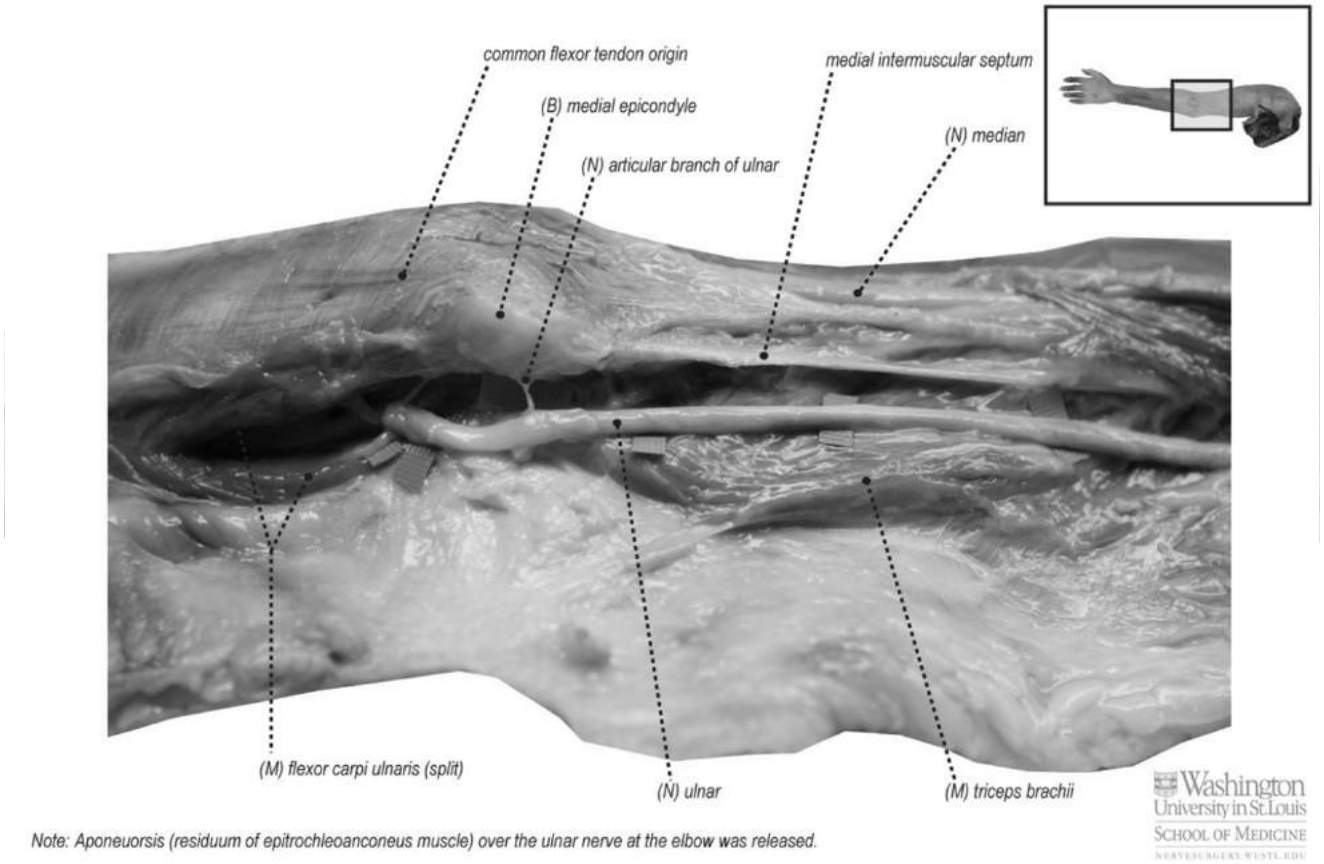
Ulnar nerve anatomy review

Course in the Proximal Arm

- Derived from medial cord of brachial plexus
- Travels medial to the brachial artery in the arm



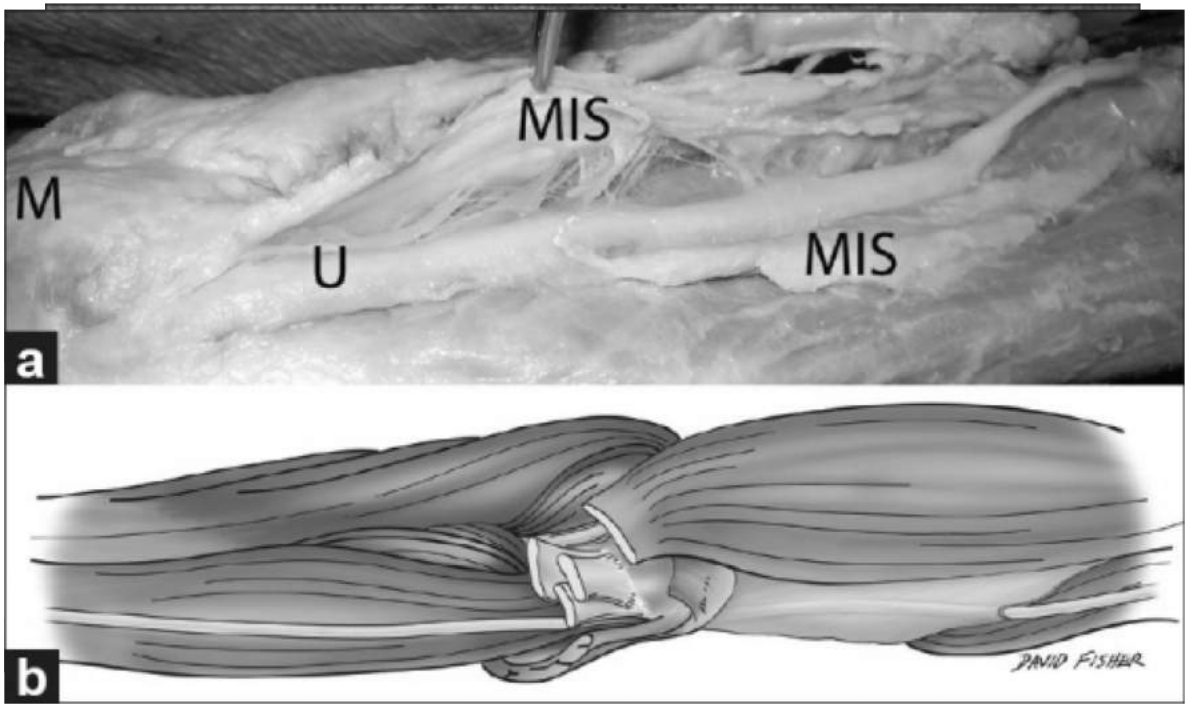
- Middle 1/3 of the arm pierces the medial intermuscular septum (IMS)
- **1st potential site of entrapment**
  - so called Arcade of Struthers



Note: Aponeuorsis (residuum of epitrochleoanconeus muscle) over the ulnar nerve at the elbow was released.

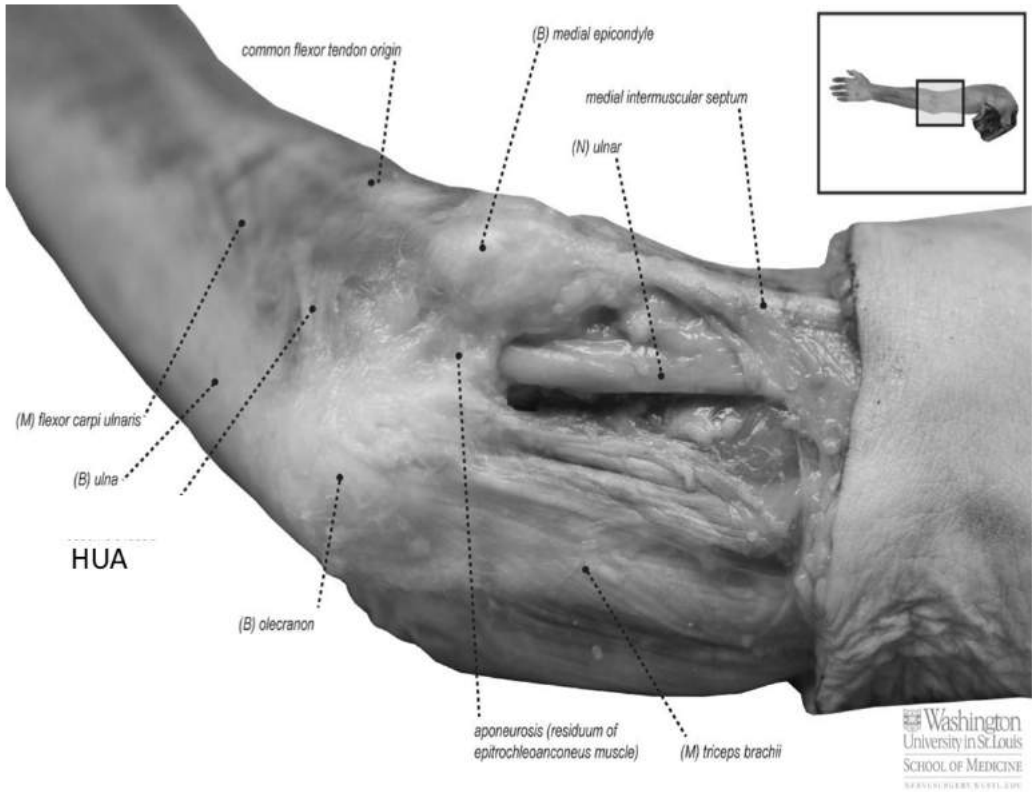
https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0562.jpg
https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0569.jpg

- Arcade of Struthers
  - Type I Arcade:Thickening of the brachial fascia
  - Type II Arcade: Internal brachial ligament
  - Type III Arcade: Thickened IMS



Course at the Elbow

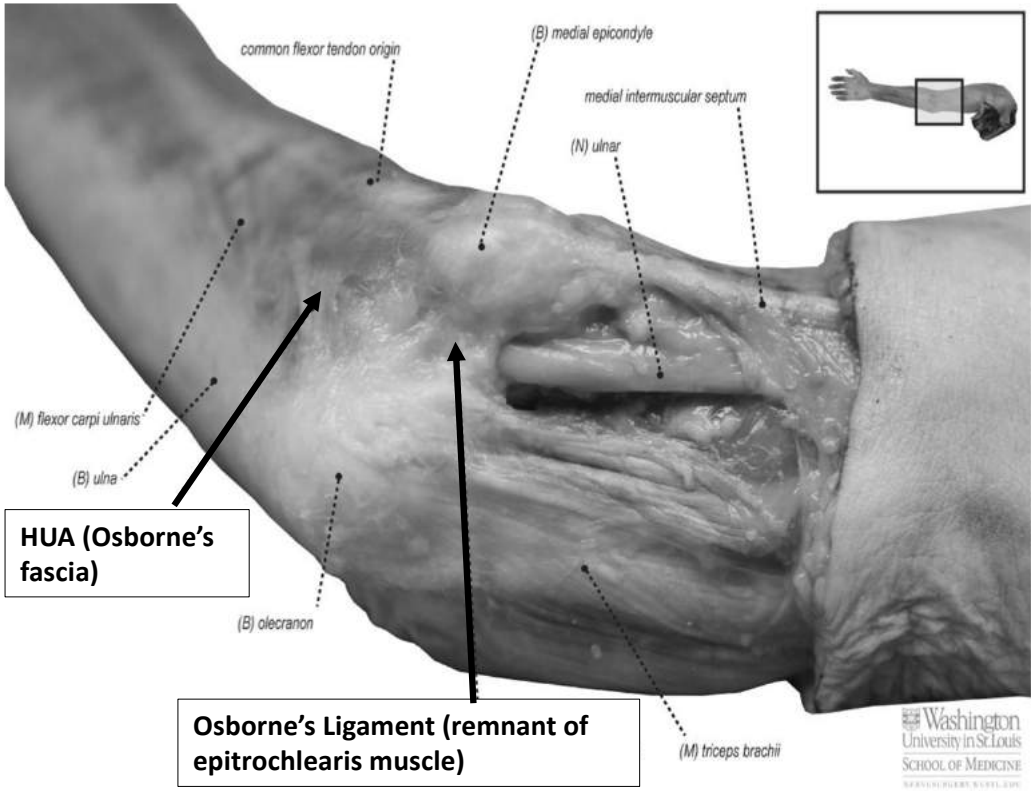
- Passes posterior to the medial epicondyle in the retro-epicondylar groove
  - ***2nd potential site of entrapment***
  - Site of subluxation



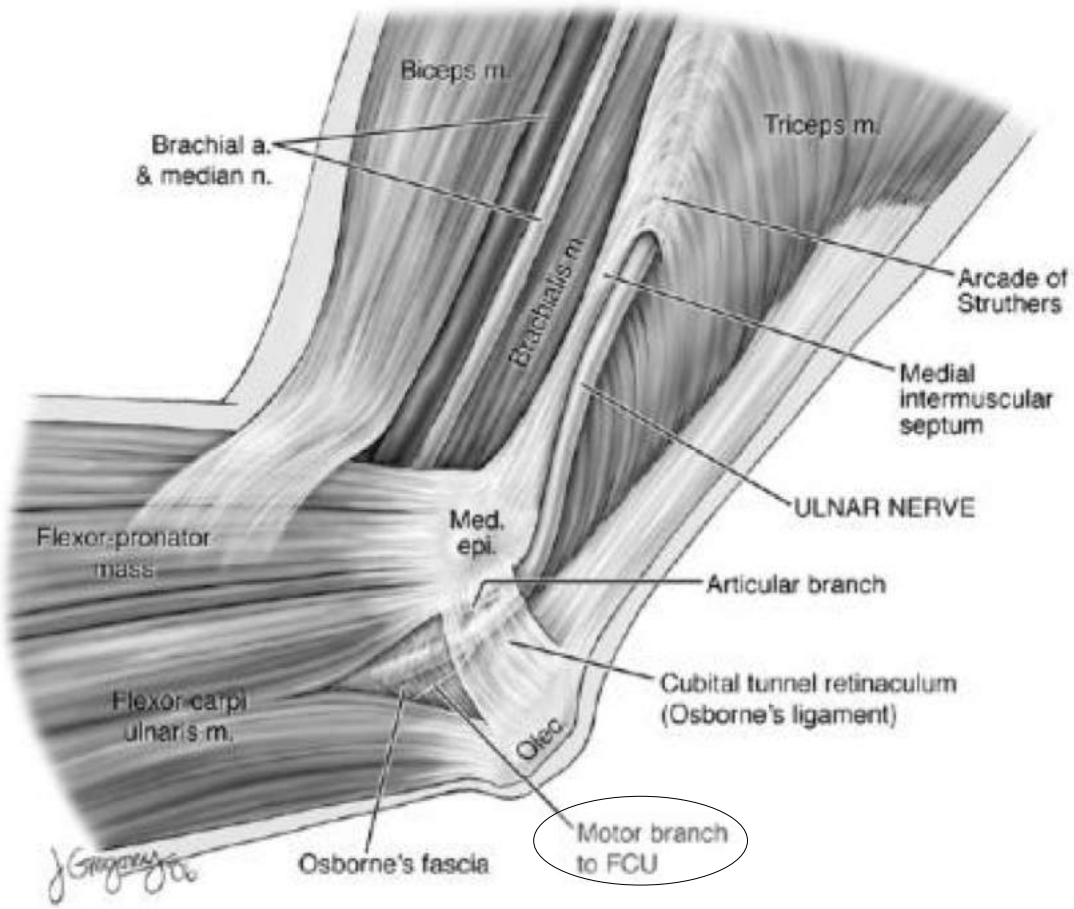
https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0500.jpg

Course at the Elbow

- Passes beneath Osborne's ligament
- Passes between the two heads of the flexor carpi ulnaris (FCU) beneath the Humeroulnar arcade (HUA) – Also known as Osborne's fascia
  - Typically occurs 1-2.5 cm distal to the medial epicondyle
  - **3rd potential site of entrapment**

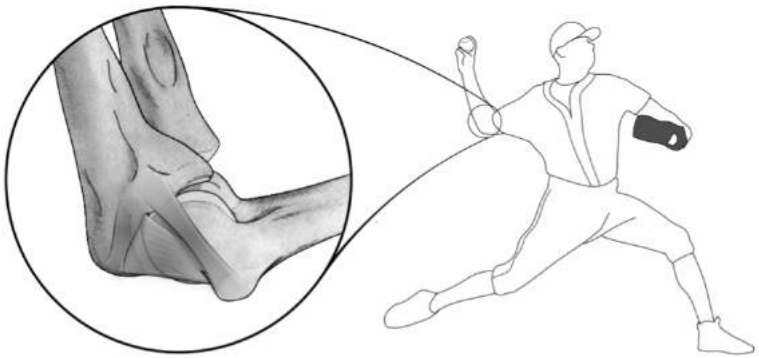


https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0500.jpg


Biceps m.
Brachial a.
& median n.
Triceps m.
Brachialis m.
Arcade of
Struthers
Medial
intermuscular
septum
ULNAR NERVE
Med.
epi.
Flexor-pronator
mass
Articular branch
Cubital tunnel retinaculum
(Osborne's ligament)
Flexor carpi
ulnaris m.
Olec.
Motor branch
to FCU
Osborne's fascia

Elbow flexion effect on ulnar nerve in the ulnar groove

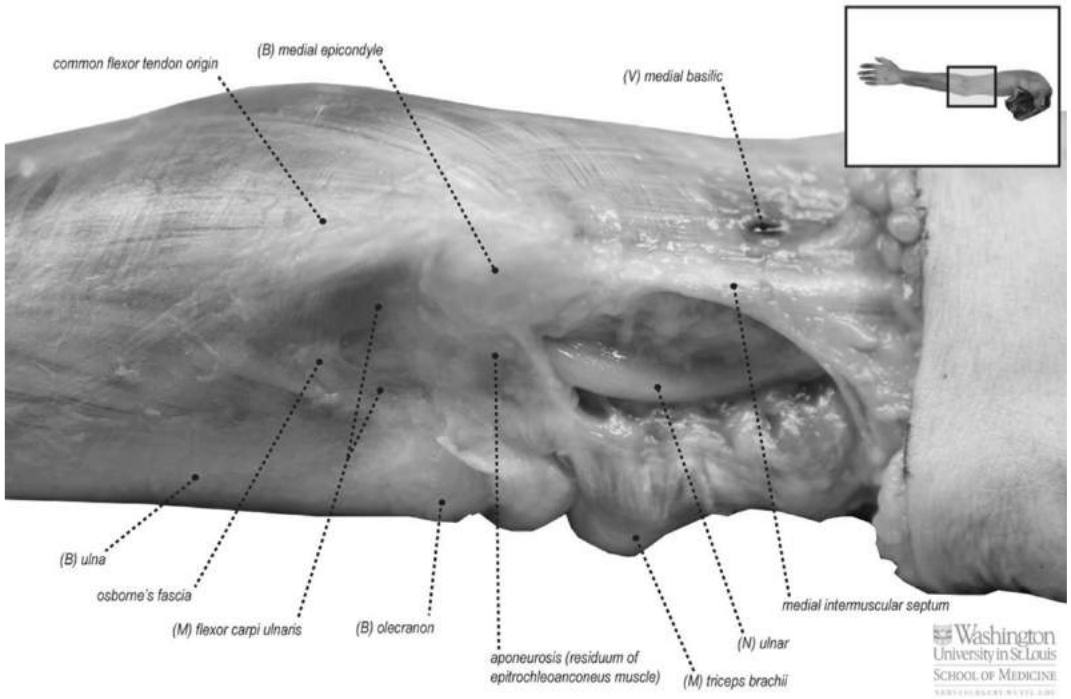
- Olecranon process moves away from medial epicondyle
- Two heads of FCU origin are pulled apart
  - Humeral head of FCU attached to medial epicondyle while the ulnar head is attached to the olecranon causes tightening of HUA
  - Increases pressure on ulnar nerve in groove to up to 19 mmHg
  - Ulnar collateral lig bulges into the floor of the ulnar groove
  - Medial head of triceps may also be pulled into the ulnar groove
  - Nerve may sublux in full flexion even in normals



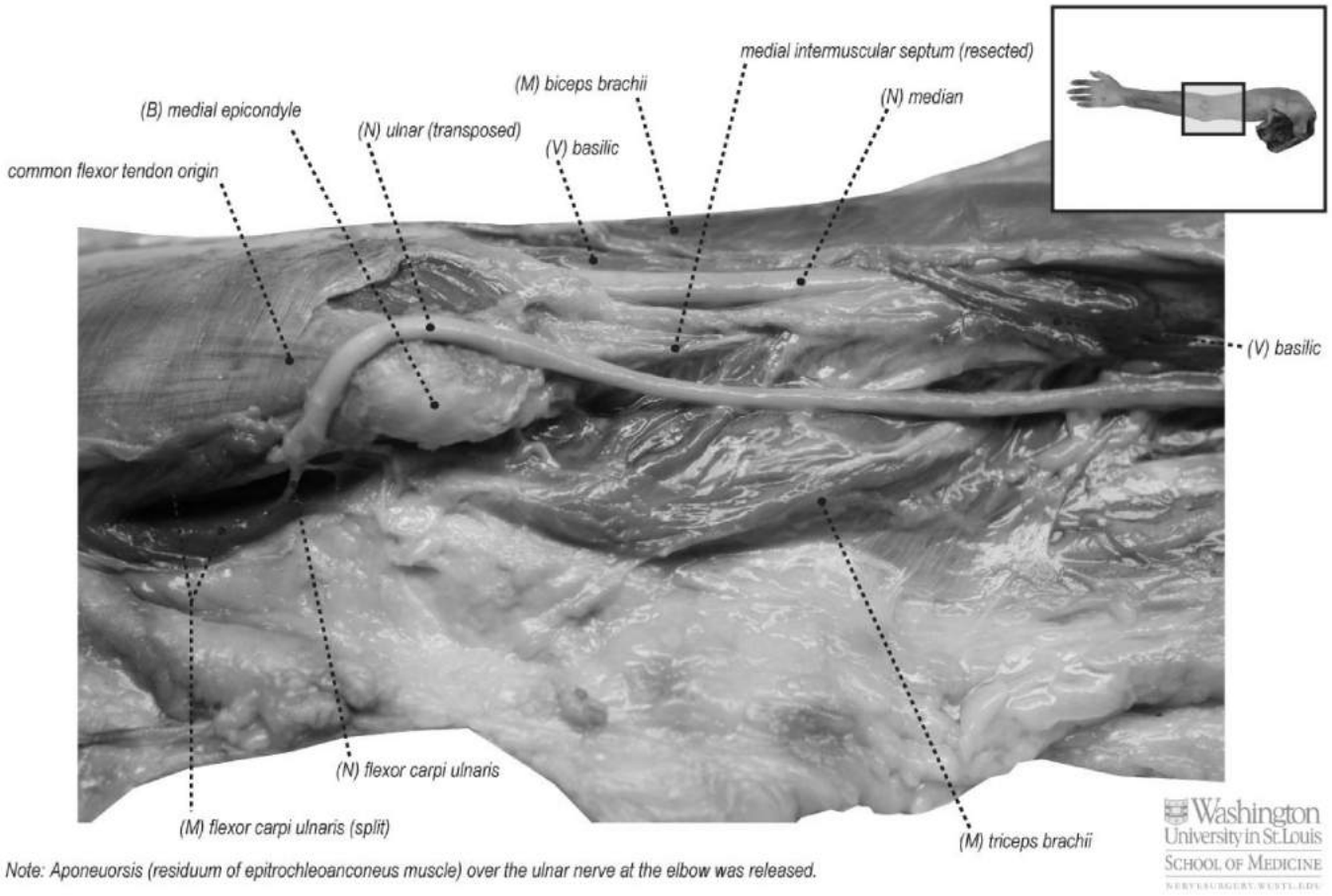
https://upload.wikimedia.org/wikipedia/commons/7/7f/Anatomy_of_the_ulnar_collateral_ligament_in_the_pitcher%27s_elbow.png

Elbow extension effect on ulnar nerve in the ulnar groove

- Elbow extension
  - Medial epicondyle and olecranon are approximated
  - Humeroulnar arcade is in slack
  - Ulnar nerve is in slack in the groove



https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0480.jpg

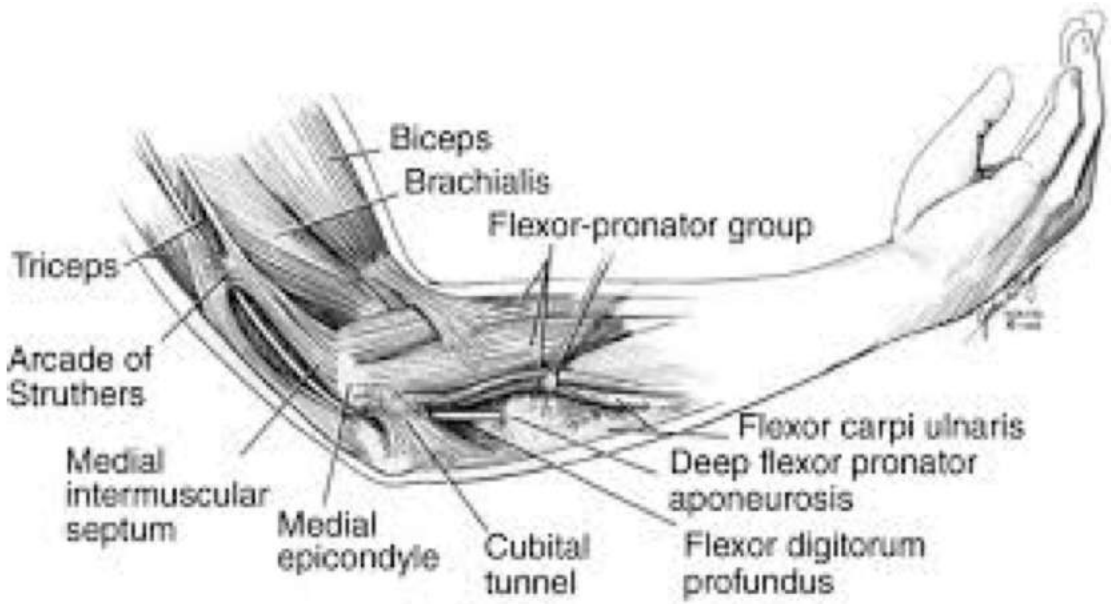


Note: Aponeuorsis (residuum of epitrochleoanconeus muscle) over the ulnar nerve at the elbow was released.

https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0586.jpg

Course through the forearm

- Travels through the ***flexor-pronator aponeurosis*** and the ***ligament of Spinner***
- **4th potential site of entrapment**



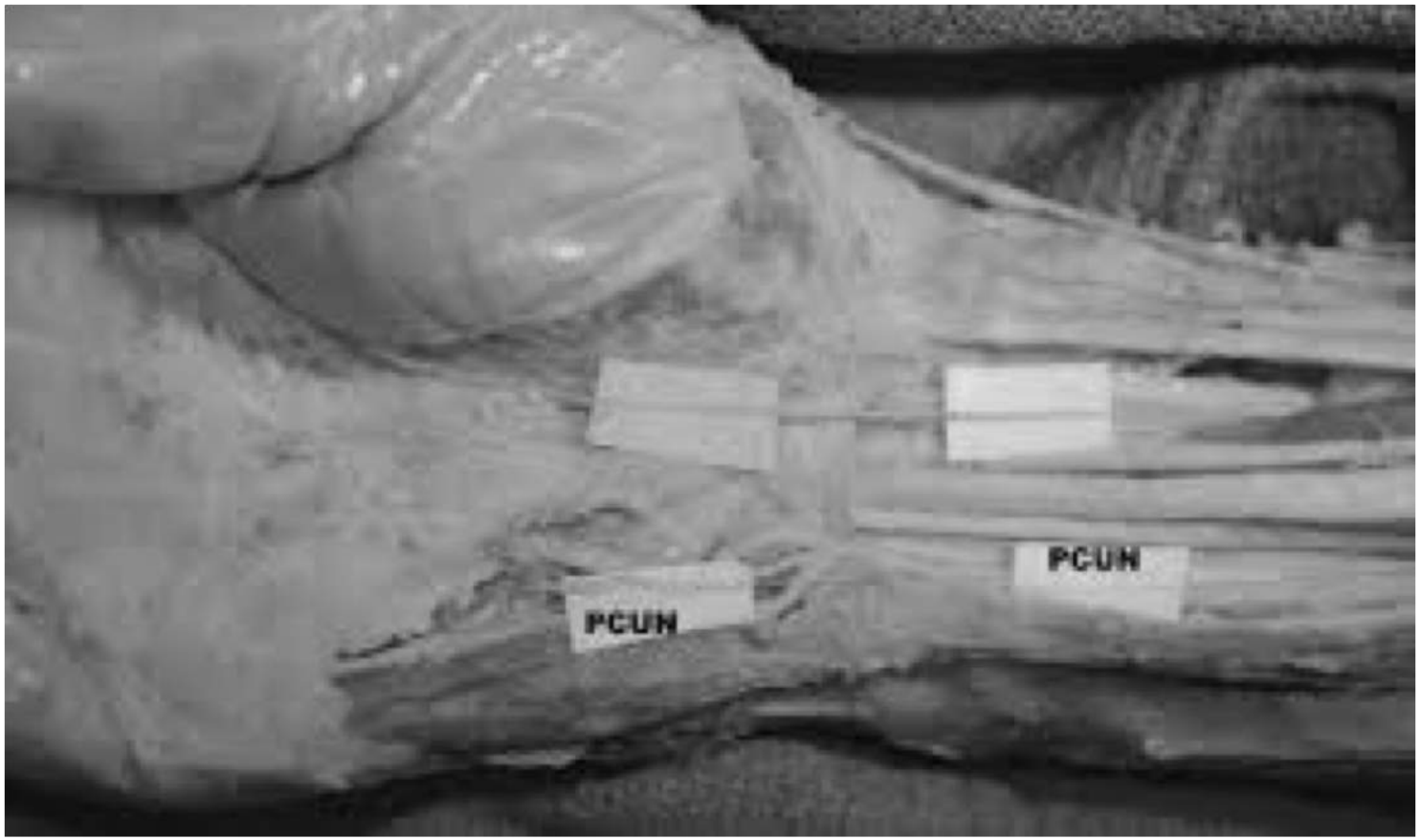
https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0486.jpg

Ulnar nerve branches in forearm

- Motor
  - Flexor carpi Ulnaris (occurs beneath the HUA)
    - (C(7),8,T1)
  - Flexor digitorum profundus
    - 4^{th} and 5^{th} digits
    - (C8, T1)
- Sensory
  - Dorsal branch (DUC) exits ulnar nerve proper approx 10 cm proximal to wrist supplying dorsal medial hand
  - Palmar ulnar cutaneous (PUC) branch separates from main branch in mid/distal forearm
    - Passes into hand superficial to Guyon's canal
    - Sensory to hypothenar skin

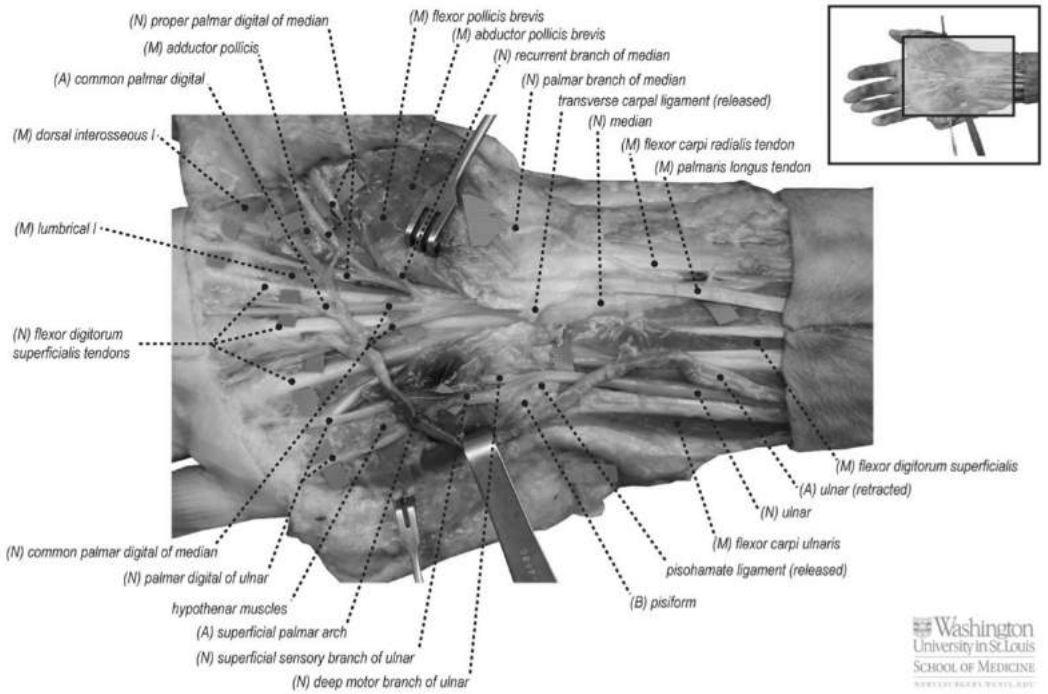
Dorsal ulnar cutaneous branch in forearm

Palmar ulnar cutaneous branch in forearm

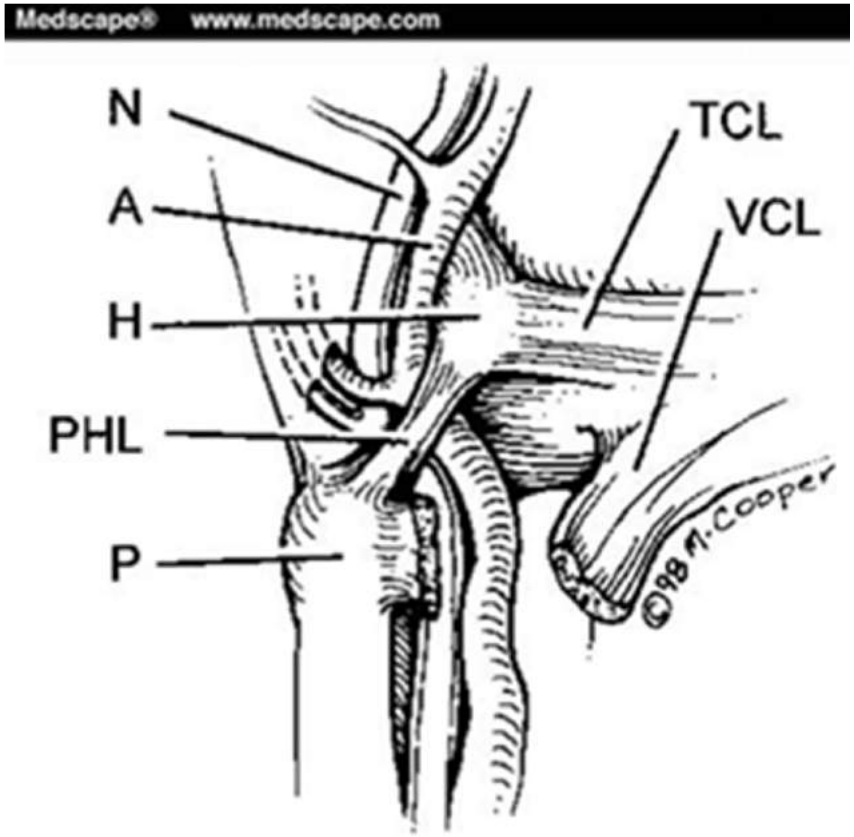


Course in the hand

- Ulnar nerve proper enters hand through Guyon's canal
- Transverse Carpal ligament forms the roof of the carpal tunnel and the floor of Guyon's canal



https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Median-Nerve---IMG_3272.jpg



- Volar carpal ligament, and pisohamate ligament form the roof of Guyon's Canal
  - ***5th site of potential entrapment***

Ulnar nerve at hand divides into two branches

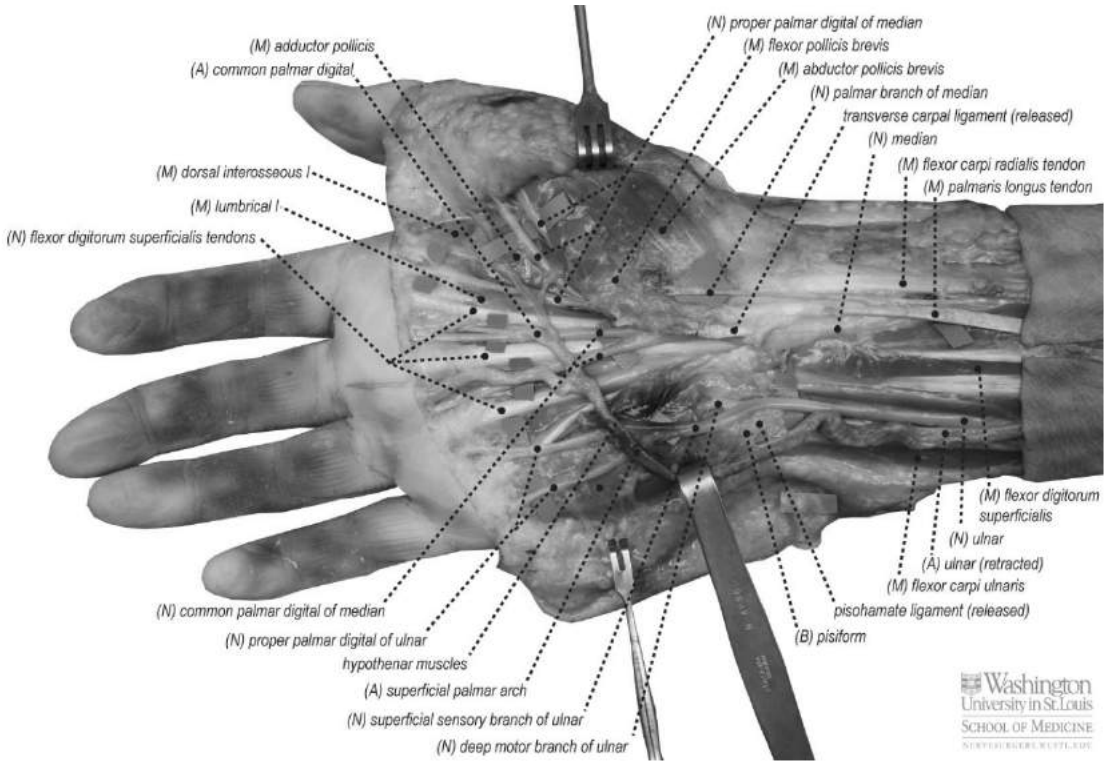
Superficial branch

- Sensation to small finger and medial half of ring finger

Deep branch

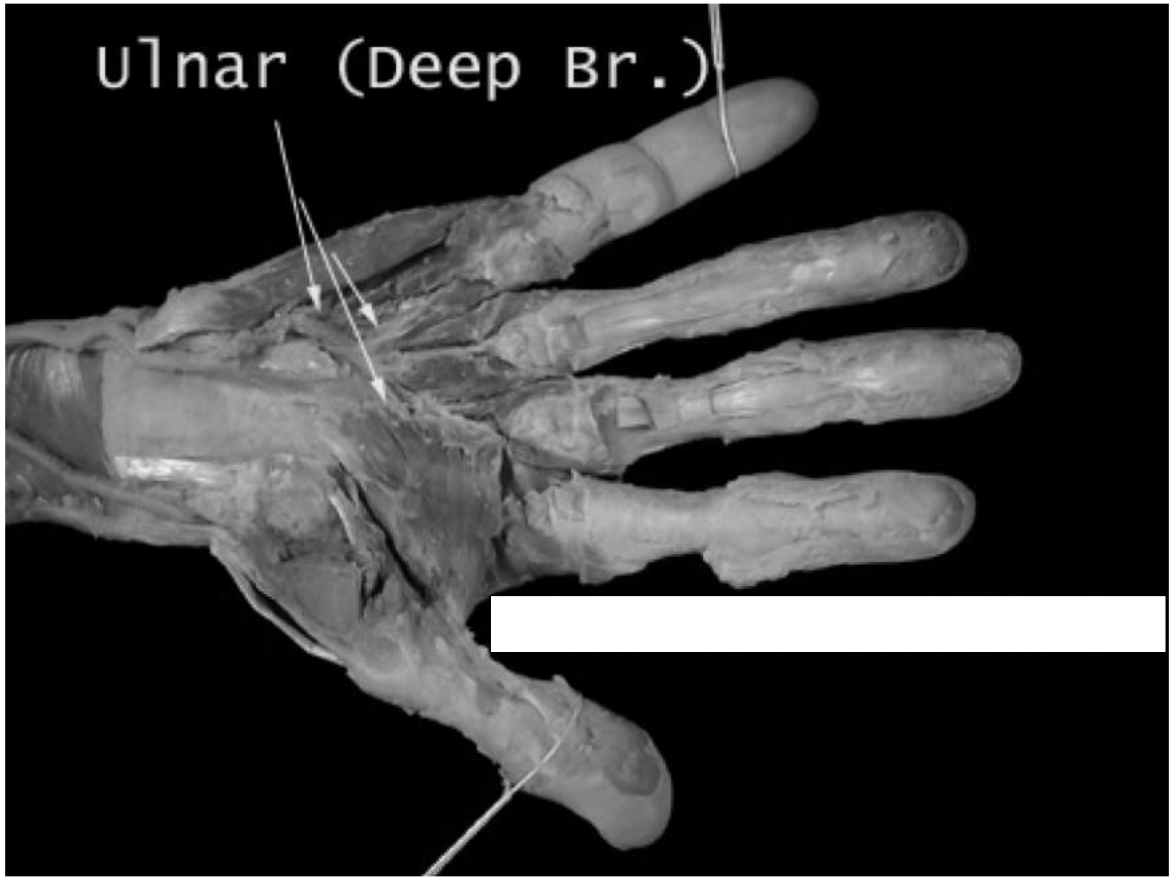
- Motor supply to:
  - Hypothenar (ADM, FDM, ODM)
  - Lumbricals 3 and 4
  - Palmar/dorsal interossei
  - Adductor pollicis
  - Deep head FPB

Superficial Branch



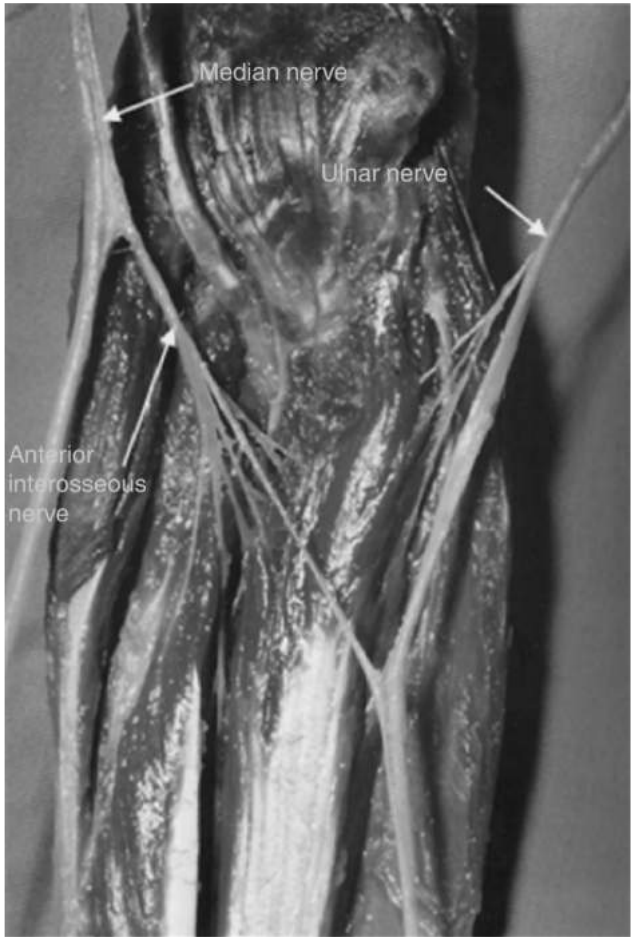
https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Median-Nerve---IMG_3299.jpg

Deep branch



Anatomic Variations- common for ulnar and median nerve

- Ulnar nerve at forearm communicates with median
  - Median fibers in forearm cross and travel with ulnar nerve usually 3-10 cm distal to medial epicondyle(Uchida)
  - Median/AIN fibers can supply “ulnar” intrinsics so that ulnar nerve compression at elbow can spare intrinsics (Uchida, Cavalheiro)
- Martin Gruber anastomosis –as 15-30% prevalence (Liebovic)



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4812040/bin/gr3.jpg

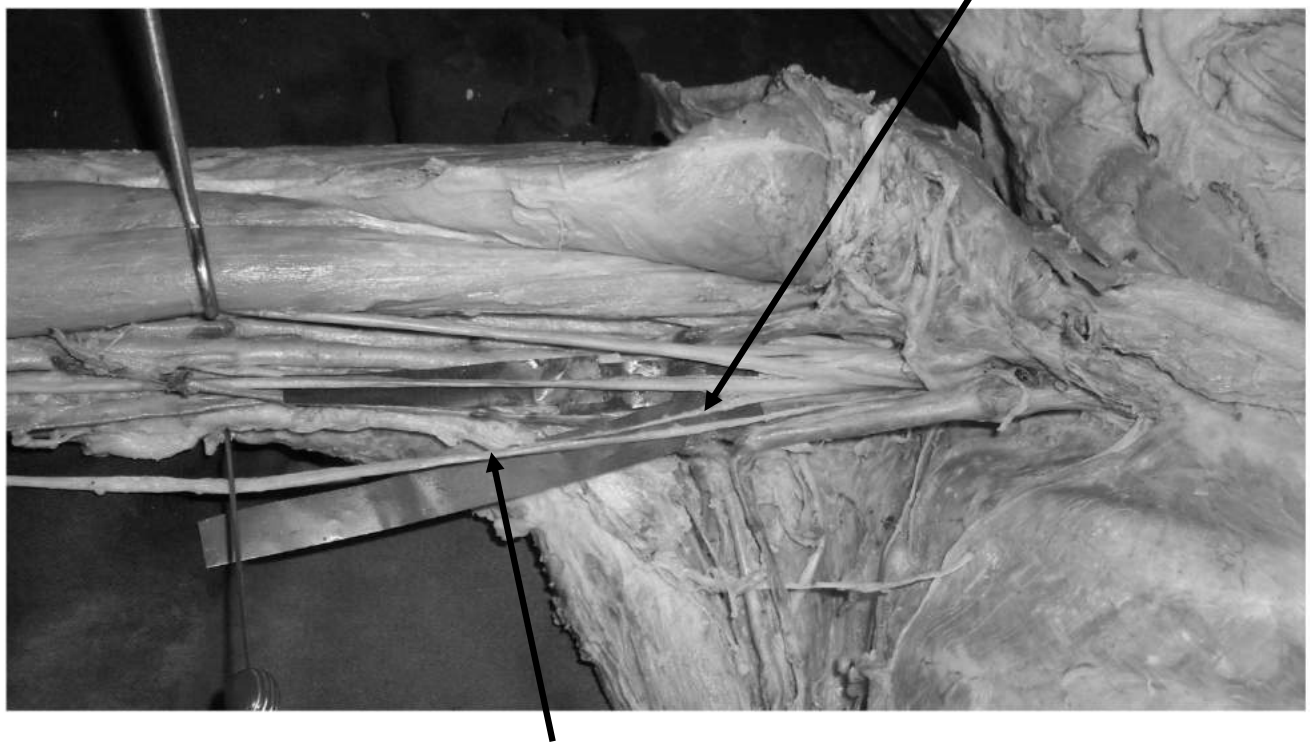
Anatomic variations

- Ulnar nerve formation from medial and lateral cords
  - Identified in 2/50 dissections

Anitha Guru, et al., "Anatomical Study of the Ulnar Nerve Variations at High Humeral Level and Their Possible Clinical and Diagnostic Implications," Anatomy Research International, vol. 2015, Article ID 378063, 4 pages, 2015. doi:10.1155/2015/378063

Anatomic variations

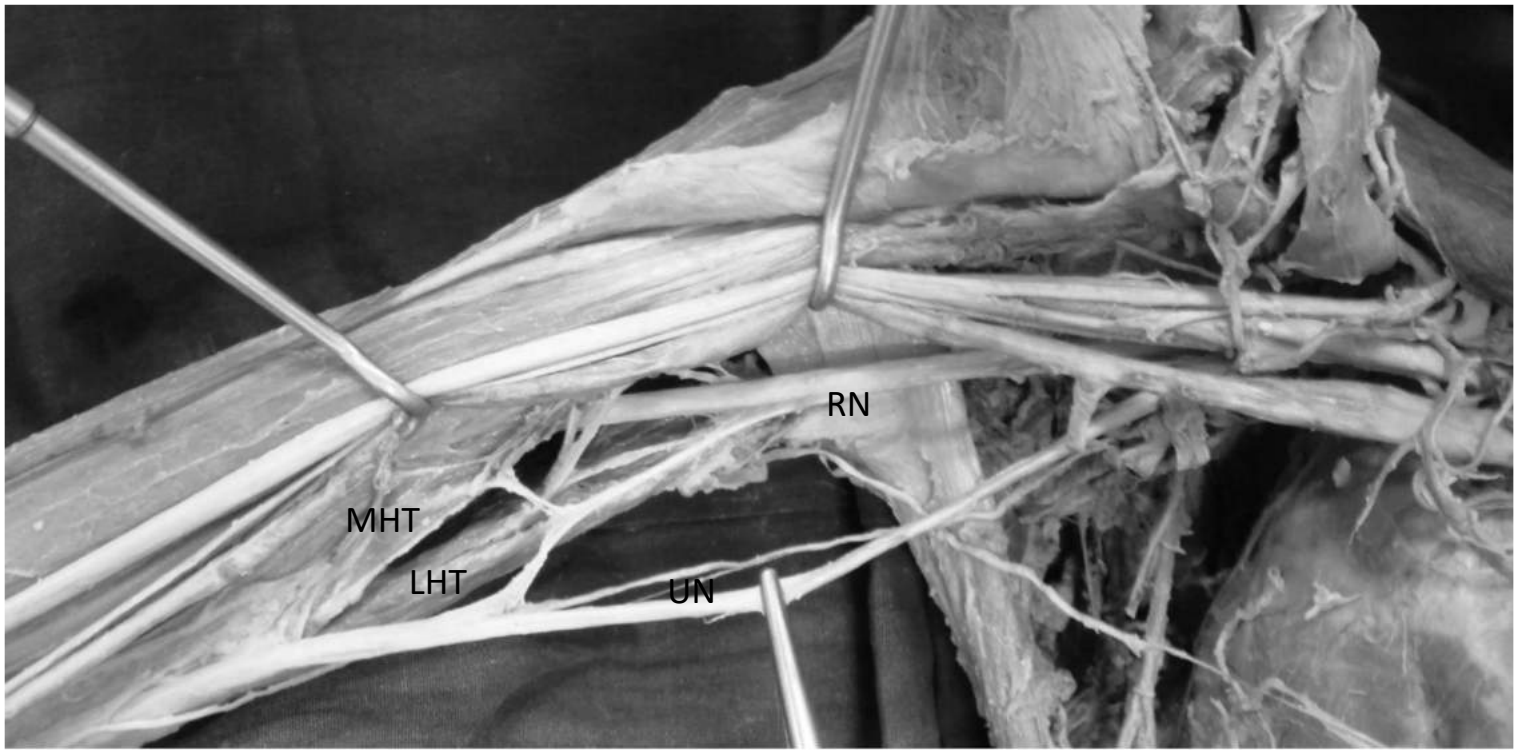
- Medial cutaneous nerve of forearm to ulnar communication reported by Anitha et al 2015



Anitha Guru, et al., "Anatomical Study of the Ulnar Nerve Variations at High Humeral Level and Their Possible Clinical and Diagnostic Implications," Anatomy Research International, vol. 2015, Article ID 378063, 4 pages, 2015. doi:10.1155/2015/378063

Anatomic Variations

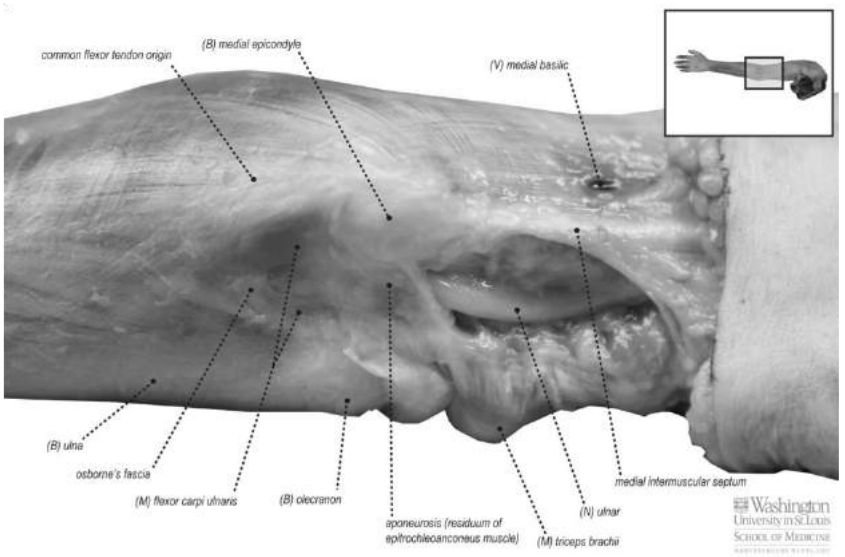
- Radial nerve to ulnar nerve communication



Anitha Guru, et al., "Anatomical Study of the Ulnar Nerve Variations at High Humeral Level and Their Possible Clinical and Diagnostic Implications," Anatomy Research International, vol. 2015, Article ID 378063, 4 pages, 2015. doi:10.1155/2015/378063

Ulnar neuropathy at the elbow (UNE)

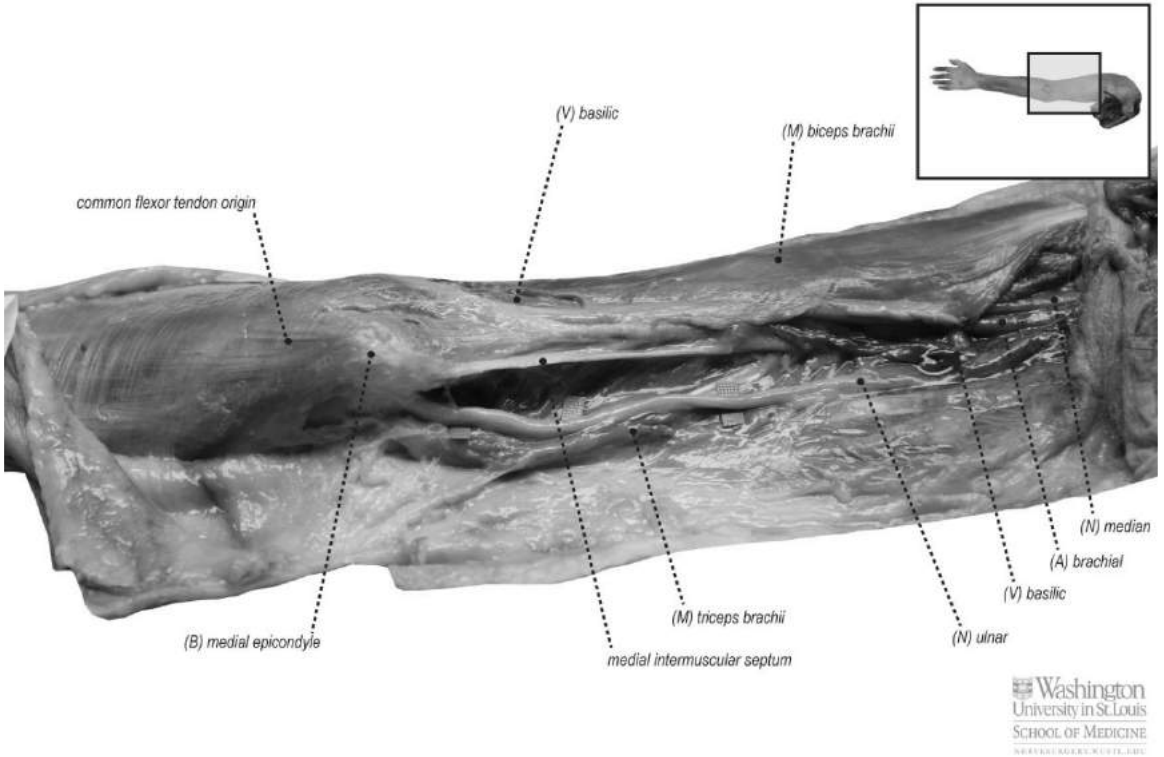
- Anatomic factors
  - May have presence of anconeus epitrochlearis muscle
    - Variable presence (up to 30%)
    - Originates posterior medial epicondyle covers ulnar nerve and attaches at olecranon
    - Ulnar innervated
    - Osbornes Band/lig is vestigial form prevalence is up to 77%
  - Lack of protective covering at elbow – so more susceptible to pressure
    - Lack of Osborne's band and anconeus epitrochlearis may lead to subluxation



https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0480.jpg

UNE

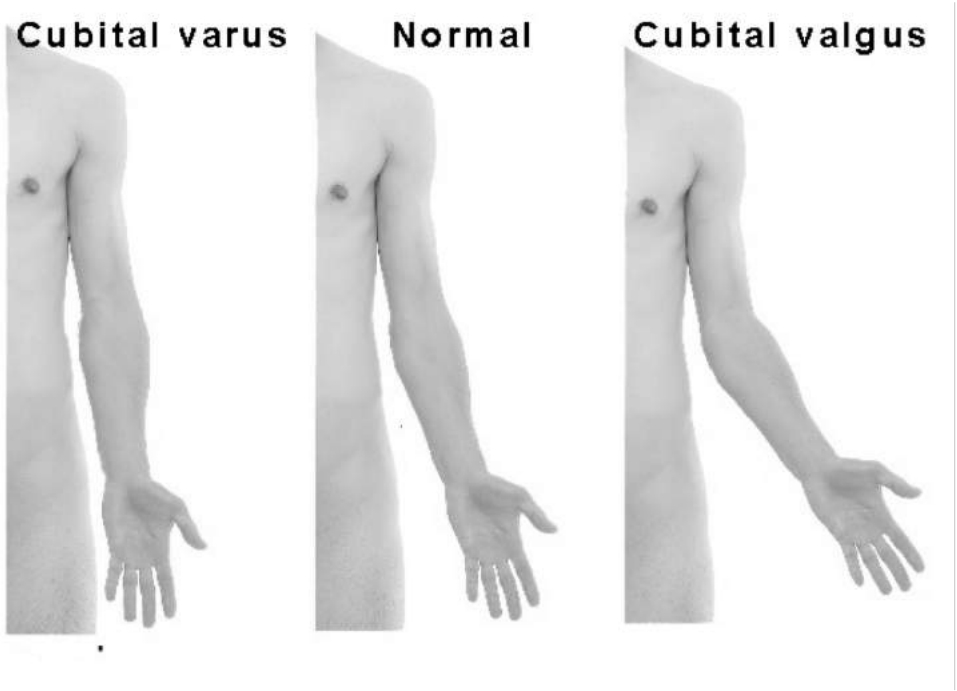
- May have compression due to enlarged or separate medial head of the triceps in the area proximal to the elbow



https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0569.jpg

UNE

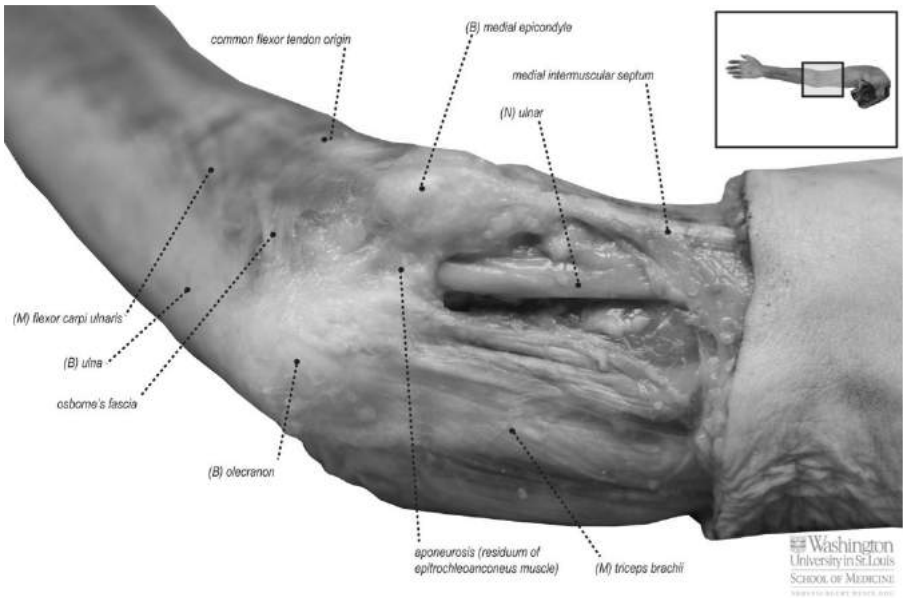
– Valgus deformity and internal derangement of the elbow related to trauma make nerve more vulnerable



https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=0ahUKEwjeoK7o6cvYAhXN61MKHagfCzEQjRwIBw&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FCubitus_valgus&psig=AOvVaw2kXWMgf6fY_N4Vlm7d8pkt&ust=1515619771990025

UNE- location

- Areas of compression:
  - Medial IMS
  - ***Retroepicondylar groove***
  - ***Humeroulnar arcade (HUA)***
  - Exit point from flexor carpi ulnaris
  - Guyon's canal



https://nervesurgery.wustl.edu/NerveImages/Anatomy%20and%20Physiology/AP-Ulnar-Nerve---IMG_0500.jpg

Internal architecture of ulnar nerve

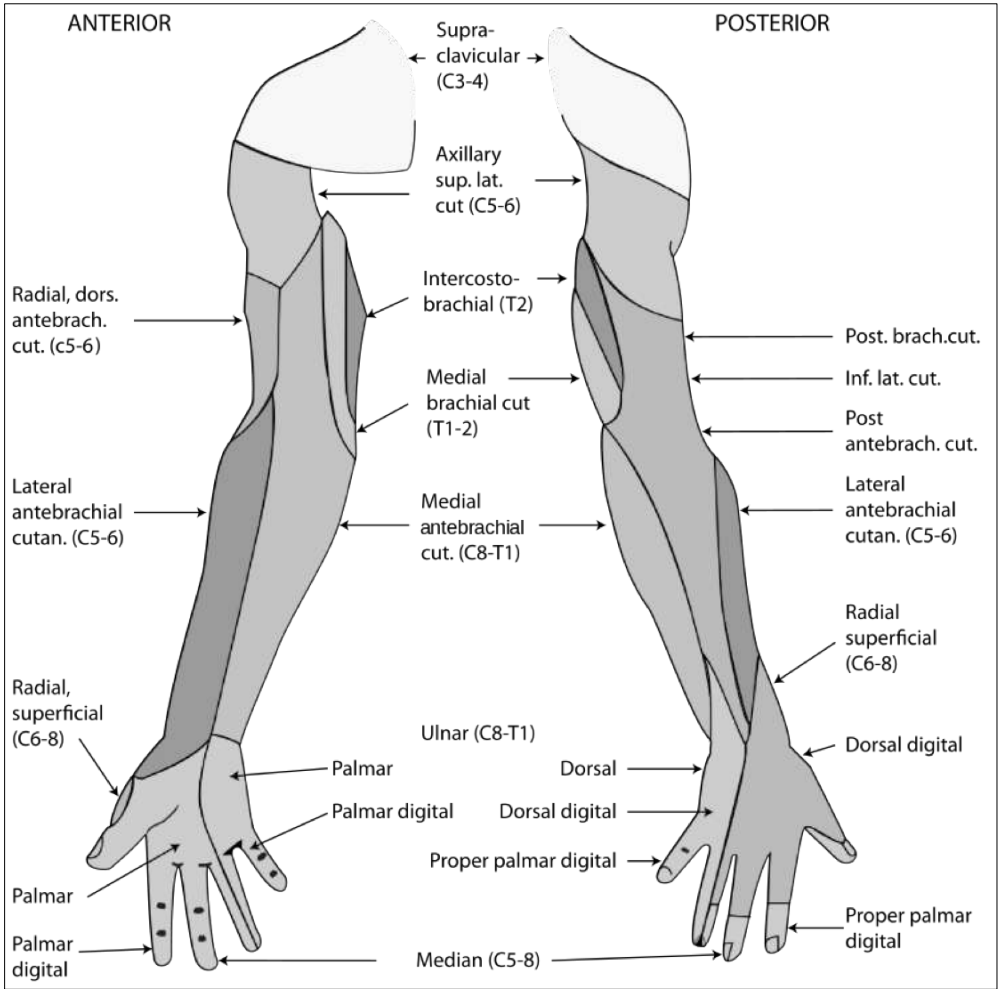
- Fascicular arrangement
  - Fibers going to FCU, PUC and DUC lie is separate fascicles at the elbow in a deep dorsolateral location therefore less likely to be involved in UNE
- This makes UNE hard to differentiate from ulnar neuropathy at the wrist (UNW) based on order of innervation

Clinical Features

- May have numbness and tingling in ulnar distribution intermittently worse in elbow flexion or at night
- Sensory complaints often not significant in contrast with CTS
- Often no complaints of pain
- Develop gradual motor loss over months to years (Vanderpool)
- Elbow pain is more likely to be present in focal trauma

Clinical features ulnar neuropathy-sensory complaints

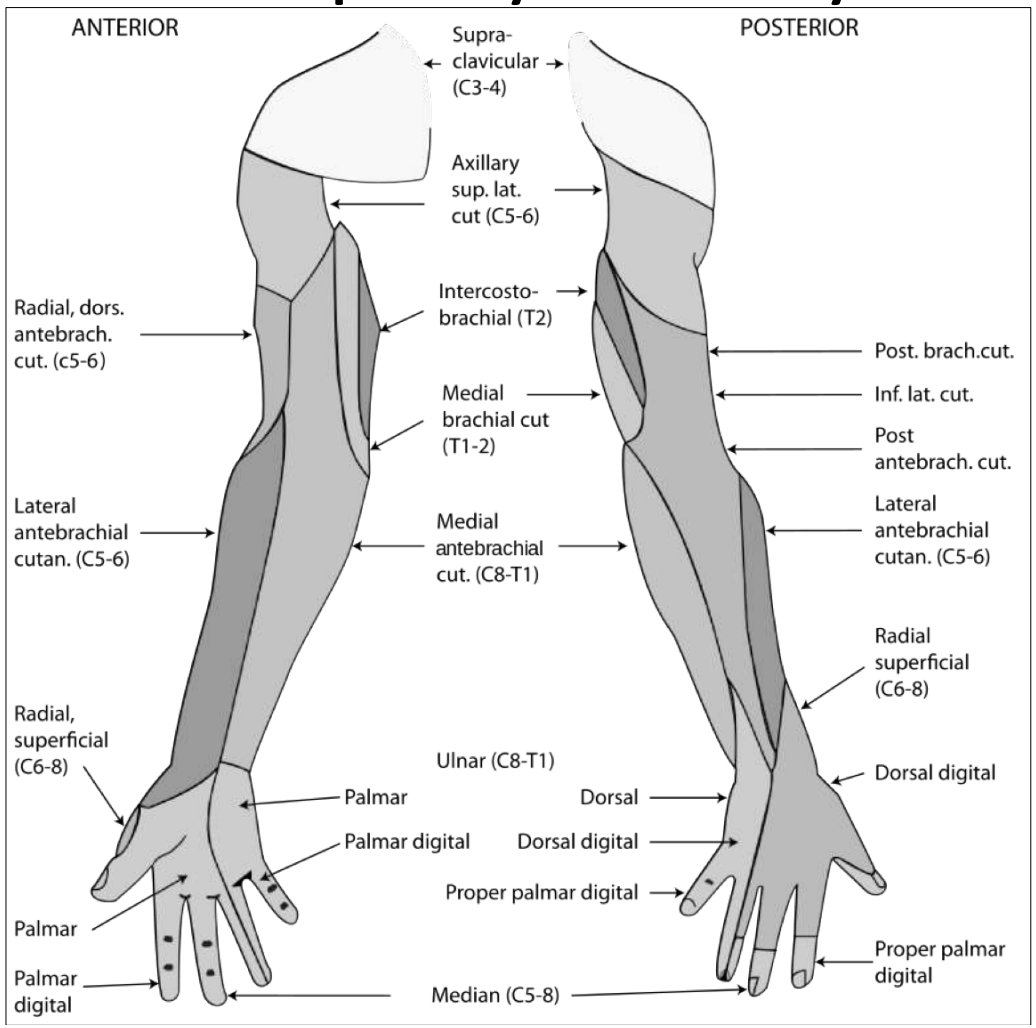
- Splitting sensation at ring finger typically indicates ulnar nerve injury
- Brachial plexopathy and C8 radiculopathy typically involve small finger and either all of the ring finger or spare the ring finger



https://en.wikipedia.org/wiki/File:Gray812and814.svg

Clinical Features Ulnar Neuropathy Sensory

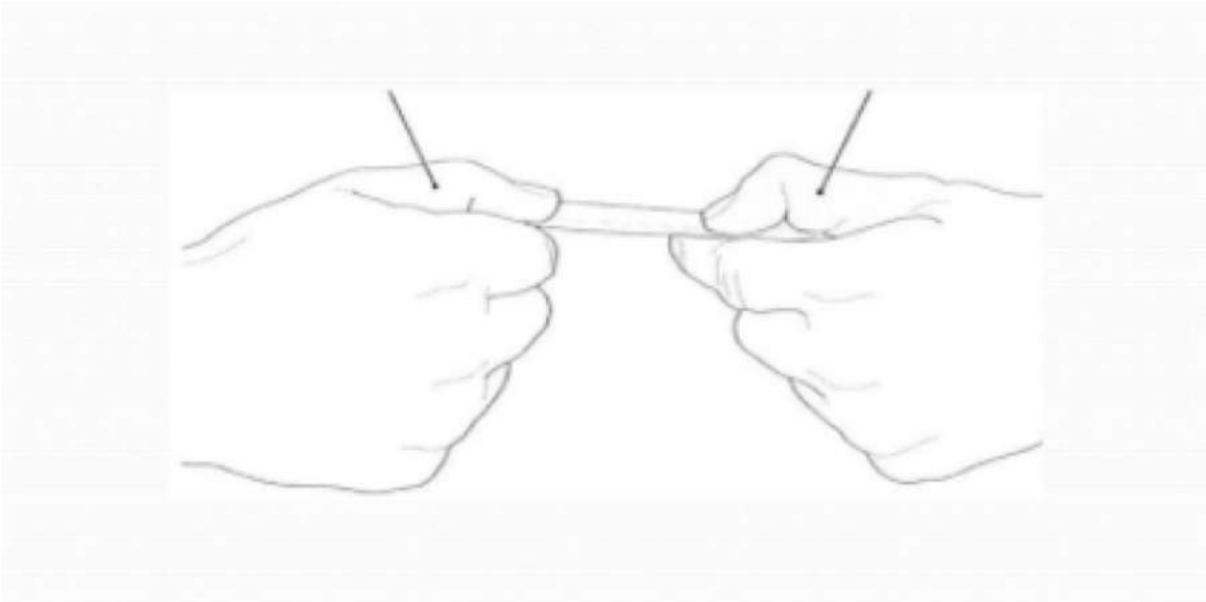
- Sensory complaints in forearm
  - Indicates proximal pathology ie. plexus or higher
- UNE
  - Mostly involve digits and spare DUC and PUC



https://en.wikipedia.org/wiki/File:Gray812and814.svg

Ulnar neuropathy motor features

- Froment sign
  - weakness of adductor pollicis and first dorsal interosseous



https://www.google.com/search?hl=en&biw=780&bih=362&tbm=isch&sa=1&ei=n5SPWvWXJcfusQXQorT4Bg&q=froment+sign&oq=Froment&gs_l=psy-ab.1.0.0l10.548524.549360.0.551366.7.6.0.1.1.0.79.400.6.6.0....0...1c.1.64.psy-ab..0.7.409...0i67k1.0.wCp1D84aUM8#imgrc=FJDUwSMUiuhorM:

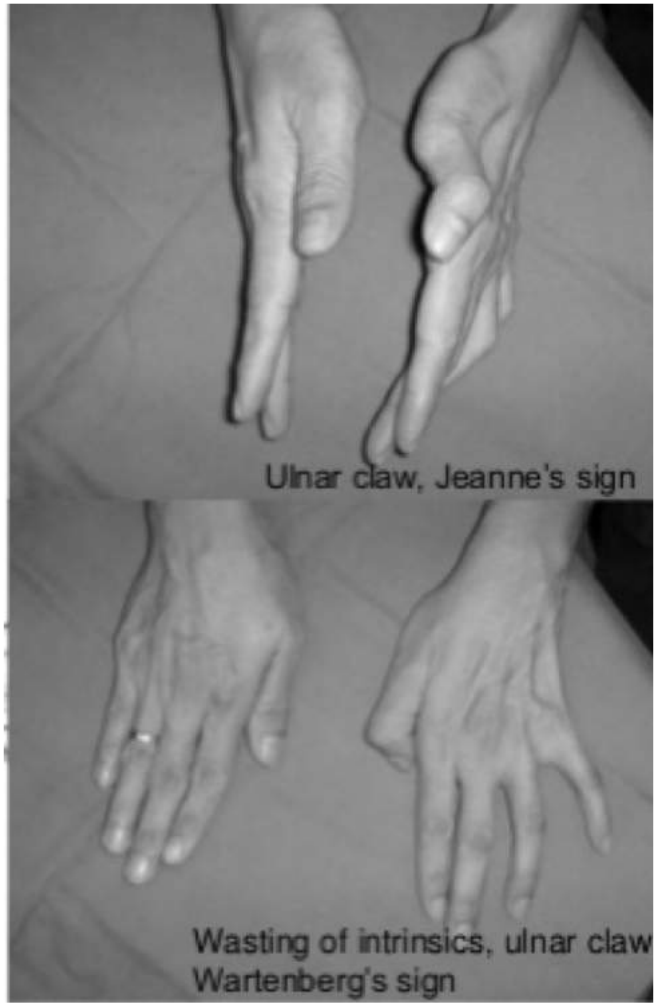
Clinical tests for Ulnar neuropathy

- Elbow flexion and Tinel's may produce false positives
  - Should flex at elbow and extend at wrists X 3 min(Buehler et al 1988)
- FCU and FDP are frequently spared in UNE
  - FCU branches don't typically arise proximal to the elbow, just spared due to position/fascicular arrangement at elbow (2, Campbell 1991)

https://i.ytimg.com/vi/VeQIS2dB3Zc/maxresdefault.jpg

Clinical tests for ulnar neuropathy

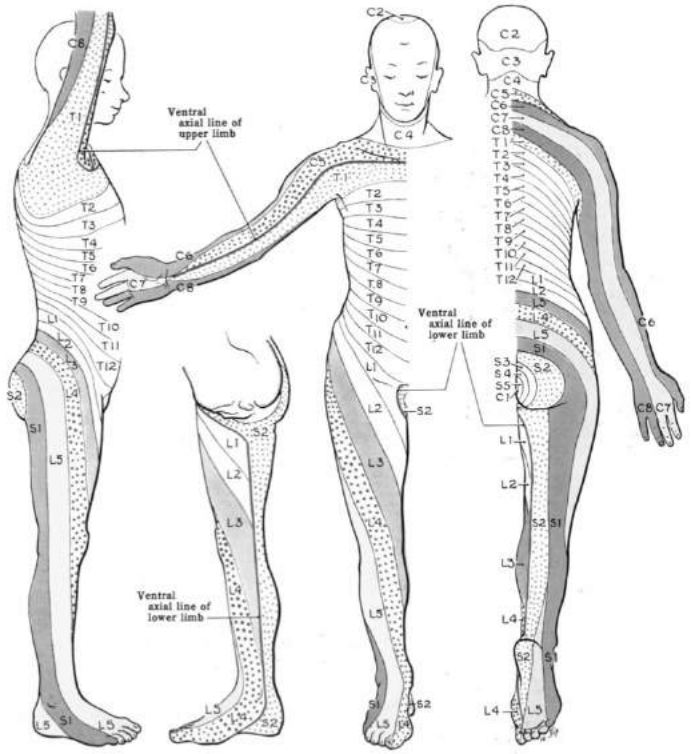
- Jeanne's Sign
  - Loss of AP and Deep head of FPB
- Pollock's Sign
  - Inability to flex 4th and 5th digits at DIP
- Wartenbergs sign
  - Weakness of 3rd palmar interosseous
  - Small finger remains abducted/unable to adduct



https://image.slidesharecdn.com/ph3approachtohandconditions5-160812132424/95/approach-to-hand-conditions-42-638.jpg?cb=1471008314

Clinical tests to evaluate ulnar nerve

- Need to screen for proximal pathology to include C8-T1 radiculopathy
  - Muscle test other C8-T1 muscles not ulnar innervated



https://upload.wikimedia.org/wikipedia/commons/thumb/9/93/Grant_1962_663.p
ng/1024px-Grant_1962_663.png

Ulnar neuropathy at the elbow risk factors

- Smoking was related to ulnar neuropathy at the elbow with an adjusted odds ratio of 4.31 (Frost et al 2013, Bartels 2007)
- Male gender
- Heavy work/manual labor
- Diabetes
- Hypothyroid
- CTS related to UNW
- Increased age

(Kiylioglu 2011, Bartels et al 2007, Bartels et al 1998)

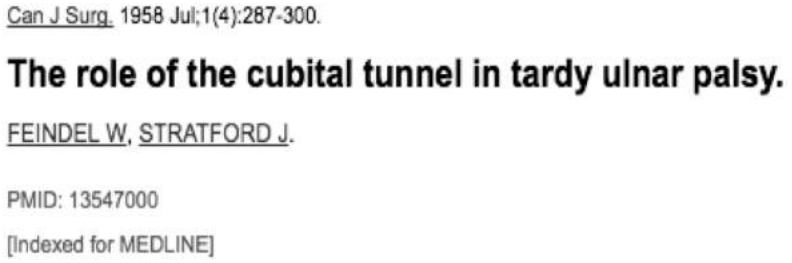
Break!!

Roadmap

- Intro
- Part 1
  - Anatomy review
  - Clinical features
  - Terminology
  - Etiology
- Part 2
  - AANEM Practice Parameter
  - The 2 x 4cm inching study
  - Fatal flaws
  - Cases
  - Suggested Approach

Terminology

- “Nosologic Quagmire”
- Tardy Ulnar Palsy
  - Panas, 1878
  - Degenerated into nonspecific term for any UNE
- HUA
  - 1916 Buzzard/Sargent
- Cubital Tunnel Syndrome
  - 1950’s Osbourne/Fiendel/Stratford
  - Also degenerated into non-specific term
  - Not original authors intent!
- Preferred term: UNE



Etiology

- 4 Locations
  1. MIS
  2. RTC groove
     - 85%/69%/62%
  3. HUA
     - 15%/23%/28%
  4. Exit from FCU

Clin Neurophysiol. 2015 Dec;126(12):2390-6. doi: 10.1016/j.clinph.2015.01.023. Epub 2015 Feb 14.

Precise localization of ulnar neuropathy at the elbow.

Omejec G[1], Podnar S[2].

Format: Abstract

Arch Phys Med Rehabil. 1988 Nov;69(11):959-63.

Ulnar nerve entrapment at the elbow localized by short segment stimulation.

Kanakamedala RV[1], Simons DG, Porter RW, Zucker RS.

Muscle Nerve. 1992 Sep;15(9):1050-4.

Short segment incremental studies in the evaluation of ulnar neuropathy at the elbow.

Campbell WW[1], Pridgeon RM, Sahni KS.

Electrophysiologic Evaluation

- Electrodiagnosis can play several roles in UNE:
  - Document presence of mononeuropathy
  - Localize the lesion
  - Distinguish from plexopathy, radiculopathy, poly or MND
  - Confirm lesion prior to surgery and document recovery

Format: Abstract

Muscle Nerve Suppl. 1999;8:S171-205.

Guidelines in electrodiagnostic medicine. Practice parameter for electrodiagnostic studies in ulnar neuropathy at the elbow.

American Association of Electrodiagnostic Medicine, Campbell WW.

1999

ELSEVIER

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

2015

Proposal for electrodiagnostic evaluation of patients with suspected ulnar neuropathy at the elbow

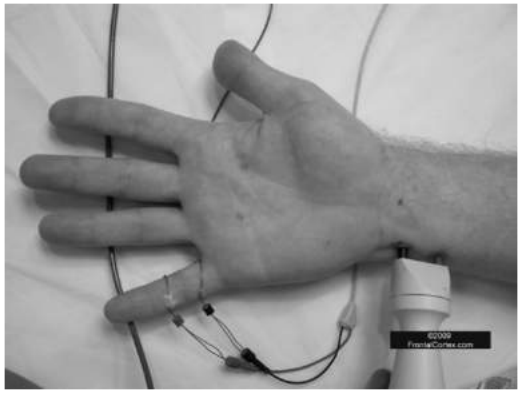
Gregor Omejec, Simon Podnar *

Institute of Clinical Neurophysiology, Division of Neurology, University Medical Center Ljubljana, Slovenia

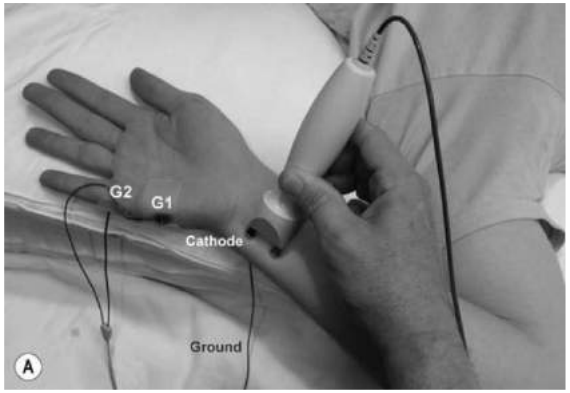
2x4cm technique

2015

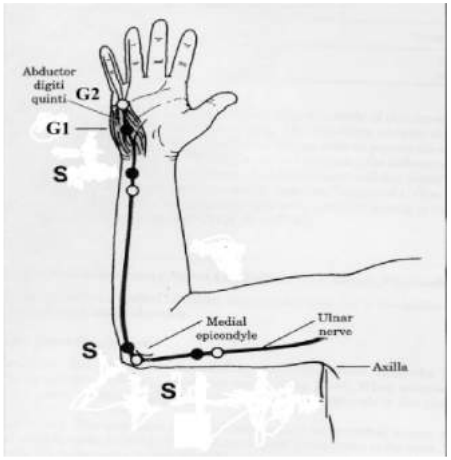
AANEM Practice Parameter

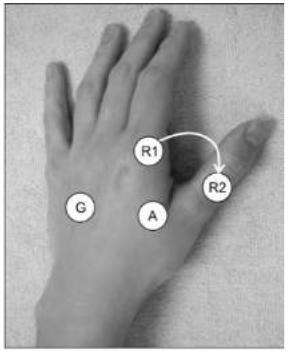


Sensory conduction to Digit V (std)

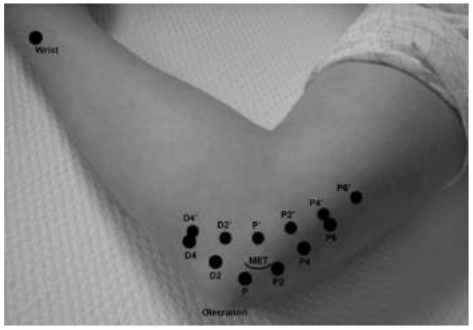


Motor conduction to ADM (std)





Motor conduction to FDI (alt)



Inching studies (alternative)

American Association of Electrodiagnostic Medicine, Campbell WW. Guidelines in electrodiagnostic medicine. Practice parameter for electrodiagnostic studies in ulnar neuropathy at the elbow. *Muscle Nerve Suppl*. 1999;8:S171-205.

Synopsis of AANEM Practice Parameter:

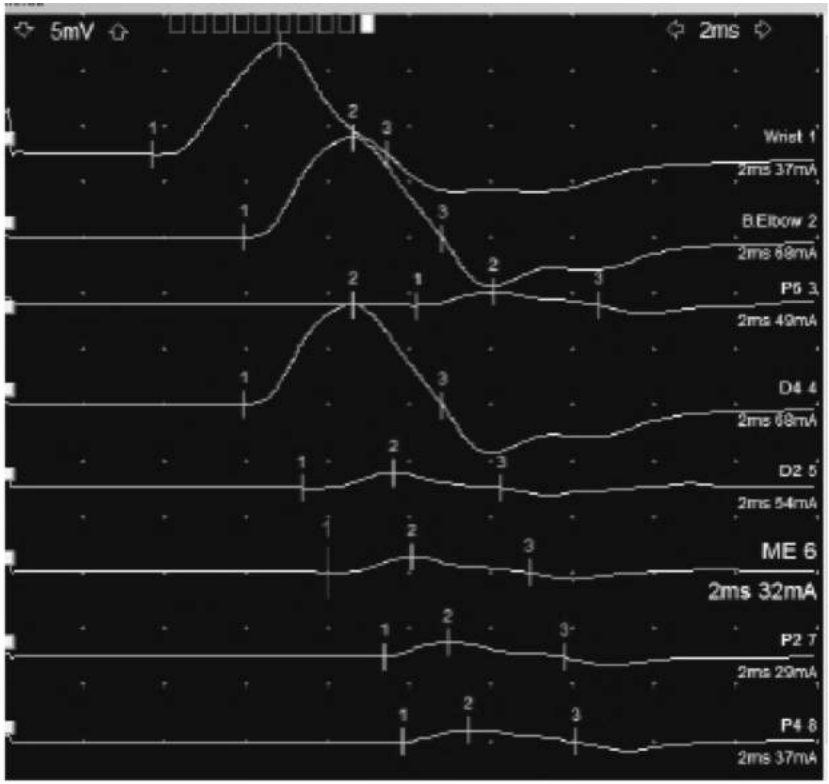
- When using moderate flexion (70-90 from horizontal, 10cm distance and surface stim and recording the following suggest a focal lesion at the elbow:
  - Absolute NCV from AE to BE of less than 50 m/s
  - AE to BE segment greater than 10 m/s slower than the BE to Wrist segment.
  - A CMAP drop from BE to AE greater than 20%
  - Significant change in CMAP configuration AE to BE
  - Multiple internally consistent abnormalities

AAEM Practice Parameter (options):

- If NCV to ADM is inconclusive, the following may be of benefit:
  - NCS recorded from FDI
  - Inching study (stay tuned!!)
  - With Severe Wallerian degeneration, BE to W may be slow, making localization difficult. Might compare Axilla to AE to AE/BE. Option.
  - NCS to forearm muscles not generally useful (option)
  - Needle Exam (if done): FDI, ulnar forearm muscles. If abnormal, must test other non ulnar C8/MC/lower trunk

Short segment studies (Inching)

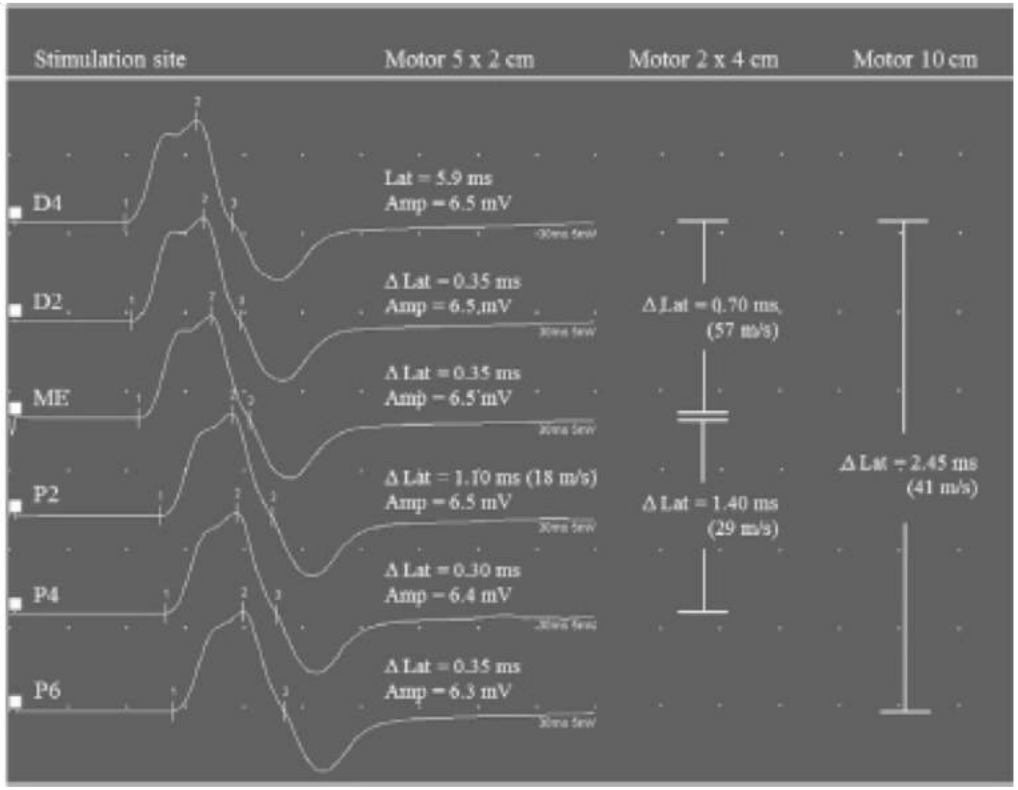
- Allows more precise localization
- With definitive CB, exact location often easy to find with movement and stim along the nerve looking for amp drop
- Can differentiate RTC from HUA



Omejec G, Podnar S. Proposal for electrodiagnostic evaluation of patients with suspected ulnar neuropathy at the elbow. *Clinical Neurophysiology*. 2016;127(4):1961-1967.

Ulnar Inching Study for UNE

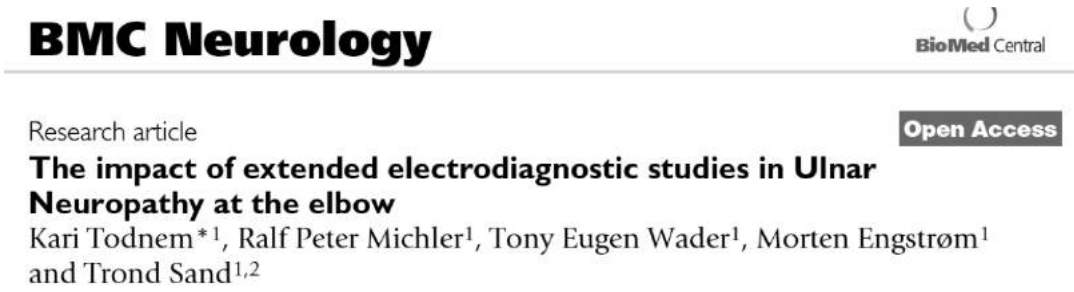
- Short segment studies across the elbow
- Inching studies
  - 5 x 2 cm
  - 2 x 4 cm
-



Omejec G, Podnar S. Proposal for electrodiagnostic evaluation of patients with suspected ulnar neuropathy at the elbow. *Clinical Neurophysiology*. 2016;127(4):1961-1967.

So what study to use?

- 10 cm still common practice but poor Sn
- 5 x 2 cm considered gold standard
- 2 x 4 cm study promising and easy to use



BMC Neurology

BioMed Central

Research article

Open Access

The impact of extended electrodiagnostic studies in Ulnar Neuropathy at the elbow

Kari Todnem*[1], Ralf Peter Michler[1], Tony Eugen Wader[1], Morten Engstrøm[1] and Trond Sand[1,2]

Inching studies

NORMATIVE VALUES FOR SHORT-SEGMENT NERVE CONDUCTION STUDIES AND ULTRASONOGRAPHY OF THE ULNAR NERVE AT THE ELBOW

GREGOR OMEJEC, PT, and SIMON PODNAR, MD, DSc
Institute of Clinical Neurophysiology, Division of Neurology, University Medical Center, SI-1525, Ljubljana, Slovenia
Accepted 24 June 2014

Clin Neurophysiol. 2015 Dec;126(12):2390-6. doi: 10.1016/j.clinph.2015.01.023. Epub 2015 Feb 14.

Precise localization of ulnar neuropathy at the elbow.

Omejec G[1], Podnar S[2].

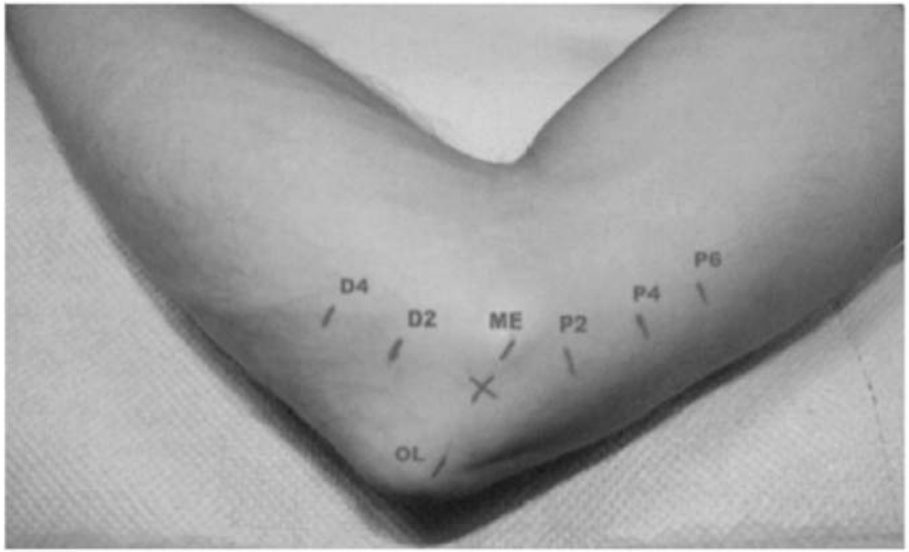
Clin Neurophysiol. 2016 Apr;127(4):1961-7. doi: 10.1016/j.clinph.2016.01.011. Epub 2016 Jan 28.

Proposal for electrodiagnostic evaluation of patients with suspected ulnar neuropathy at the elbow.

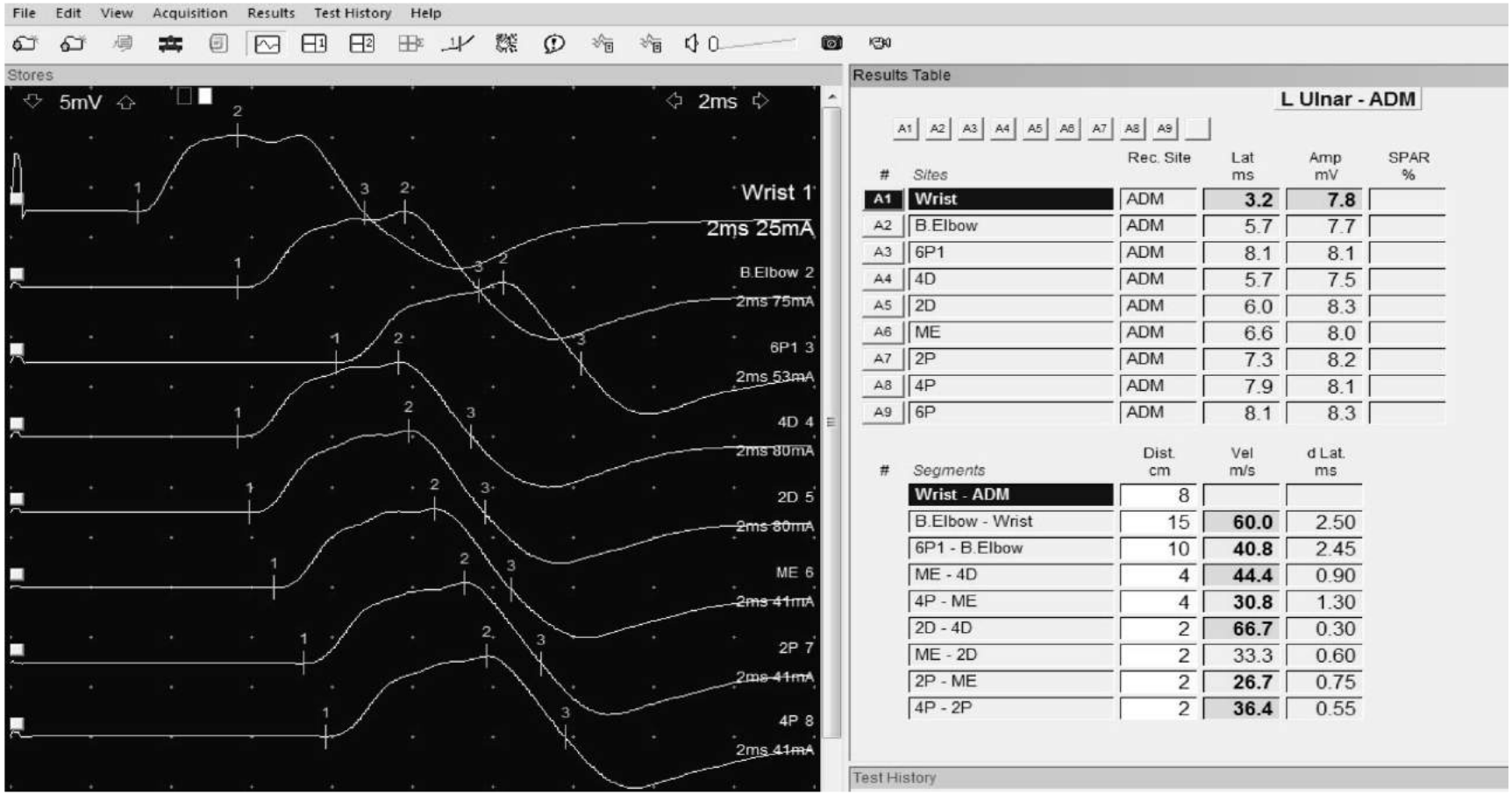
Omejec G[1], Podnar S[2].

5 x 2cm inching study

- Record from ADM or FDI
- Wrist stimulation at 8cm
- 6 stimulation points around elbow, 2 cm segments
  - D4 (4 cm distal to ME)
  - D2 (2 cm distal to ME)
  - @ ME
  - P2, P4 and P6 (proximal to ME)

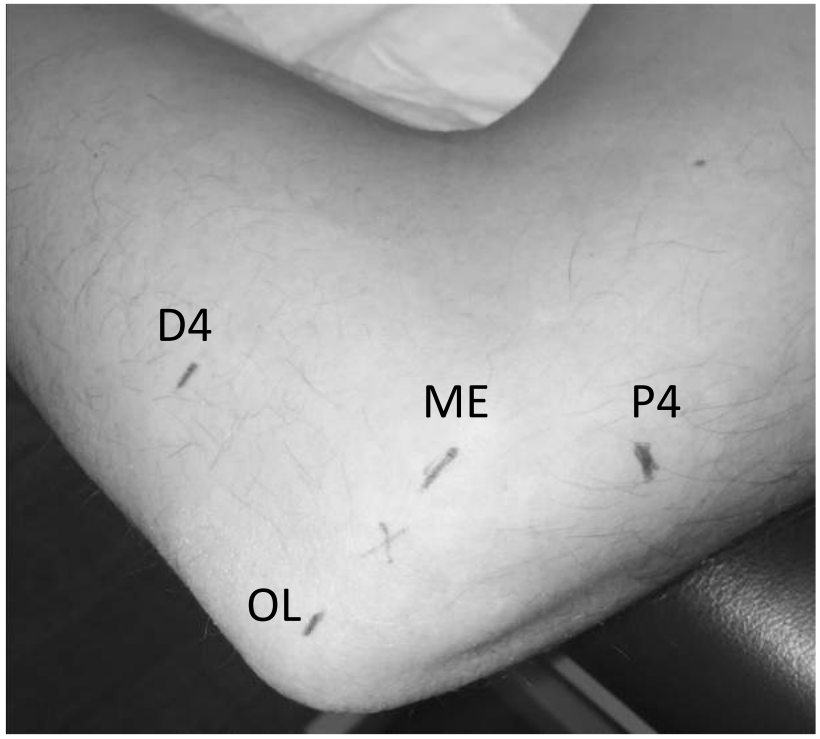


5 x 2cm study

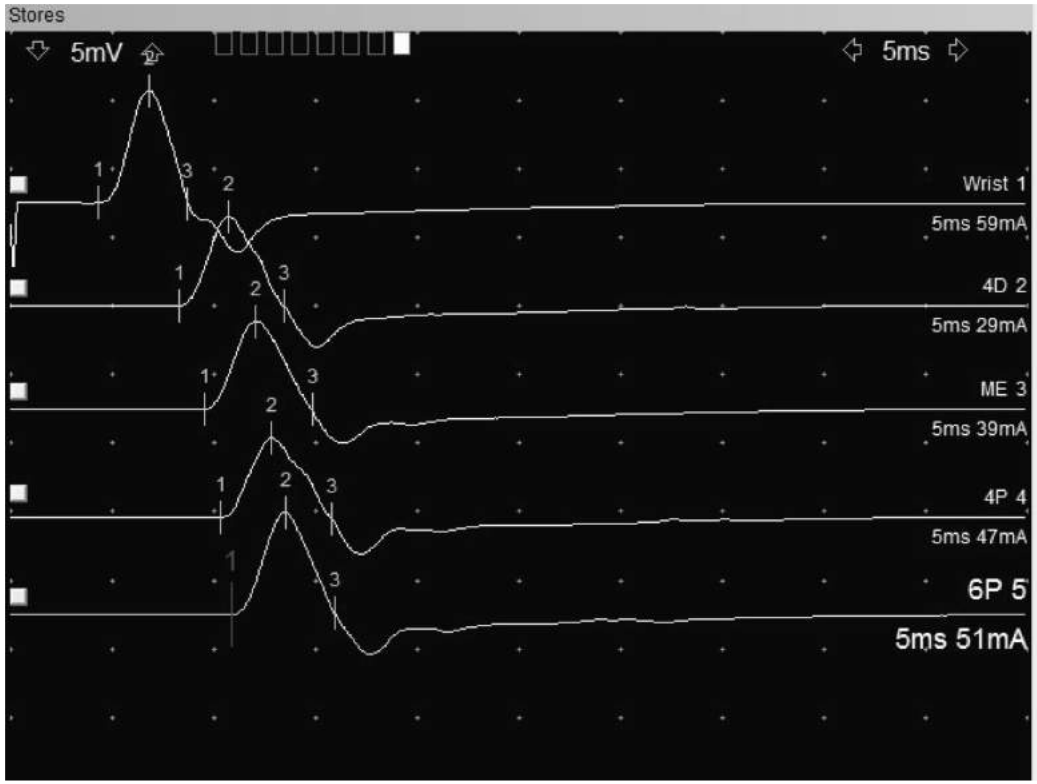

File Edit View Acquisition Results Test History Help
Stores
5mV
2ms
Wrist 1
2ms 25mA
B.Elbow 2
2ms 75mA
6P1 3
2ms 53mA
4D 4
2ms 80mA
2D 5
2ms 80mA
ME 6
2ms 41mA
2P 7
2ms 41mA
4P 8
2ms 41mA
Results Table
L Ulnar - ADM
A1 A2 A3 A4 A5 A6 A7 A8 A9
Sites Rec. Site Lat ms Amp mV SPAR %
A1 Wrist ADM 3.2 7.8
A2 B.Elbow ADM 5.7 7.7
A3 6P1 ADM 8.1 8.1
A4 4D ADM 5.7 7.5
A5 2D ADM 6.0 8.3
A6 ME ADM 6.6 8.0
A7 2P ADM 7.3 8.2
A8 4P ADM 7.9 8.1
A9 6P ADM 8.1 8.3
Segments Dist. cm Vel m/s d Lat. ms
Wrist - ADM 8
B.Elbow - Wrist 15 60.0 2.50
6P1 - B.Elbow 10 40.8 2.45
ME - 4D 4 44.4 0.90
4P - ME 4 30.8 1.30
2D - 4D 2 66.7 0.30
ME - 2D 2 33.3 0.60
2P - ME 2 26.7 0.75
4P - 2P 2 36.4 0.55
Test History

2 x 4cm

- Record from ADM or FDI
- Wrist stimulation at 8cm from ADM
- 3 stimulation points around elbow, 4 cm segments
  - D4 (4 cm distal to ME)
  - @ ME
  - P4 (4 cm proximal to ME)



2 x 4cm



Results Table

R Ulnar - FDI inching

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.3	8.2	
A2	4D	FDI	8.3	6.5	
A3	ME	FDI	9.5	6.4	
A4	4P	FDI	10.4	5.8	
A5	**6P**	FDI	10.9	7.5	
A6	Arm	FDI			
A7	2D	FDI			
A8	2P	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist			3.95
	ME - 4D	4	**32.0**	1.25
	4P - ME	4	**47.1**	0.85
	6P - 4D	10	**38.5**	2.60
	Arm - 6P	10		

Study Results (n=175)

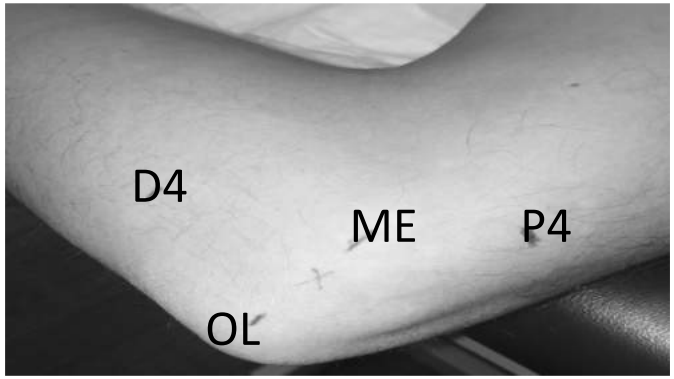
- 5 x 2cm
  - Sn: 93%
  - Localization: 92%
  - Same results on ADM and FDI
  - NCV norm: 31 m/s over 2cm
  - Amp drop >12%
- 2 x 4 cm
  - Sn: 89% ADM
  - Sn: 85% FDI
  - Localization: 83%
  - NCV norm: 33 m/s over 4 cm
  - Amp drop > 12%
- 10 cm
  - Sn: 82% ADM
  - Sn: 78% FDI
  - Localization: 0%
  - NCV norm: > 41 m/s over 10cm

Clin Neurophysiol. 2016 Apr;127(4):1961-7. doi: 10.1016/j.clinph.2016.01.011. Epub 2016 Jan 28.

Proposal for electrodiagnostic evaluation of patients with suspected ulnar neuropathy at the elbow.

Omejec G[1], Podnar S[2].

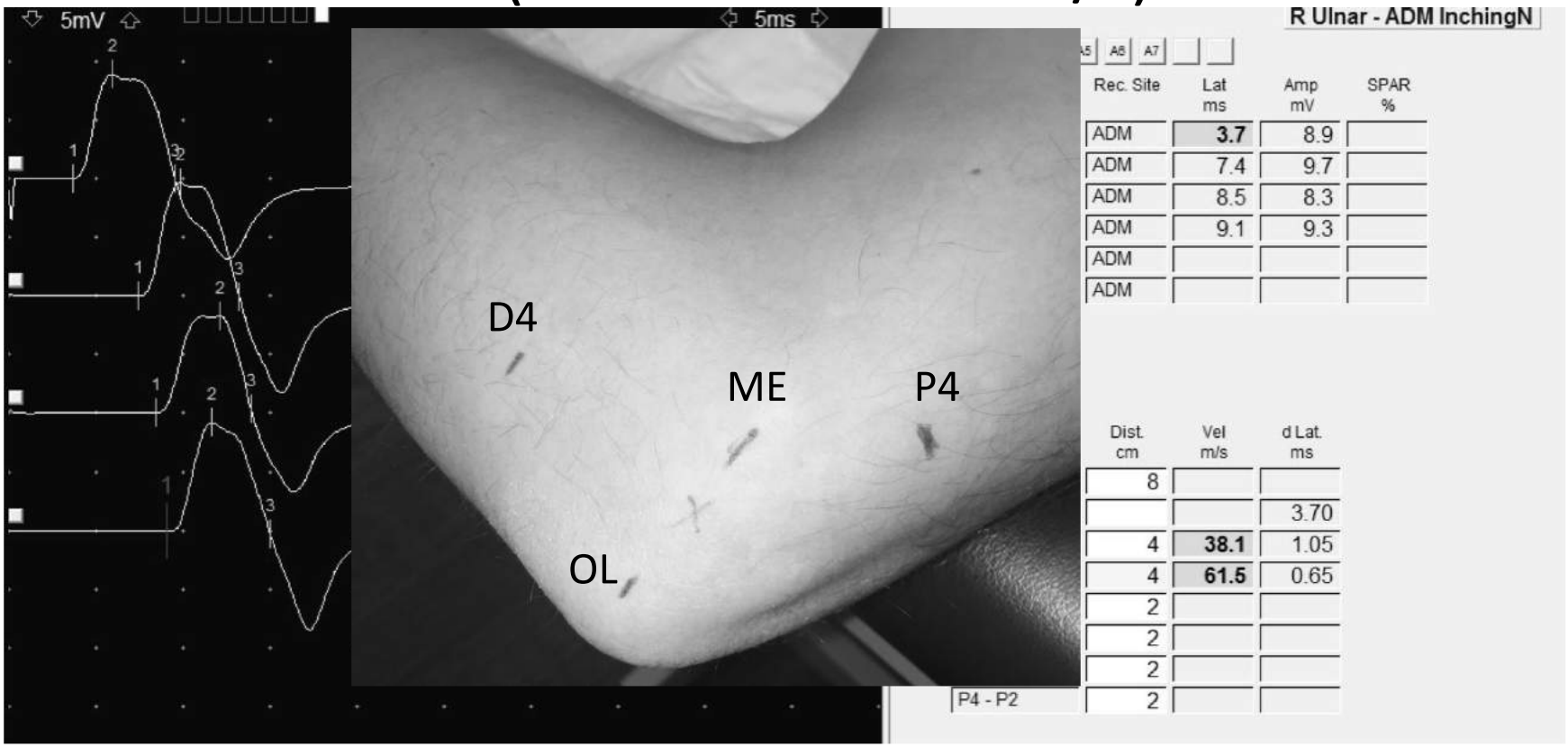
EDX Patient Approach for UNE



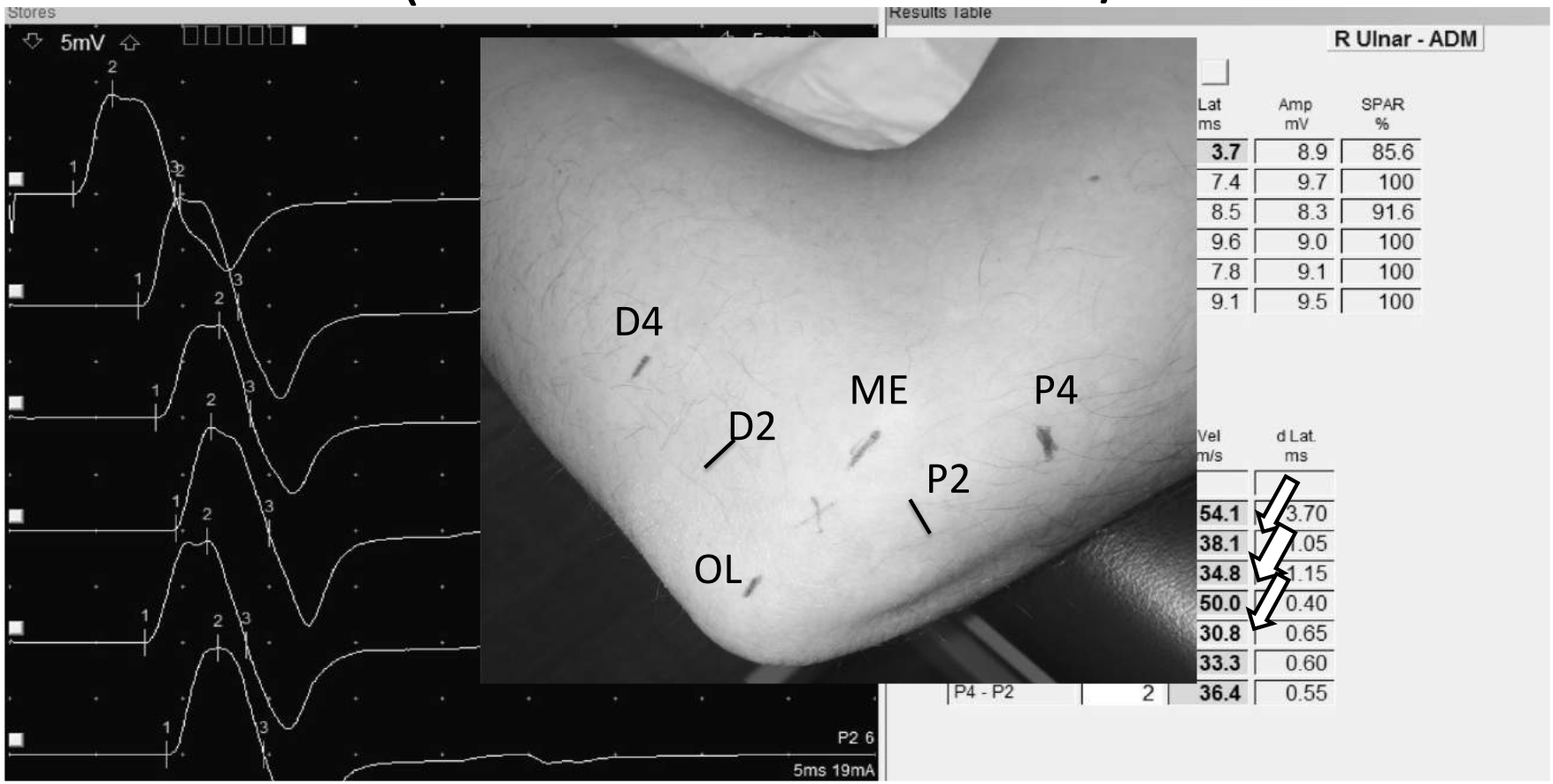
- Ulnar SNAP: Sn: 67% for low amp
- Motor studies:
  - Ulnar n. using FDI using 2x4cm technique
    - Expand if normal by adding a D2 and P2 stim point (hybrid 4 x 2cm)
    - Expand to ADM
- Needle EMG
  - FDI is most frequently involved
  - ADM
  - FCU commonly spared (or recovered)
  - Other C8/T1 muscles to rule out other diagnosis

”2x4cm Robust, sensitive and time efficient”
Omejic

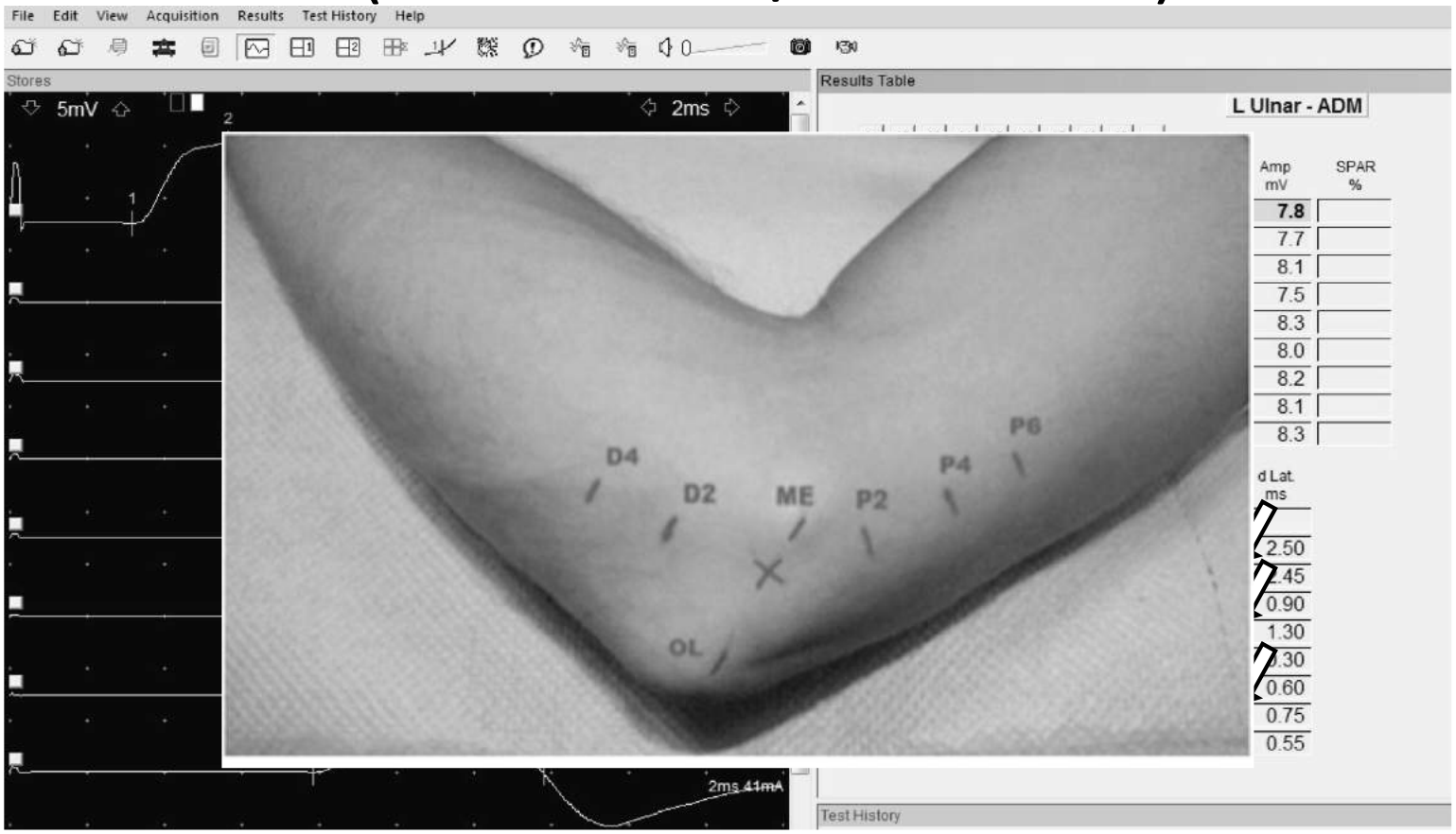
2 x 4cm Recommended
(4 cm norm:>33m/s)



2x4cm (hybrid with P2/D2)
(Norm over 2 cm: 31 m/s



5 x 2cm
(Norm: 31 m/s over 2cm)



Pitfalls for Ulnar Studies

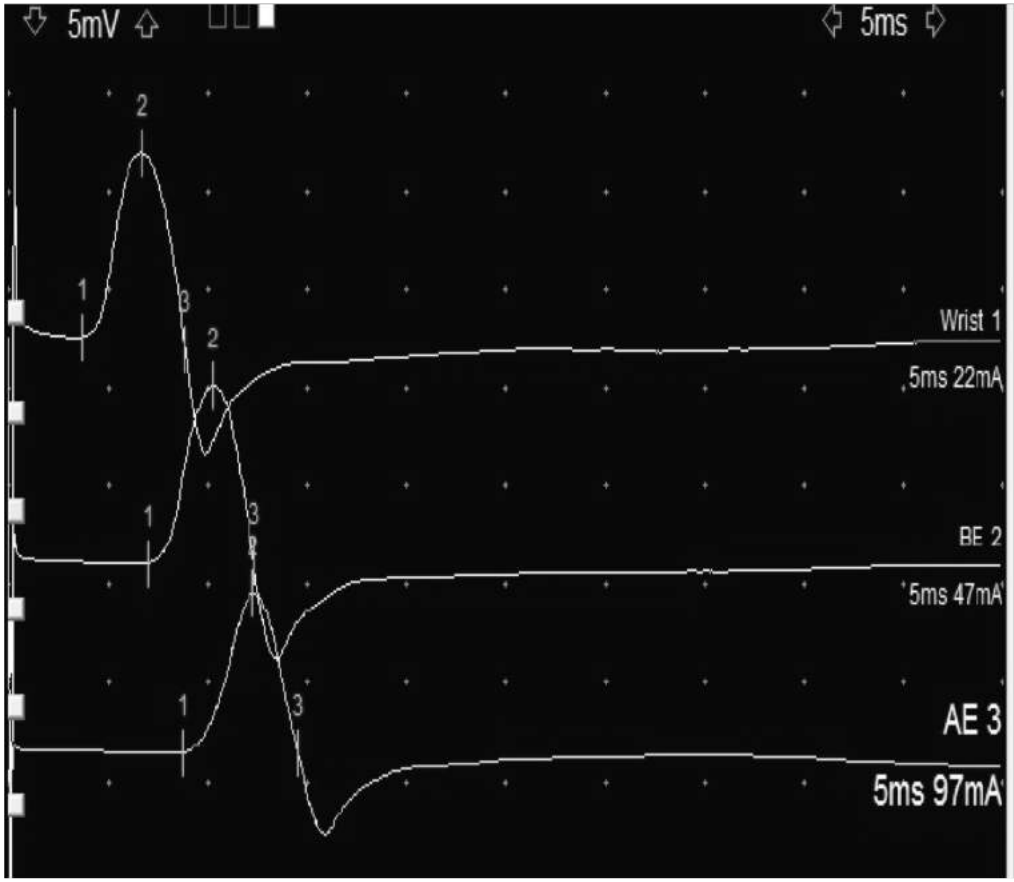
- Stimulation level (supra/sub max)
- Measurement errors
- Elbow position
- Recording muscle
- Length of segment
- BMI
- Temperature at elbow
- Axon loss ulnar neuropathy

Landau ME, Campbell WW. Clinical features and electrodiagnosis of ulnar neuropathies. *Phys Med Rehabil Clin N Am*. 2013;24(1):49-66.

Stimulation level

- Ensure Supramaximal stimulation
  - BE site is problematic due to depth of ulnar nerve. Turn it up!
- But don’t overstimulate proximal segments!
- Use submax stims to localize the nerve path
- AE stim point angles sharply toward biceps
- Inspect auto markers
  - Reset/restim any non physiologic velocities (>70 m/s)

Ulnar to FDI: AE overstimulated



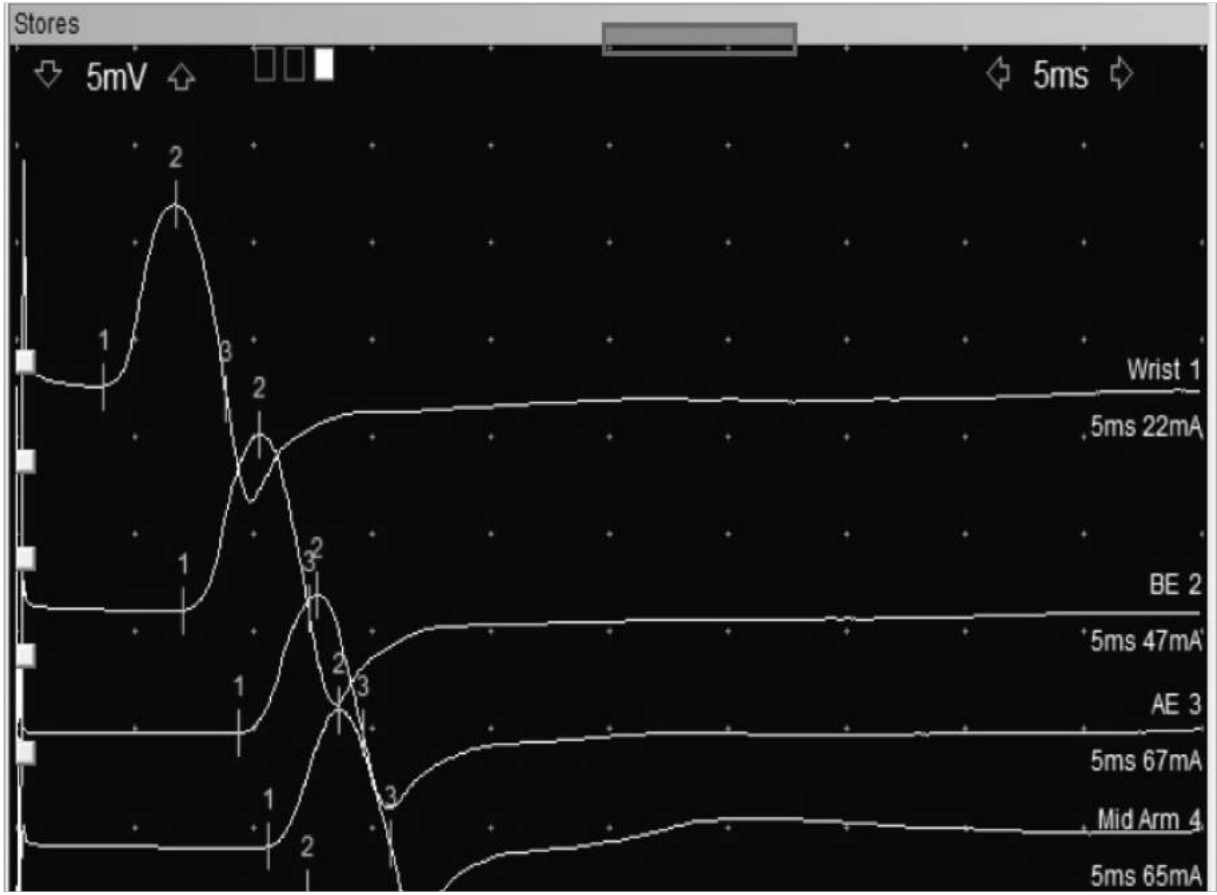
R Ulnar - FDI inching

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	3.7	9.3	
A2	BE	FDI	7.1	9.0	
A3	AE	FDI	8.8	8.2	
A4	Mid Arm	FDI	10.6	7.0	
A5	overstim at BE	FDI	8.8	8.2	
A6	2cm distal ME	FDI	9.4	7.1	
A7	@Med Epi	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	BE - Wrist	20	59.7	
	AE - BE	10	**58.8**	1.70
	Mid Arm - AE	8	43.2	1.85

Ulnar to FDI: no overstim AE



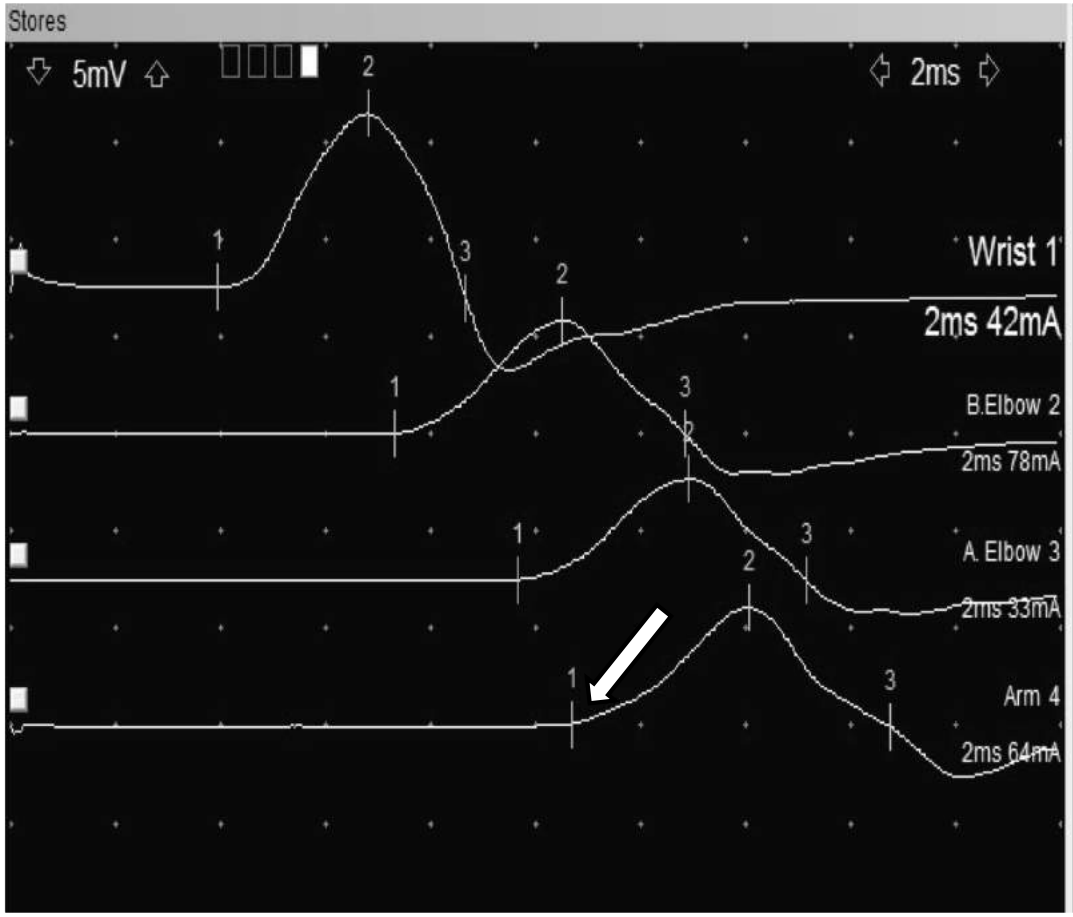
Results Table

R Ulnar - FDI

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV
A1	Wrist	FDI	3.7	9.3
A2	BE	FDI	7.1	9.0
A3	AE	FDI	9.4	7.1
A4	Mid Arm	FDI	10.6	7.0
A5	overstim at BE	FDI	8.8	8.2
A6	2cm distal ME	FDI		
A7	@Med Epi	FDI		

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	BE - Wrist	20	59.7	
	AE - BE	10	**42.6**	2.35
	Mid Arm - AE	8	66.7	1.20



Results Table

L Ulnar - FDI

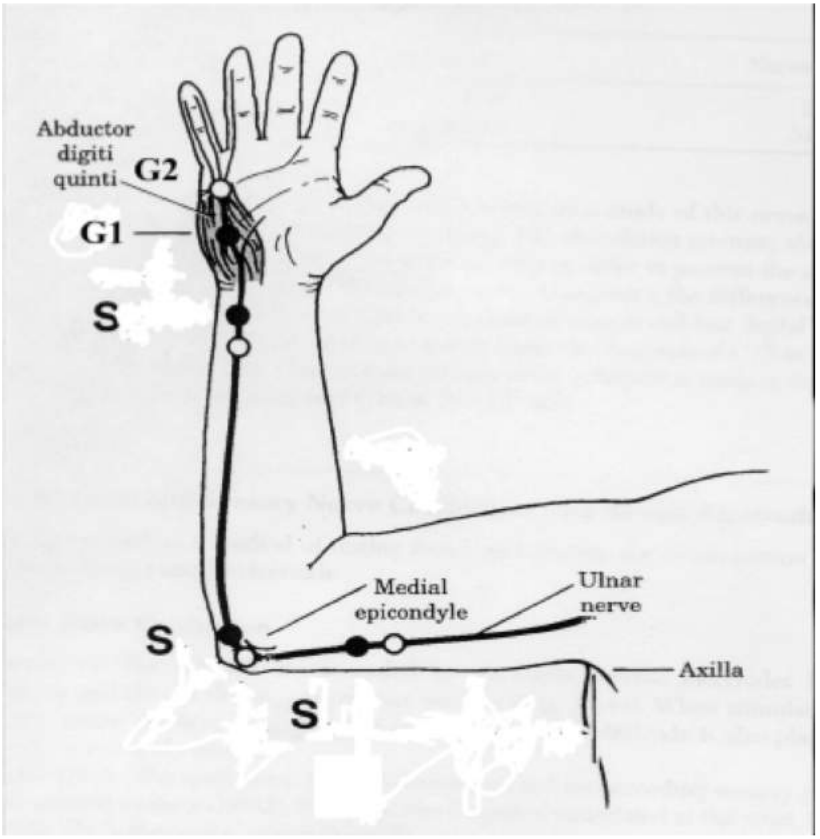
A1 A2 A3 A4 A5 A6 A7 A8 A9

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.0	8.9	
A2	B.Elbow	FDI	7.3	5.8	
A3	A. Elbow	FDI	9.7	5.1	
A4	Arm	FDI	10.7	6.0	
A5	arm	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	B.Elbow - Wrist	21	**62.7**	3.35
	A. Elbow - B.Elbow	10	**42.6**	1.35
	Arm - A. Elbow	8	76.2	1.05
	ME - arm			

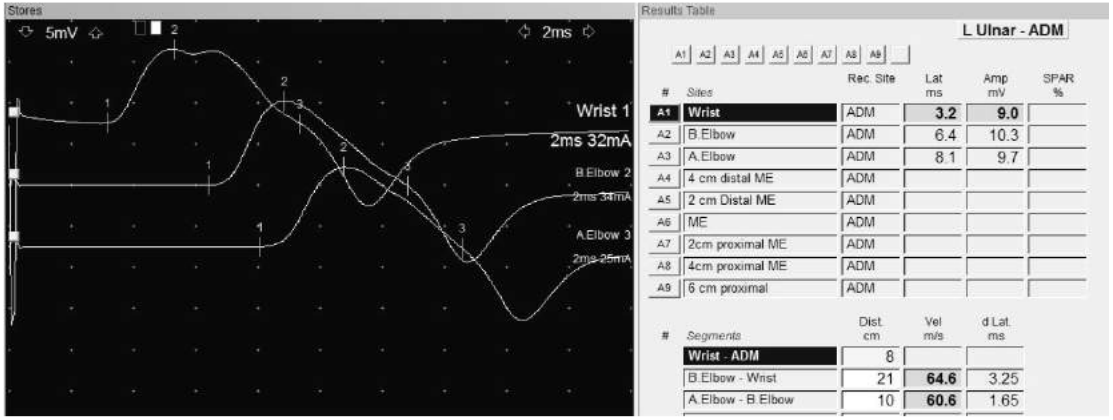
Elbow Position

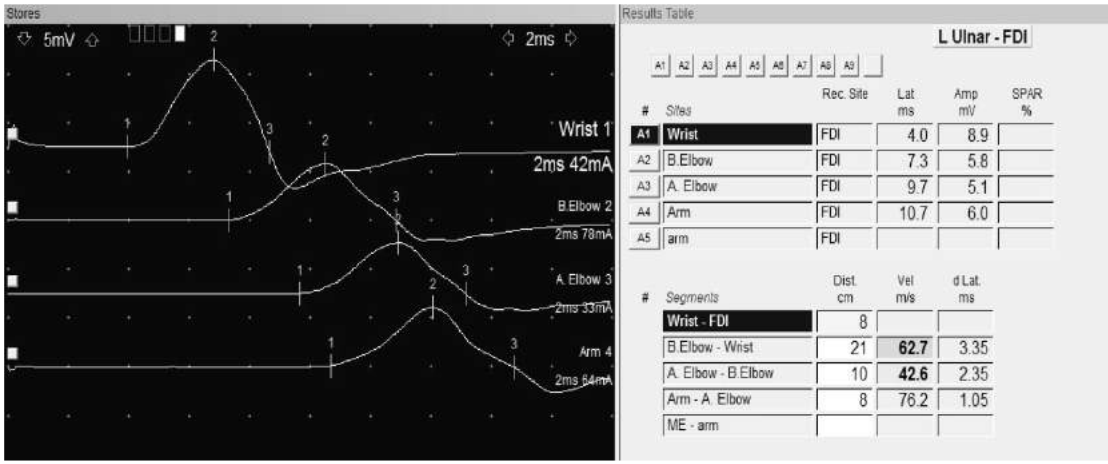
- Elbow position
  - "Moderate elbow flexion, 70-90 deg from horizontal"
  - Nerve is redundant in extension
  - Taut or even subluxed in flexion
  - Checkles et al showed 20-30 m/s difference with elbow flex/ext
  - Key: Consistency

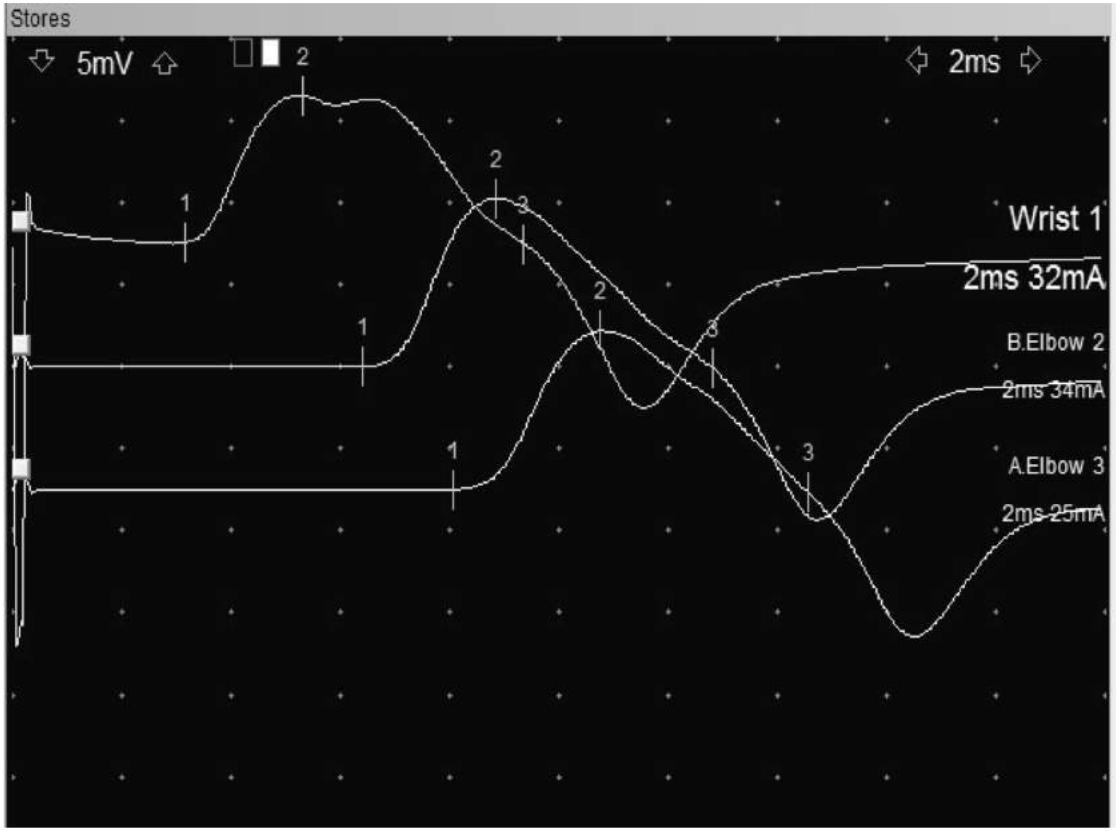


Recording Muscle: ADM vs FDI

- ADM vs FDI
  - Practice parameter: If routine studies inconclusive use FDI
- Literature ??
- Our lab:
  - Start with FDI
    - Motor fibers to FDI more likely to show UNE
    - Studies are not definitive on this
  - More likely to show conduction block (CB)
  - Useful gauge for deep palmar branch







Results Table

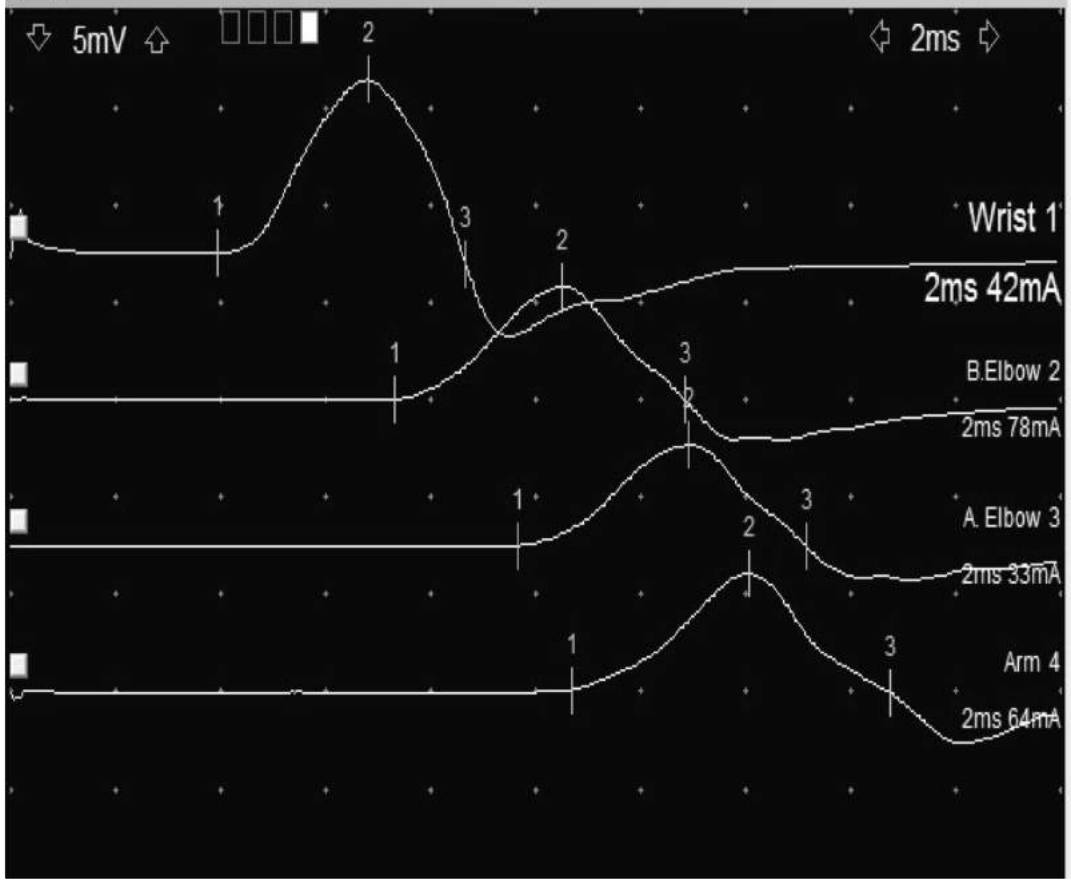
L Ulnar - ADM

A1 A2 A3 A4 A5 A6 A7 A8 A9

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	**Wrist**	ADM	**3.2**	**9.0**	
A2	B.Elbow	ADM	6.4	10.3	
A3	A.Elbow	ADM	8.1	9.7	
A4	4 cm distal ME	ADM			
A5	2 cm Distal ME	ADM			
A6	ME	ADM			
A7	2cm proximal ME	ADM			
A8	4cm proximal ME	ADM			
A9	6 cm proximal	ADM			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - ADM	8		
	B.Elbow - Wrist	21	**64.6**	3.25
	A.Elbow - B.Elbow	10	**60.6**	1.65

Stores



Results Table

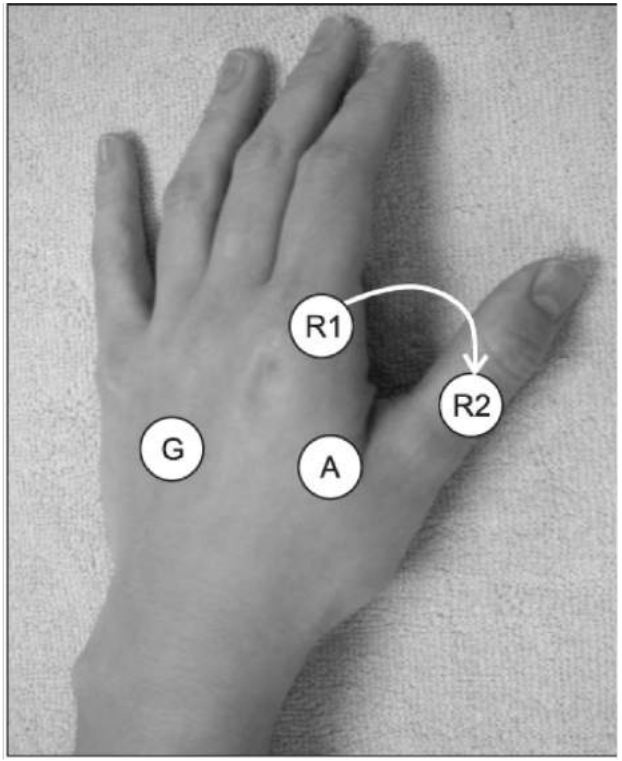
L Ulnar - FDI

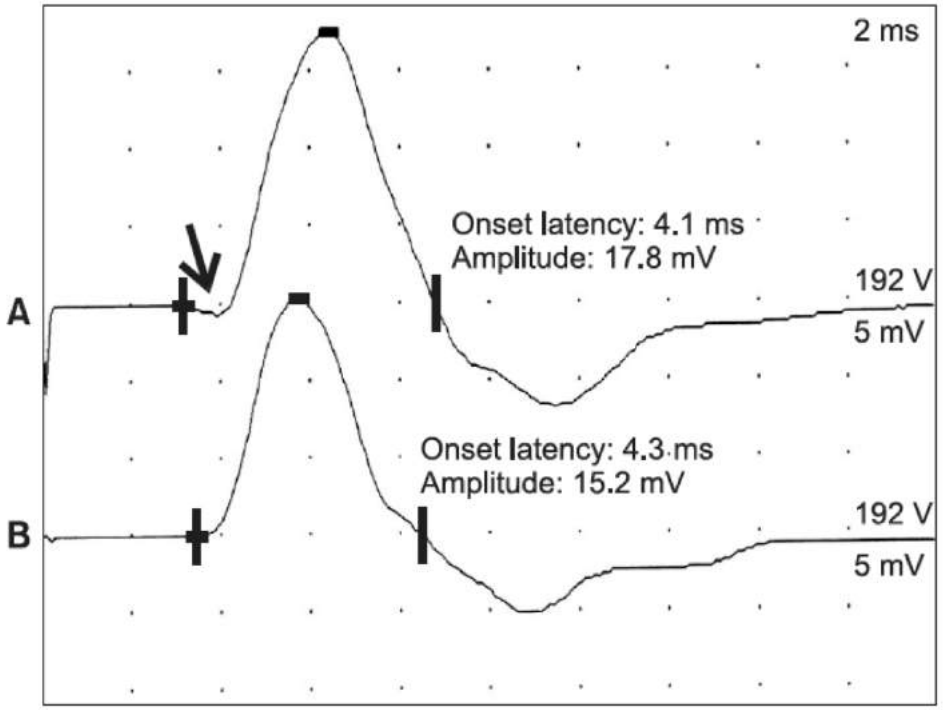
A1 A2 A3 A4 A5 A6 A7 A8 A9

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	**Wrist**	FDI	4.0	8.9	
A2	B.Elbow	FDI	7.3	5.8	
A3	A. Elbow	FDI	9.7	5.1	
A4	Arm	FDI	10.7	6.0	
A5	arm	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	B.Elbow - Wrist	21	**62.7**	3.35
	A. Elbow - B.Elbow	10	**42.6**	2.35
	Arm - A. Elbow	8	76.2	1.05
	ME - arm			

Ulnar: FDI electrode position
Use R2 to get rid of + deflection





Kim, D. H. (2011). Ulnar Nerve Conduction Study of the First Dorsal Interosseous Muscle in Korean Subjects. *Annals of Rehabilitation Medicine*, *35*(5), 658–663.

Length of segment

- Focal nerve injuries typically occur over a 1 cm segment
- Long segment may mask pathology
- Shorter distances improve Sn.
- We recommend the 2 x 4cm segment method
- If you don't use that, at least:
  - Use a 10 cm across elbow length recommended to lessen measurement error (AAEM practice parameter)
    - NCV from AE to BE (D4) < 50 m/s abnormal (AAEM practice parameter)
    - More recently AANEM (Chen et al): < 43 m/s (10cm)
    - Omejec: < 41 m/s (10cm)

Chen S, Andary M, Buschbacher R, et al. Electrodiagnostic reference values for upper and lower limb nerve conduction studies in adult populations. *Muscle Nerve*. 2016;54(3):371-377.

BMI

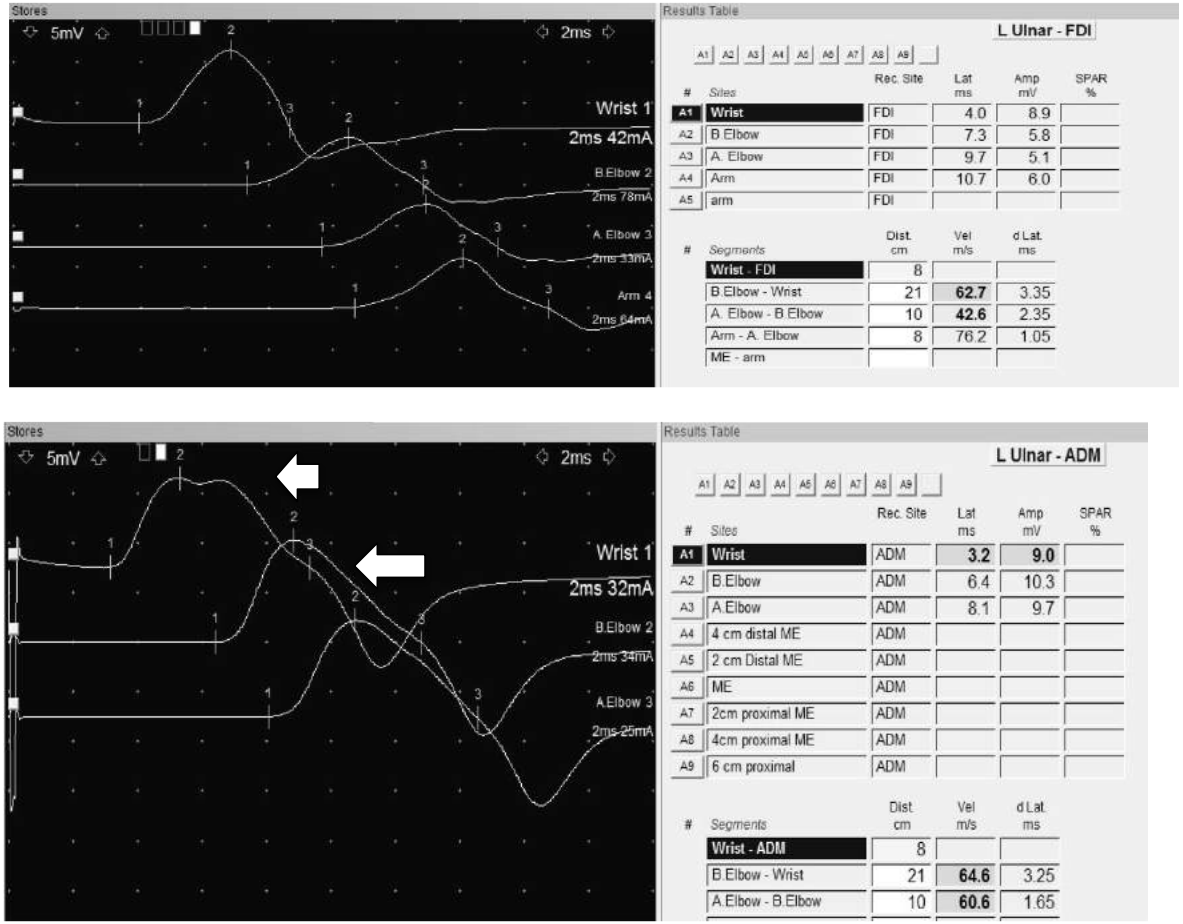
- Associations between BMI and NCV have been shown for across elbow, but not forearm
- With inc BMI, distance measurement around elbow increases and dissociates from actual nerve distance
- Problematic in using comparison values of forearm segment to elbow segment in high BMI

Temperature

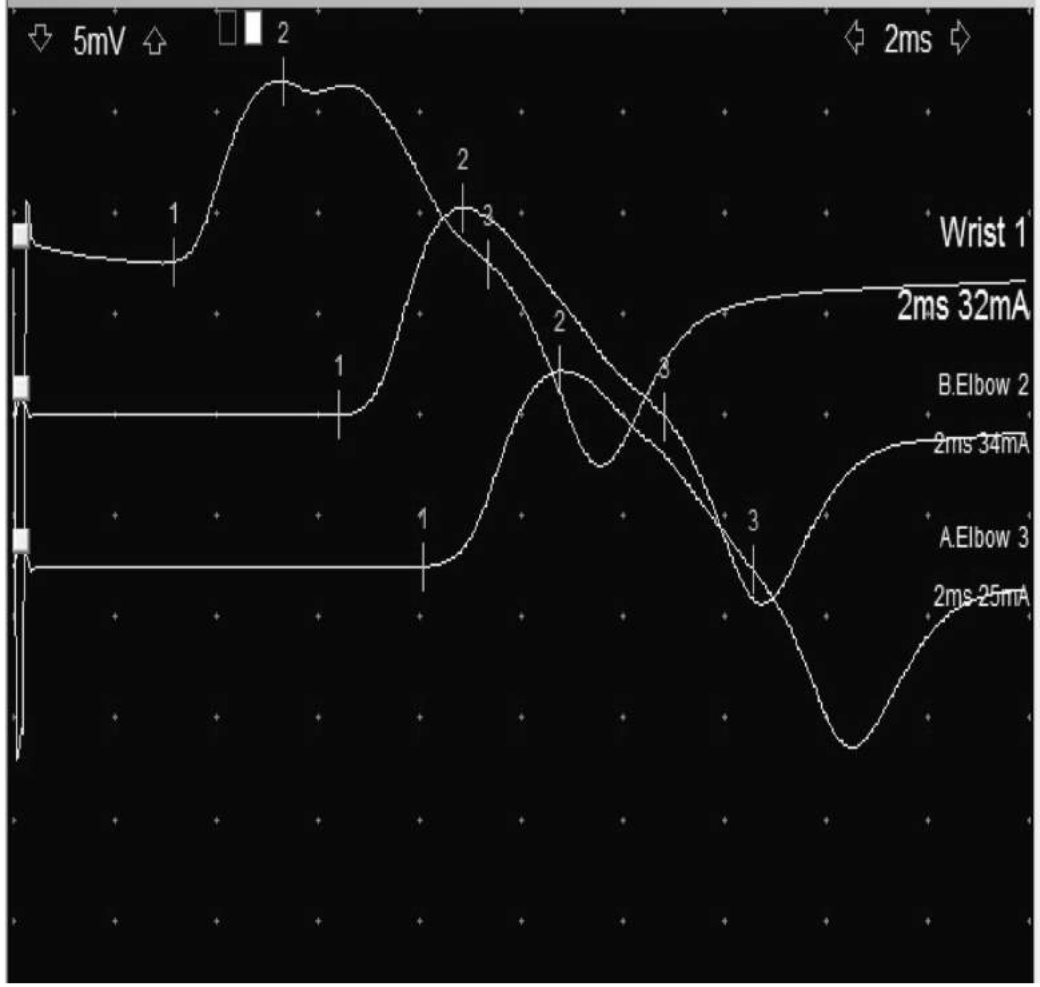
- Low skin temperature rarely affects forearm velocity, but significant across the elbow
- Consider heating elbow when there are no other clinical or Edx findings that support UNE
  - (and you are comparing elbow to forearm for your reference)
- Forearm to across elbow comparison
  - Practice parameter: 10 m/s difference
  - Chen 2016: 15 m/s, 23% amp change
  - Omejec: Don’t use the forearm comparison. Too problematic

Waveform size/shape

- Reduction or a significant change in CMAP configuration between BE and AE is suggestive of UNE
  - Practice parameter: 20%
  - Chen: no reference
  - Omejec: 12%



Stores



Results Table

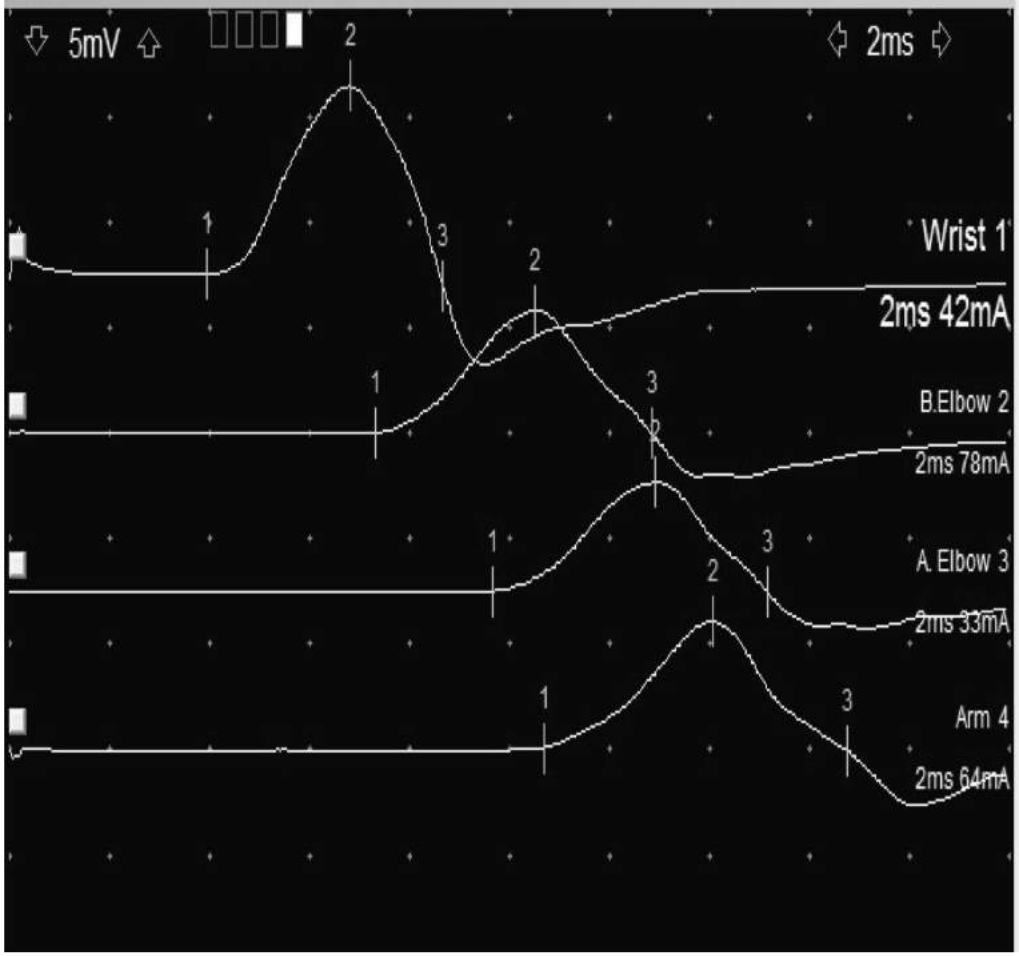
L Ulnar - ADM

A1 A2 A3 A4 A5 A6 A7 A8 A9

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	**Wrist**	ADM	**3.2**	**9.0**	
A2	B.Elbow	ADM	6.4	10.3	
A3	A.Elbow	ADM	8.1	9.7	
A4	4 cm distal ME	ADM			
A5	2 cm Distal ME	ADM			
A6	ME	ADM			
A7	2cm proximal ME	ADM			
A8	4cm proximal ME	ADM			
A9	6 cm proximal	ADM			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - ADM	8		
	B.Elbow - Wrist	21	**64.6**	3.25
	A.Elbow - B.Elbow	10	**60.6**	1.65

Stores



Results Table

L Ulnar - FDI

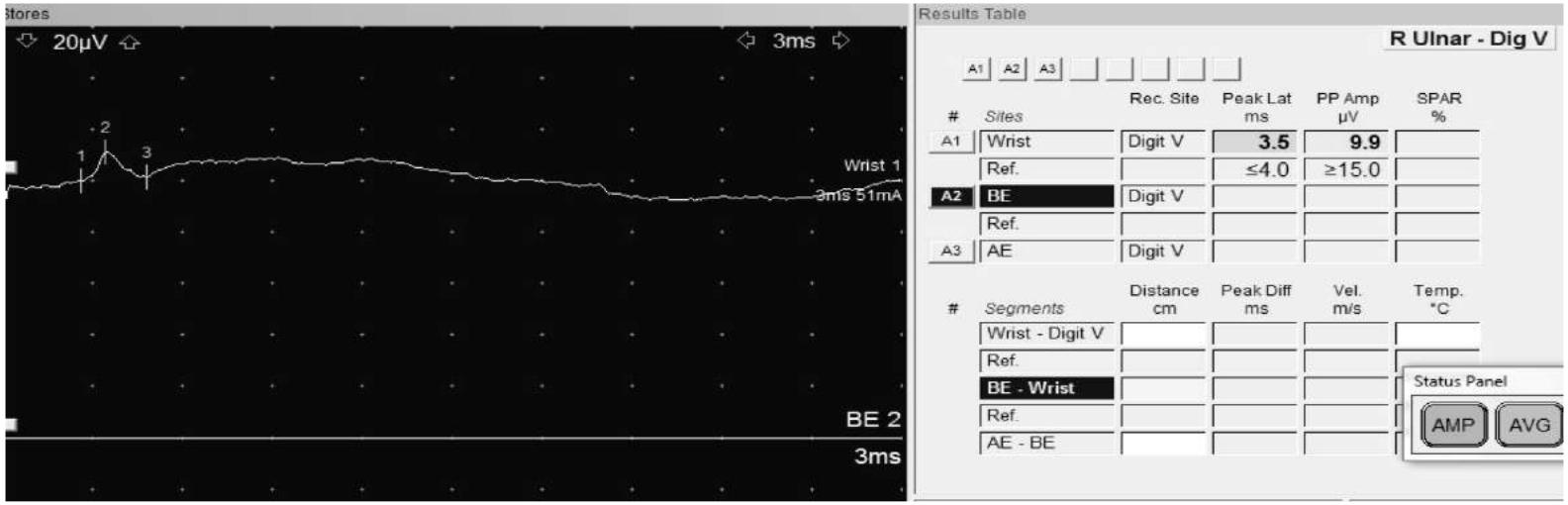
A1 A2 A3 A4 A5 A6 A7 A8 A9

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.0	8.9	
A2	B.Elbow	FDI	7.3	5.8	
A3	A. Elbow	FDI	9.7	5.1	
A4	Arm	FDI	10.7	6.0	
A5	arm	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	B.Elbow - Wrist	21	**62.7**	3.35
	A. Elbow - B.Elbow	10	**42.6**	2.35
	Arm - A. Elbow	8	76.2	1.05
	ME - arm			

Ulnar Sensory Study

- Sensitive indicator of ulnar nerve function
- Commonly low amplitude or absent NAP with UNE
- Sn: 67% low snap, 73% with slow + low SNAP (Omejic)



Summary of Clinical Pearls

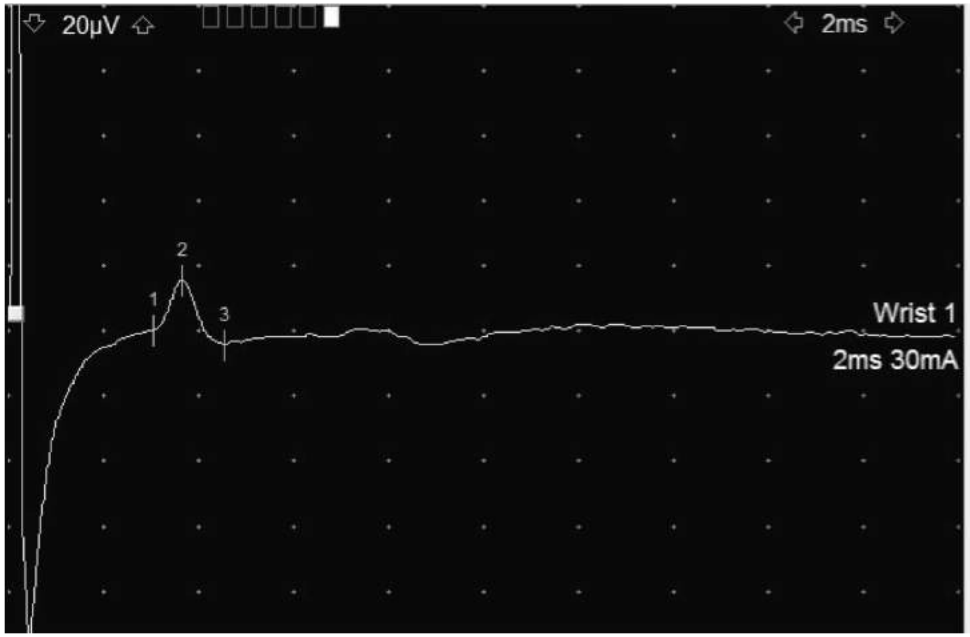
- 2 x 4cm technique from FDI is recommended. Follow up with hybrid 4 x 2cm if needed and/or ADM
  - 4cm: >33 m/s
  - 2cm: > 31 m/s
  - Add location to your report (RTC or HUA or…)
- Most lesions at RTC, P2-ME (likely focal demyelination)
  - Then HUA, ME-D2 (increased severity, axonal changes more likely)
- Look for low amplitude or absent ulnar sensory response with UNE
- Overstimulation will lead to false neg studies!
- Map nerve path with submax stimulation
- Elbow position: Be consistent!
- Observe waveforms for subtle shape changes
- Place reference electrode on Thumb when using FDI to get rid of + deflection
- Inspect auto markers
  - Reset/restim any non physiologic velocities (>70 m/s)

Case Studies

Case 1

- 54 yo male with complaints of left hand numbness in the medial border of his hand for about 7 months. He was holding his cell phone and he felt a pop at this elbow with a burning sensation down his arm. Since that time he has had constant numbness in the small finger and splitting the ring finger. He denies neck pain and has no history of diabetes. He is referred for left UE EMG to rule out ulnar neuropathy.

Median Sensory



L Median - Index (14-8 cm)

A1 A2

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	index	3.7	20.4	
	Ref.		≤3.8	≥15.0	
A2	Palm	Index			
	Ref.				

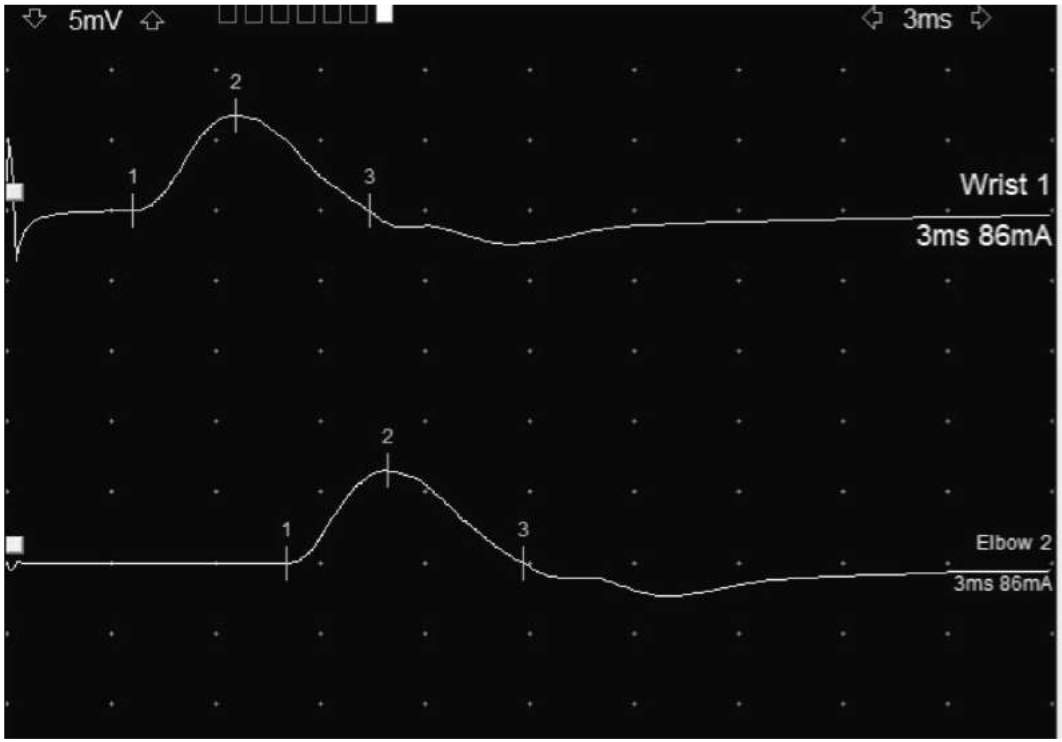
#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp.
	Wrist - index	14		45.9	
	Ref.				
	Palm - Index	7			
	Ref.				
	Wrist - Palm				

Status Panel

AMP AVG ACQ

VH118

Median Motor



L Median - APB

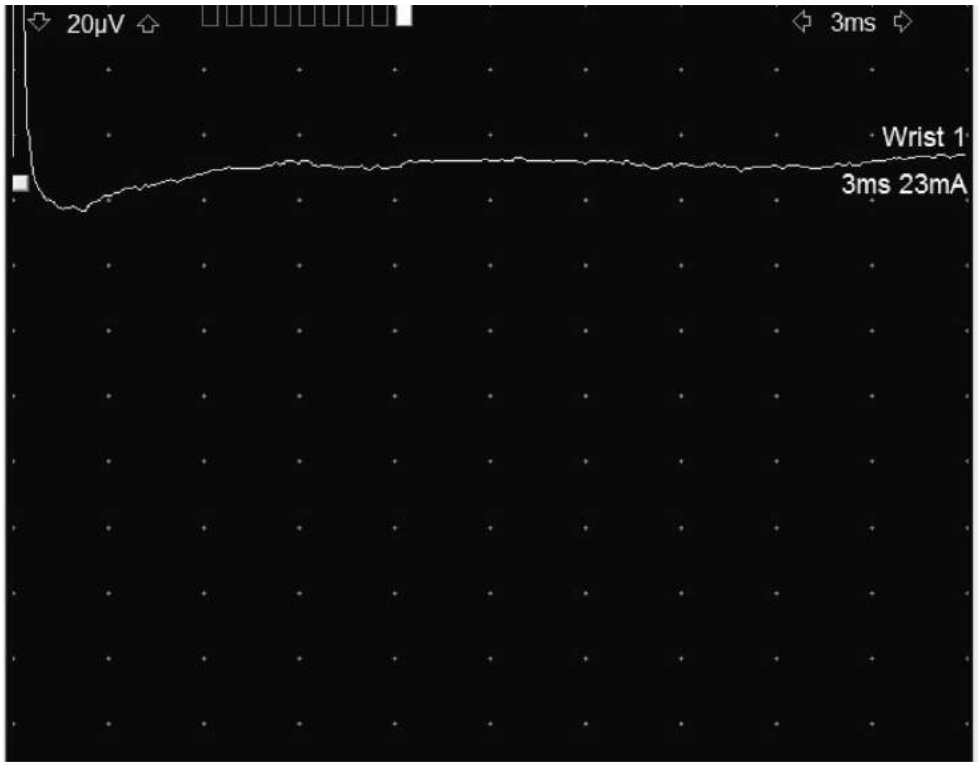
A1 A2 A3

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	APB	3.6	6.9	
A2	Elbow	APB	8.0	6.6	
A3	Above Elbow	APB			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - APB	8		
	Elbow - Wrist	23	52.3	4.40
	Above Elbow - Elbow			

VH118

Ulnar Sensory



L Ulnar - Dig V

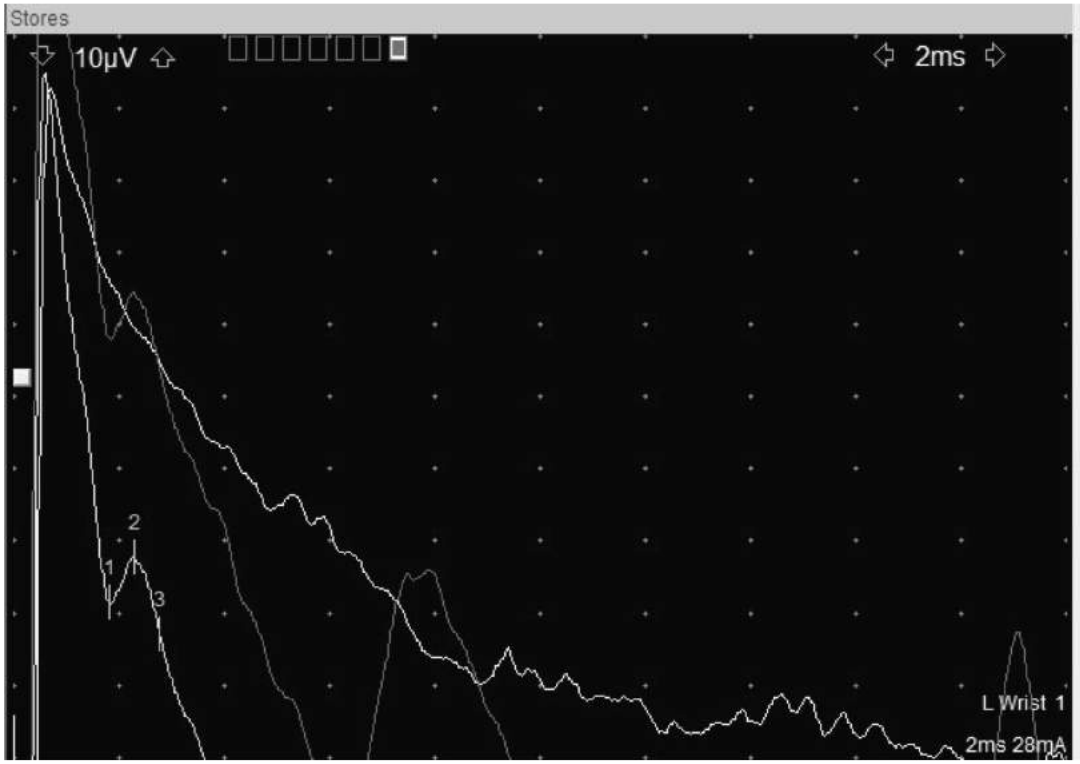
A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	Digit V	NR	NR	
	Ref.		≤4.0	≥15.0	
A2	BE	Digit V			
	Ref.				
A3	AE	Digit V			
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Wrist - Digit V				
	Ref.				
	BE - Wrist		NR		
	Ref.				
	AE - BE				
	Ref.				

VH118

L and R DUC



Results Table

L Dorsal ulnar cutaneous

A1 A2

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	L Wrist	DUC	NR	NR	NR
	Ref.		≤2.9	≥5.0	
A2	R Wrist	DUC	2.3	10.6	
	Ref.				

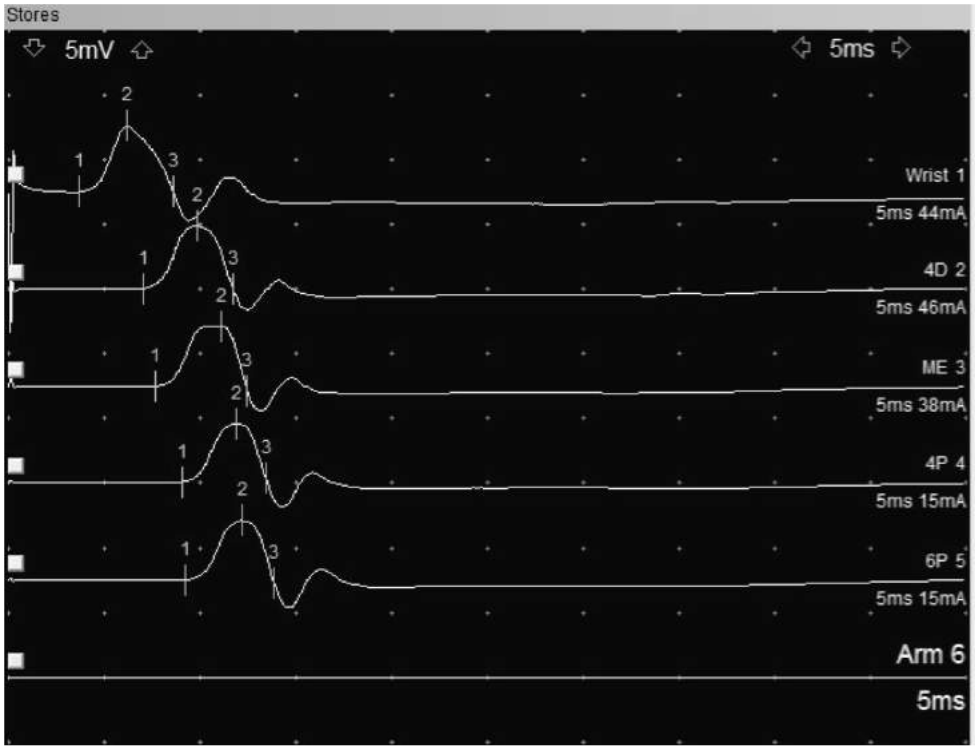
#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp.
	L Wrist - DUC	10		NR	
	Ref.				
	R Wrist - DUC	10		55.6	
	Ref.				

Status Panel

AMP AVG ACQ

VH118

Ulnar M. to FDI
Note 10 cm segment is normal



Results Table

L Ulnar - FDI inching

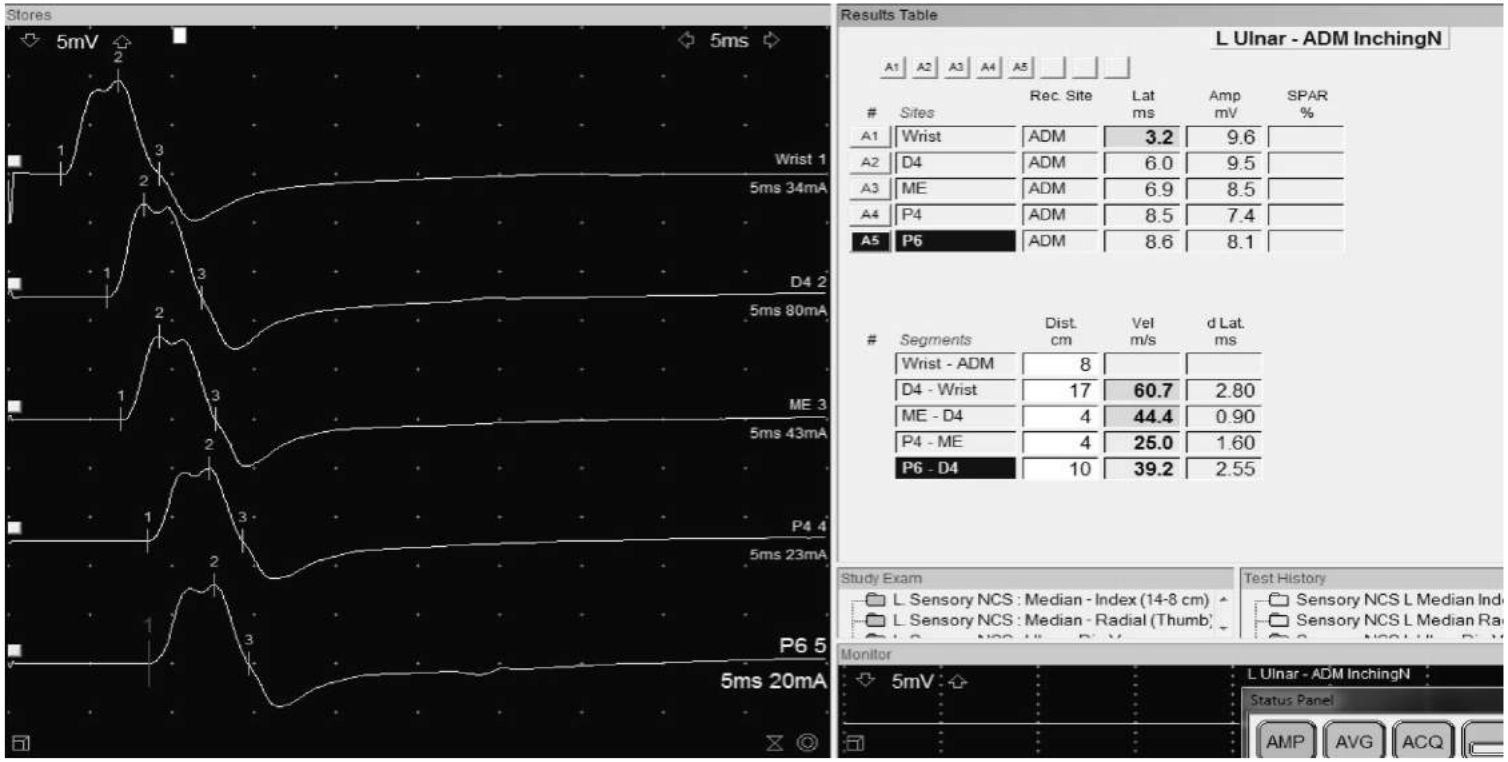
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	3.7	5.1	
A2	4D	FDI	7.0	4.9	
A3	ME	FDI	7.7	4.7	
A4	4P	FDI	9.1	4.5	
A5	6P	FDI	9.3	4.6	
A6	Arm	FDI			
A7	2D	FDI			
A8	2P	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist	17	50.7	3.35
	ME - 4D	4	**61.5**	0.65
	4P - ME	4	**28.6**	1.40
	6P - 4D	10	**44.4**	2.25
	Arm - 6P	10		

VH118

Ulnar M. to ADM
Notice 10cm segment is slow



VH118

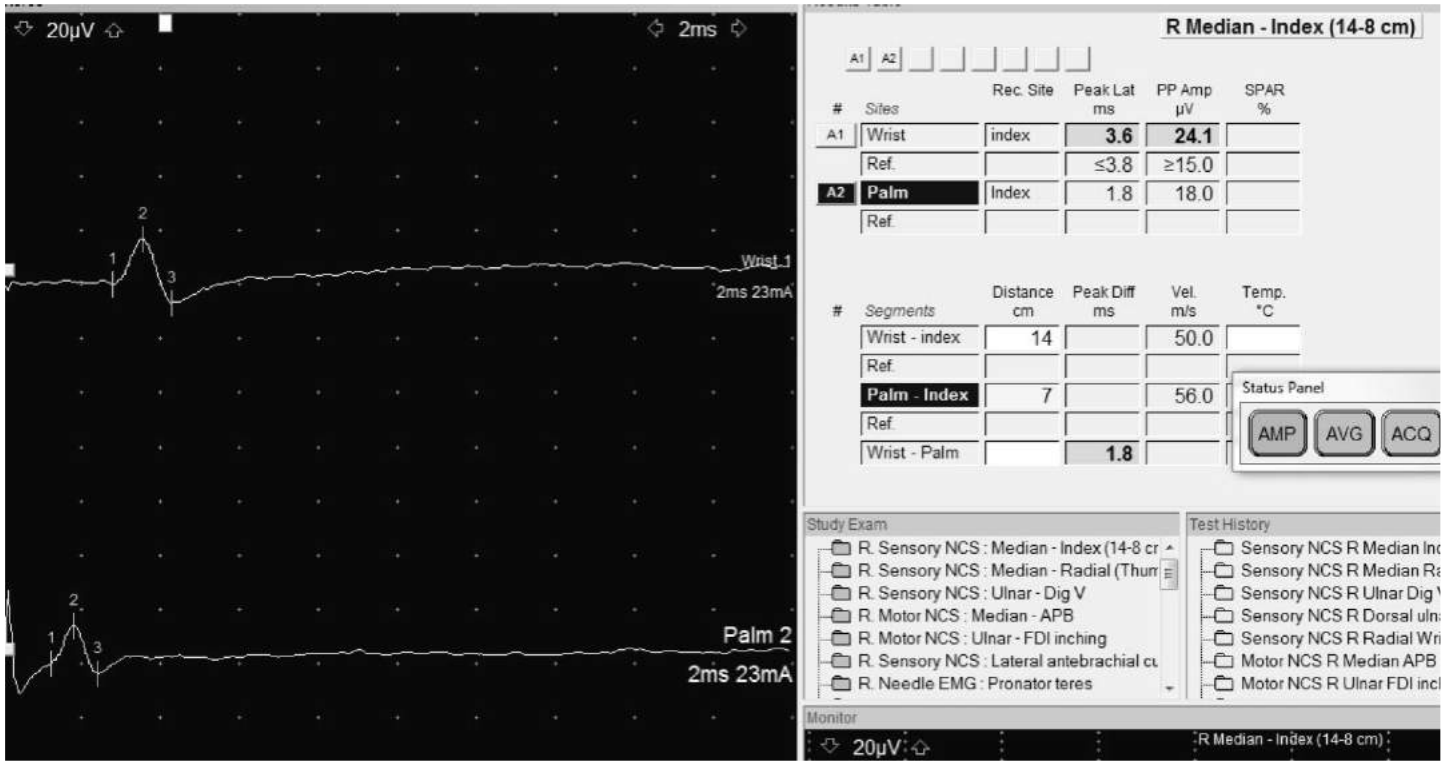
Case 1: Impression

- Nerve conduction studies of the left upper extremity are consistent with axonal ulnar neuropathy at the elbow (UNE) at the retroepicondylar groove. (RTC). Basis for axonal loss lesion is the absent sensory responses to digit V and also at the dorsal ulnar cutaneous. The ulnar motor conduction velocity is slow across the proximal elbow segment (28 m/s) but with normal amplitudes. Needle EMG shows no acute denervation but there is reduced recruitment in the FCU and FDI. Polyphasic units were noted in the FCU and FDI indicative of some level of recovery.

Case 2: History

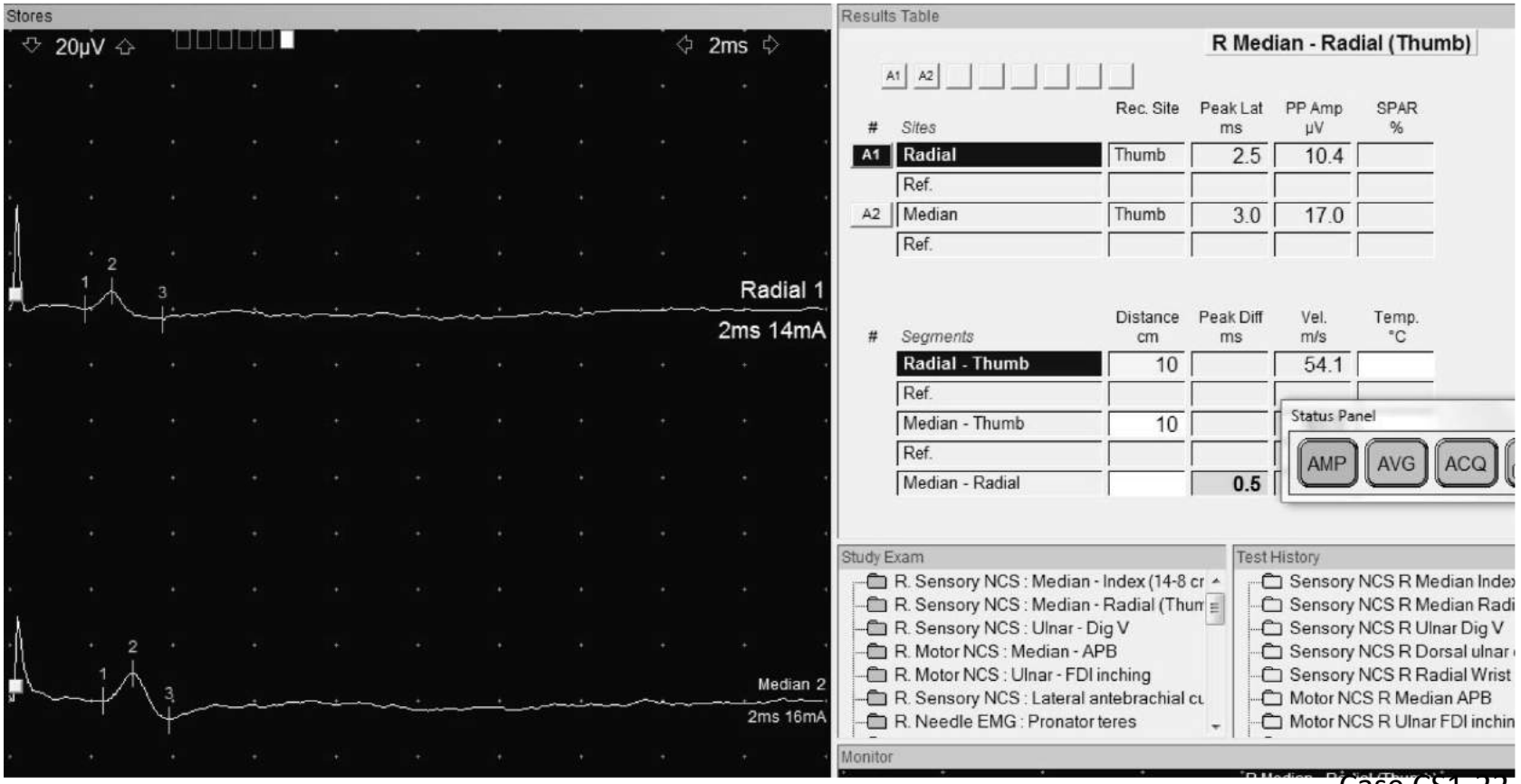
- Xxx has complaints of right hand pain for several months. She notes continued loss of strength in the right hand and can't manipulate a zipper or press buttons on her car remote. She denies any numbness. She has hand intrinsic wasting in the right hand at FDI and ADM. She has no mechanism for injury. she had left CTR in 2004 due to tingling. She says this feels very different, and has no tingling, just pain "like a charlie horse". She has mild neck pain, with no radiation and has no history of diabetes. She is referred for EMG of the right UE for CTS

Median Sensory



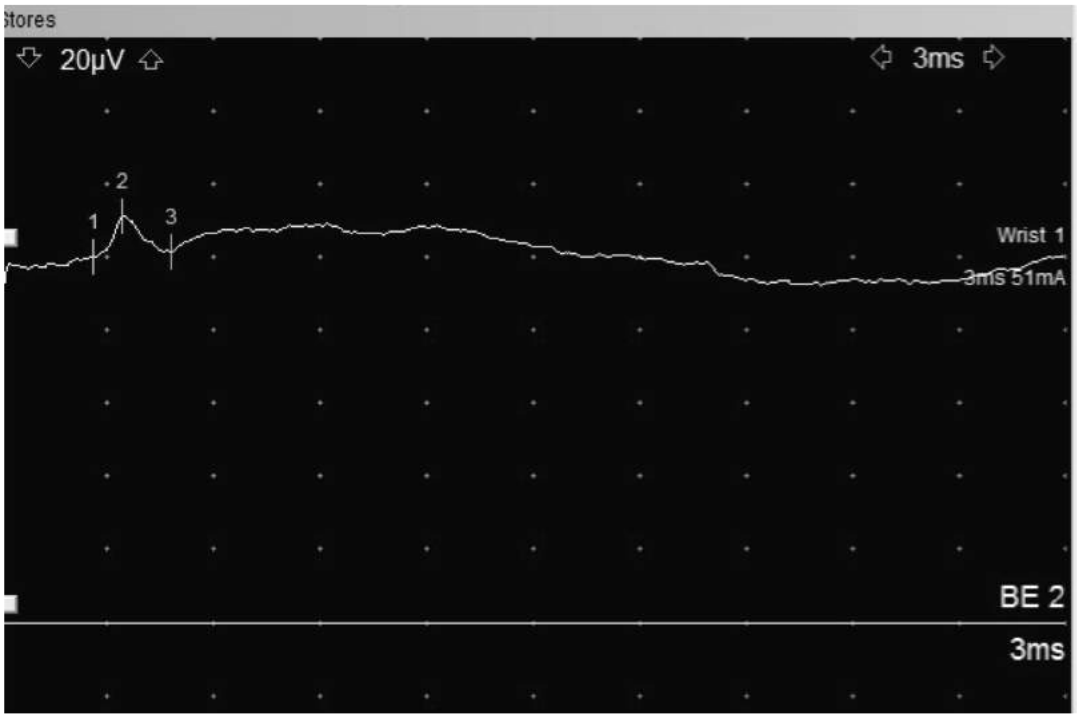
Case CS1-22

Median /Radial Sensory



Case CS1-22

Ulnar Sensory



Results Table

R Ulnar - Dig V

A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	Digit V	3.5	9.9	
	Ref.		≤4.0	≥15.0	
A2	BE	Digit V			
	Ref.				
A3	AE	Digit V			

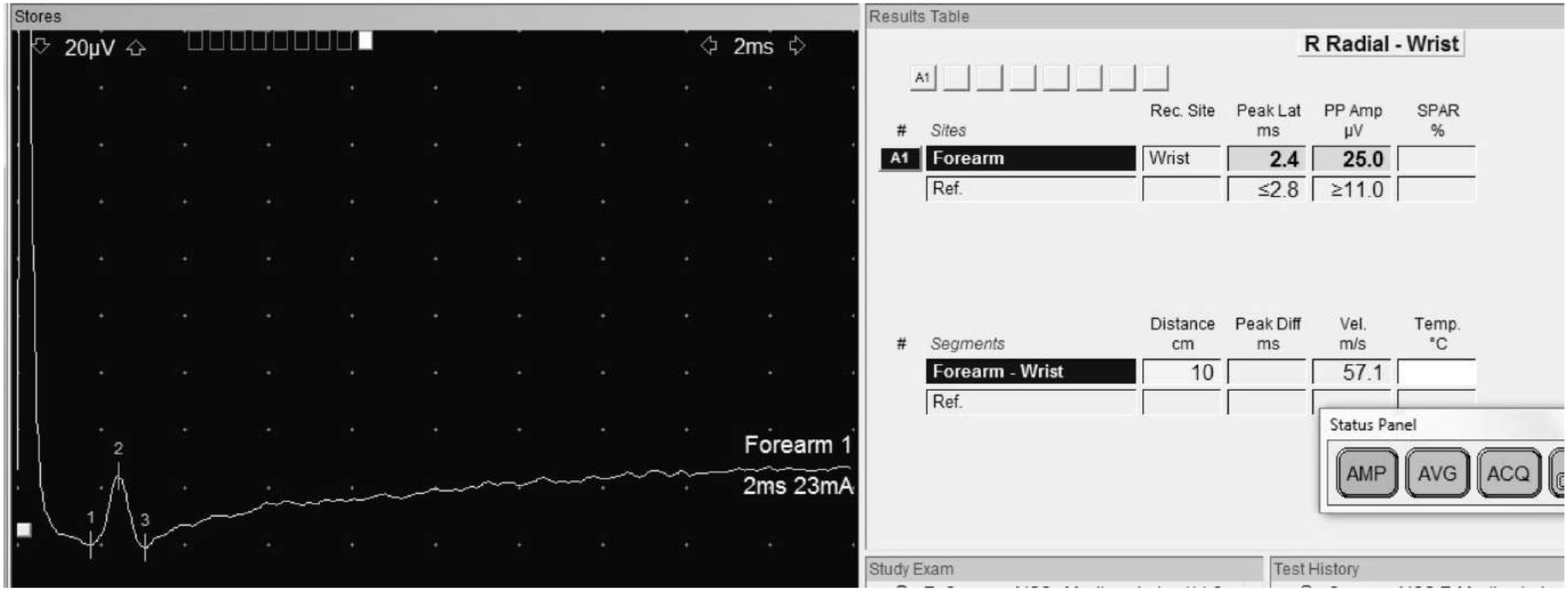
#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Wrist - Digit V				
	Ref.				
	BE - Wrist				
	Ref.				
	AE - BE				

Status Panel

AMP AVG

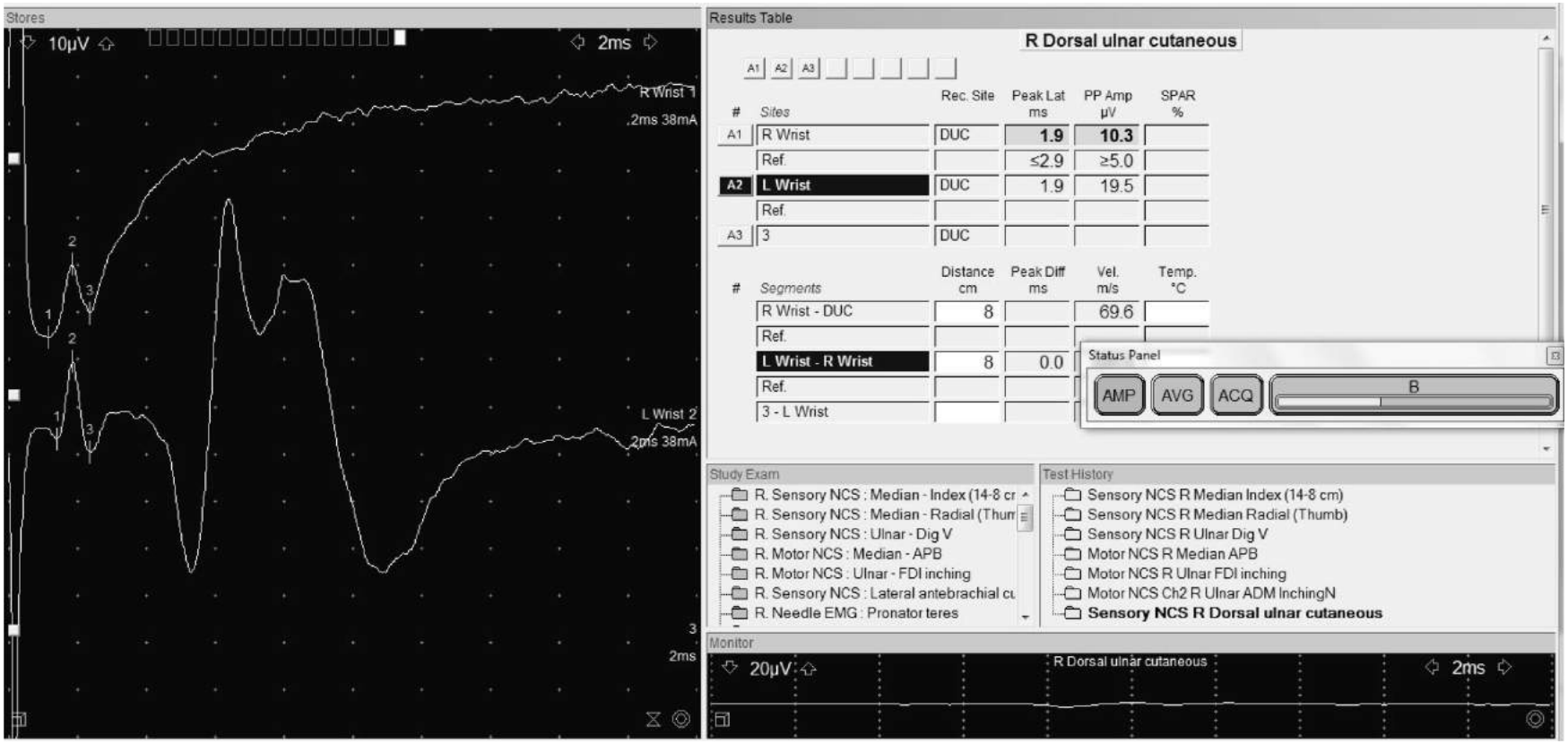
Case CS1-22

Radial Sensory



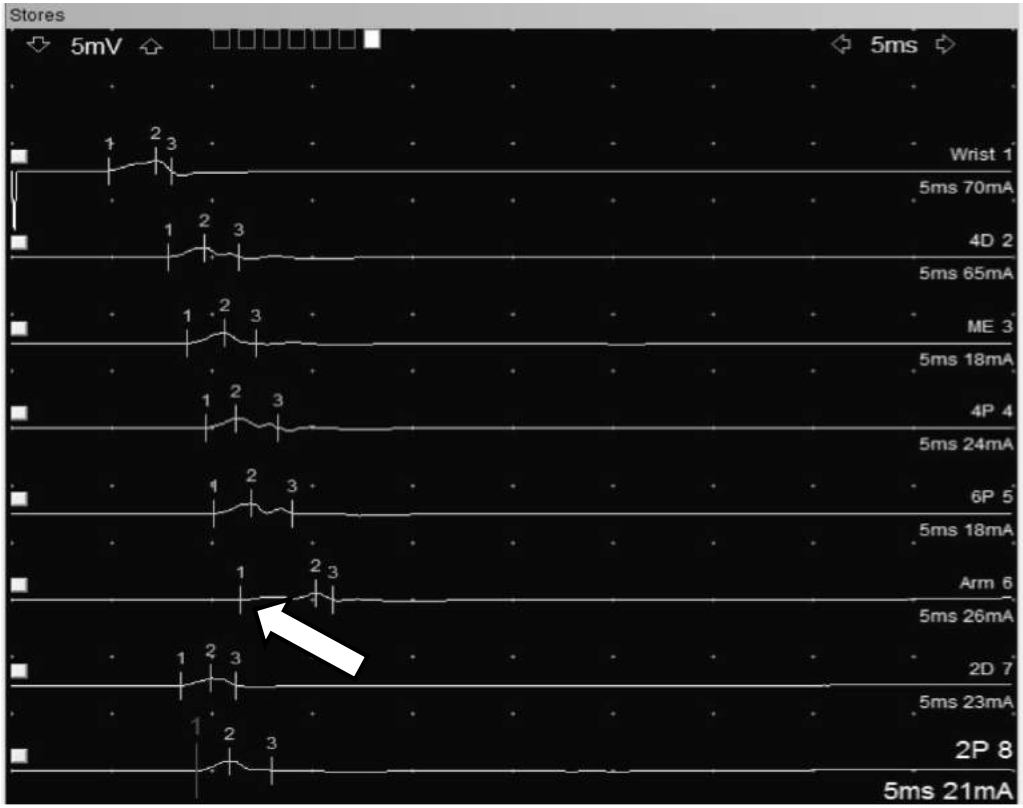
Case CS1-22

R and L DUC



Case CS1-22

Ulnar Motor: FDI
Needed 4x2cm to localize



Results Table

R Ulnar - FDI inching

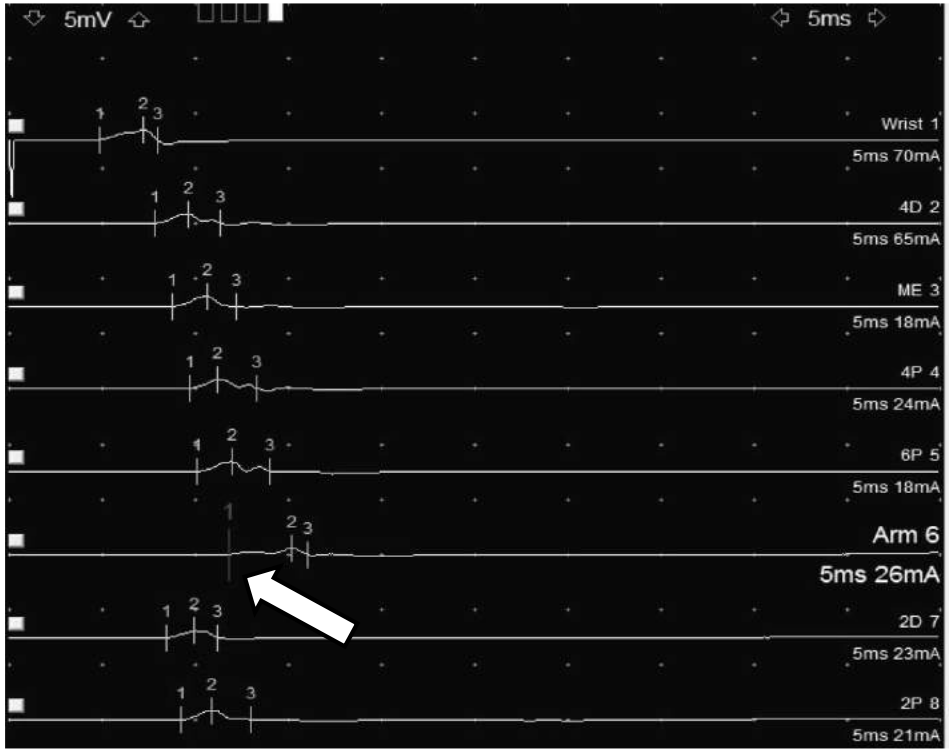
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.8	0.9	
A2	4D	FDI	7.8	0.9	
A3	ME	FDI	8.8	0.9	
A4	4P	FDI	9.7	0.8	
A5	6P	FDI	10.1	0.9	
A6	Arm	FDI	11.5	0.7	
A7	2D	FDI	8.5	0.6	
A8	2P	FDI	9.3	0.9	

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist			3.00
	ME - 4D	4	**40.0**	1.00
	4P - ME	4	**47.1**	0.85
	6P - 4D	10	**43.5**	2.30
	Arm - 6P	10	**74.1**	
	2D - 4D	2	**30.8**	0.65
	ME - 2D	2	**57.1**	0.35
	2P - ME	2	**44.4**	0.45

Case CS1-22

Ulnar Motor FDI
Adjusted Arm cursor



R Ulnar - FDI inching

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

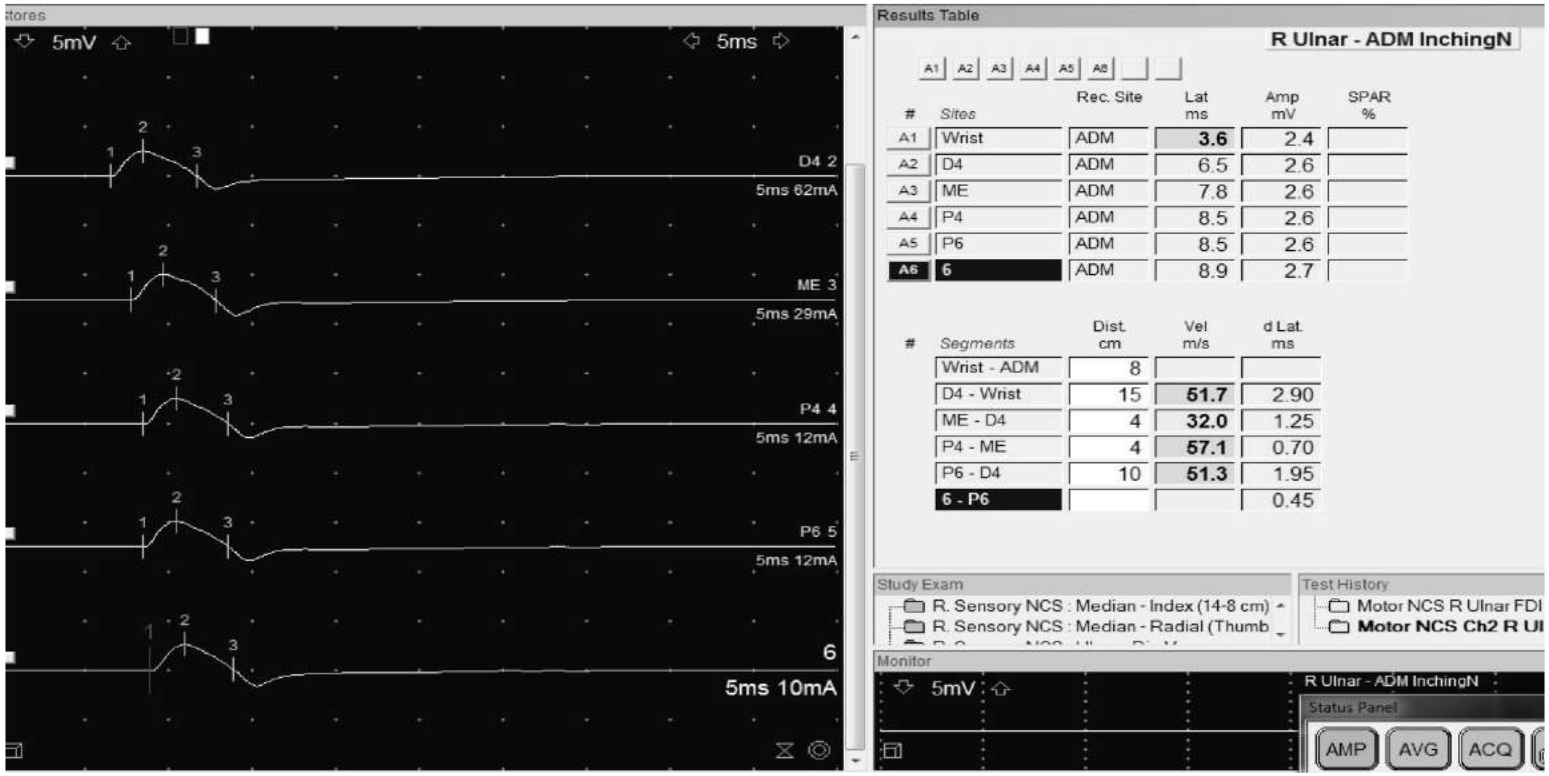
#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.8	0.9	
A2	4D	FDI	7.8	0.9	
A3	ME	FDI	8.8	0.9	
A4	4P	FDI	9.7	0.8	
A5	6P	FDI	10.1	0.9	
A6	**Arm**	FDI	11.8	0.6	
A7	2D	FDI	8.5	0.6	
A8	2P	FDI	9.3	0.9	

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist	19	63.3	3.00
	ME - 4D	4	**40.0**	1.00
	4P - ME	4	**47.1**	0.85
	6P - 4D	10	**43.5**	2.30
	Arm - 6P	10	**58.8**	1.70
	2D - 4D	2	**30.8**	0.65
	ME - 2D	2	**57.1**	0.35
	2P - ME	2	**44.4**	0.45

Test History

Case CS1-22

Ulnar Motor to ADM
2 x 4cm (note long segment nl)



Case CS1-22

Case 2: Impression

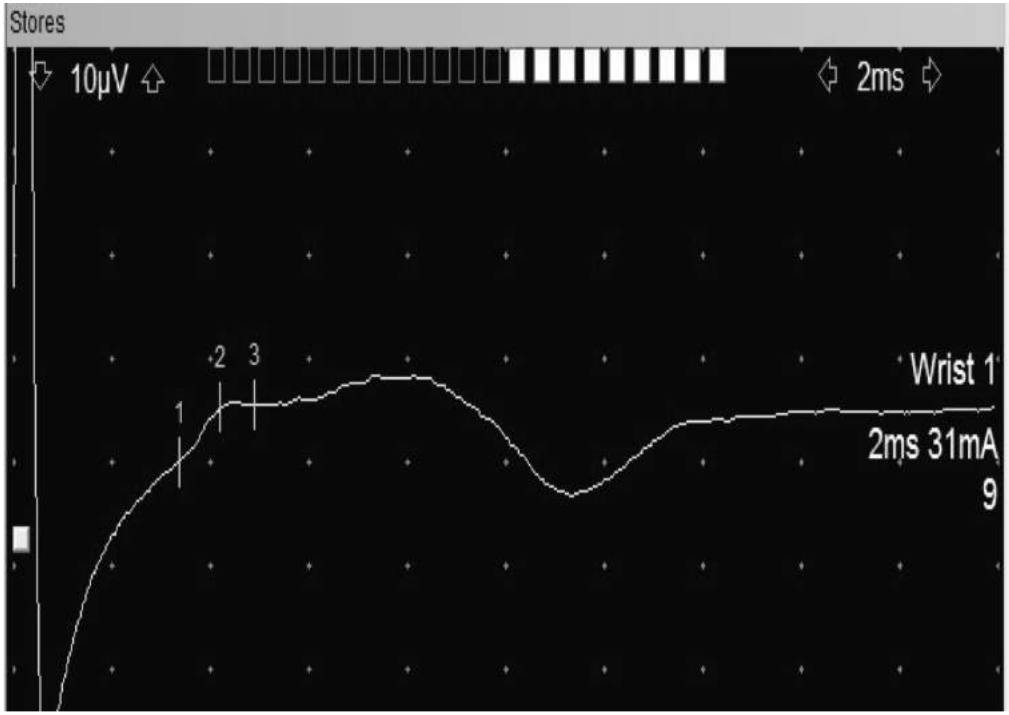
- Nerve conduction studies of the right upper extremity are consistent with severe ulnar neuropathy at the elbow (UNE) which appears to be at the humeroulnar arcade (cubital tunnel). The right ulnar sensory amplitude is reduced below normal limits. The ulnar motor conduction velocity across the elbow is slow in the segment just proximal to the cubital tunnel. The ulnar motor amplitude is severely reduced recording from the FDI and about 75% of normal recording from the ADM. The right DUC response also shows mildly reduced amplitude in comparison to the left side. Needle EMG shows acute denervation in the flexor carpi ulnaris, ADM and first dorsal interosseous, with poor recruitment, polyphasic motor units and severely reduced interference patterns.

Case 3

- 80 yo male. s/p CTR release many years ago, now with new complaint of hand weakness with numbness/tingling in all digits. Previous study was available from before CTR and showed a very low amplitude median motor amplitude and absent median sensory response. Study also suggested a mild, non localized ulnar neuropathy.

LS118

Median Sensory to Index



Results Table

R Median - Index (14-8 cm)

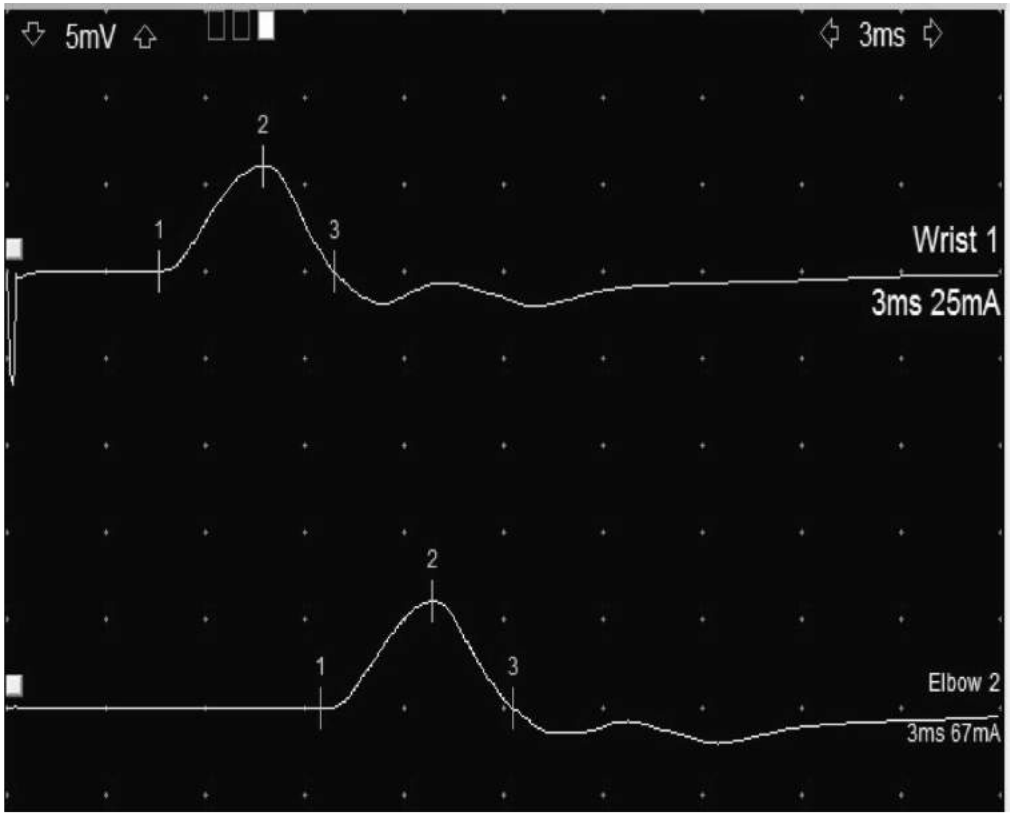
A1 A2

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	index	4.2	0.50	
	Ref.		≤3.8	≥15.0	
A2	Palm	Index			
	Ref.				

Distance Peak Diff Vel Temp

LS118

Median Motor



R Median - APB

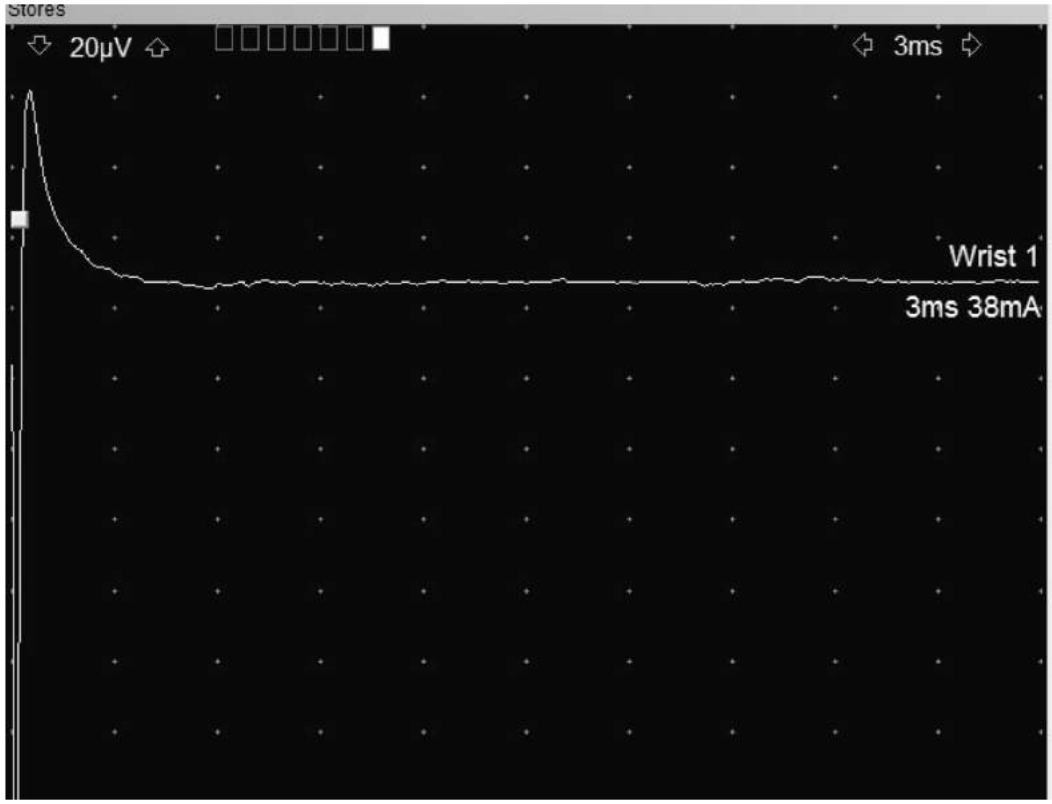
A1 A2 A3

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	APB	4.6	6.1	
A2	Elbow	APB	9.5	6.2	
A3	Above Elbow	APB			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - APB	8		
	Elbow - Wrist	24	49.5	4.85
	Above Elbow - Elbow			

LS118

Ulnar Sensory



Results Table

R Ulnar - Dig V

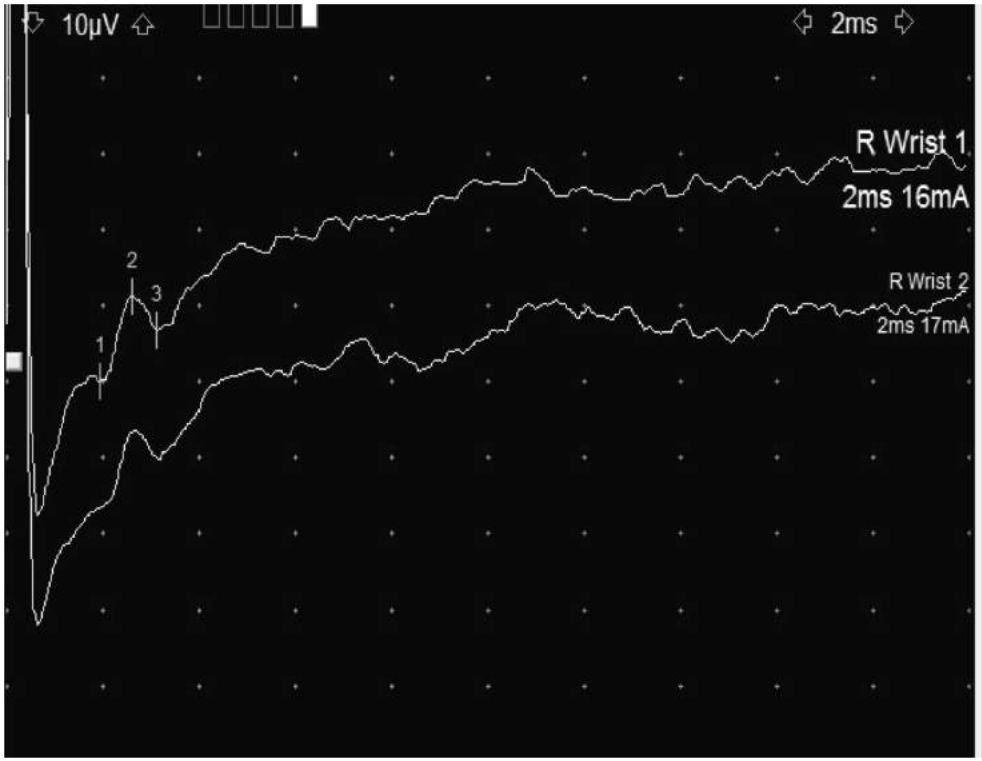
A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	**Wrist**	Digit V	**NR**	**NR**	
	Ref.		≤4.0	≥15.0	
A2	BE	Digit V			
	Ref.				
A3	AE	Digit V			
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Wrist - Digit V				
	Ref.				
	BE - Wrist		**NR**		
	Ref.				
	AE - BE				
	Ref.				

LS118

R DUC



R Dorsal ulnar cutaneous

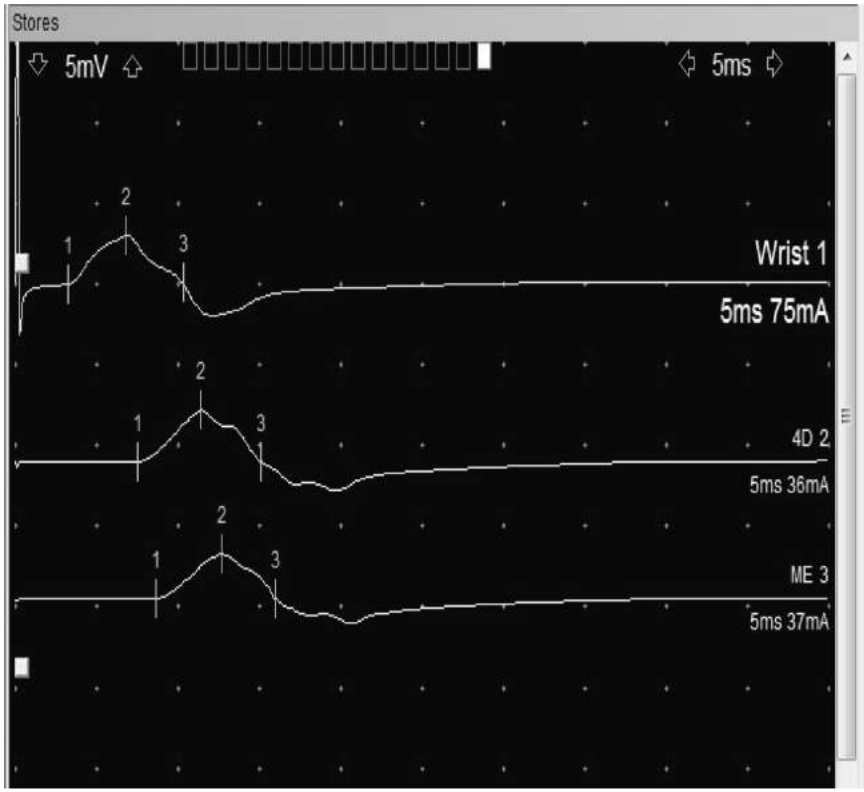
A1 A2

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	R Wrist	DUC	2.6	4.4	
	Ref.		≤2.9	≥5.0	
A2	R Wrist	DUC			
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	R Wrist - DUC	10		51.3	
	Ref.				
	R Wrist - R Wrist				
	Ref.				

LS118

ADM Study: Not localizing, but shows slowing and low amp



Results Table

R Ulnar - ADM inching

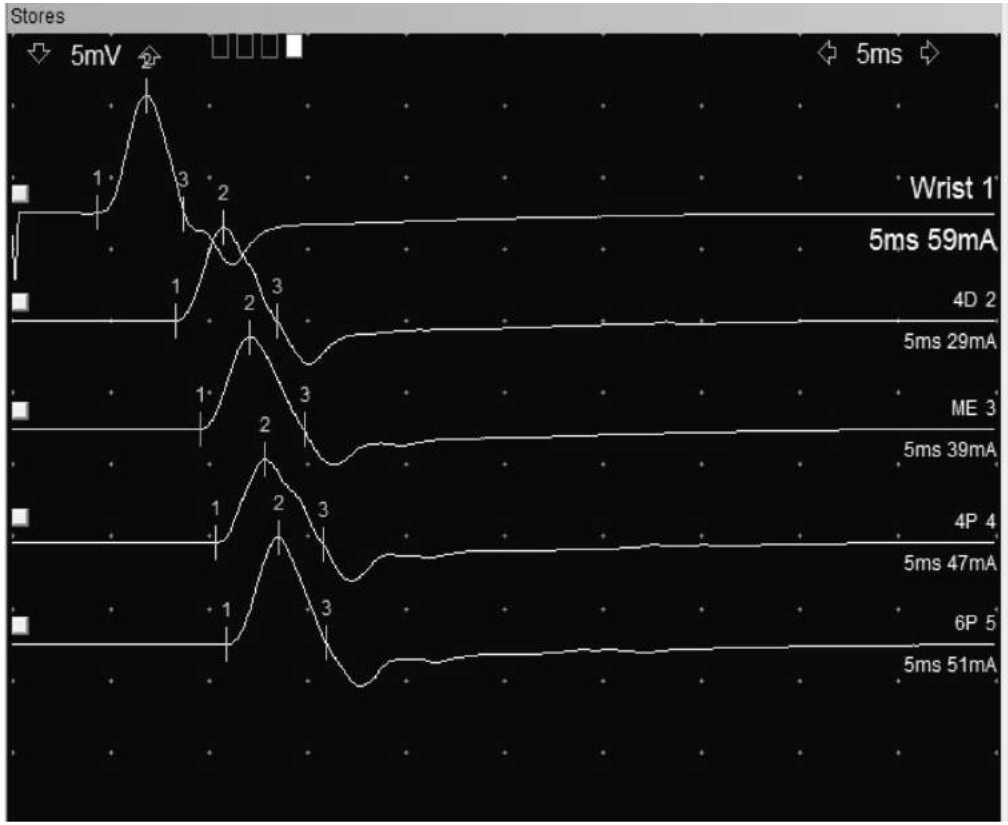
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	ADM	3.3	3.1	
A2	4D	ADM	7.5	3.2	
A3	ME	ADM	8.6	2.8	
A4	4P	ADM	9.8	2.3	
A5	6P	ADM	10.1	2.4	

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - ADM	8		
	4D - Wrist	22	51.8	4.25
	ME - 4D	4	**36.4**	1.10
	4P - ME	4	**33.3**	1.20
	6P - 4D	10	**39.2**	2.55

LS118

FDI Study: ME-4D slow



Results Table

R Ulnar - FDI inching

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.3	8.2	
A2	4D	FDI	8.3	6.5	
A3	ME	FDI	9.5	6.4	
A4	4P	FDI	10.4	5.8	
A5	6P	FDI	10.9	7.5	
A6	Arm	FDI			
A7	2D	FDI			
A8	2P	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist			3.95
	ME - 4D	4	**32.0**	1.25
	4P - ME	4	**47.1**	0.85
	6P - 4D	10	**38.5**	2.60
	Arm - 6P	10		

LS118

Case 3: Impression

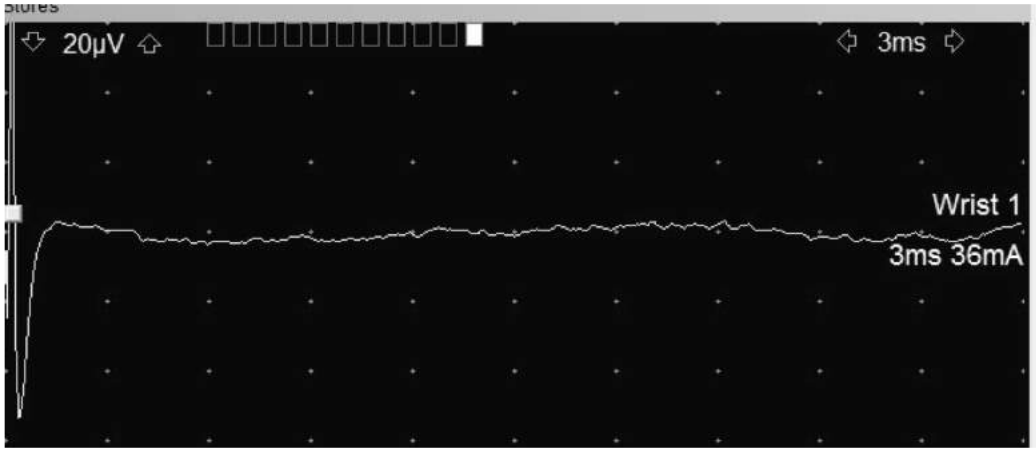
- Nerve conduction studies of the right upper extremity are consistent with axonal loss ulnar neuropathy at the elbow (UNE), which appears to be at the humeroulnar arcade (HUA, cubital tunnel). The right ulnar sensory response is not recordable and the ulnar motor conduction velocity is moderately slow across the elbow segment from ME to HUA with amplitude changes noted. Needle EMG shows no acute denervation, but marked chronic changes (polyphasic motor units, reduced recruitment) in the flexor carpi ulnaris, ADM and first dorsal interosseous.

LS118

Case 4:

- Xxx has complaints of bilateral hand tingling, now left worse than right. She notes tingling in the radial digits of her left hand and the medial digits of her right. She has been wearing a splint on the left hand with good relief. She has noticed these symptoms since October of this year. She has mild complaints of occasional neck pain, but non radiating. She has no history of diabetes. She is referred today for bilateral UE emg studies for CTS vs UNE.

R Ulnar sensory

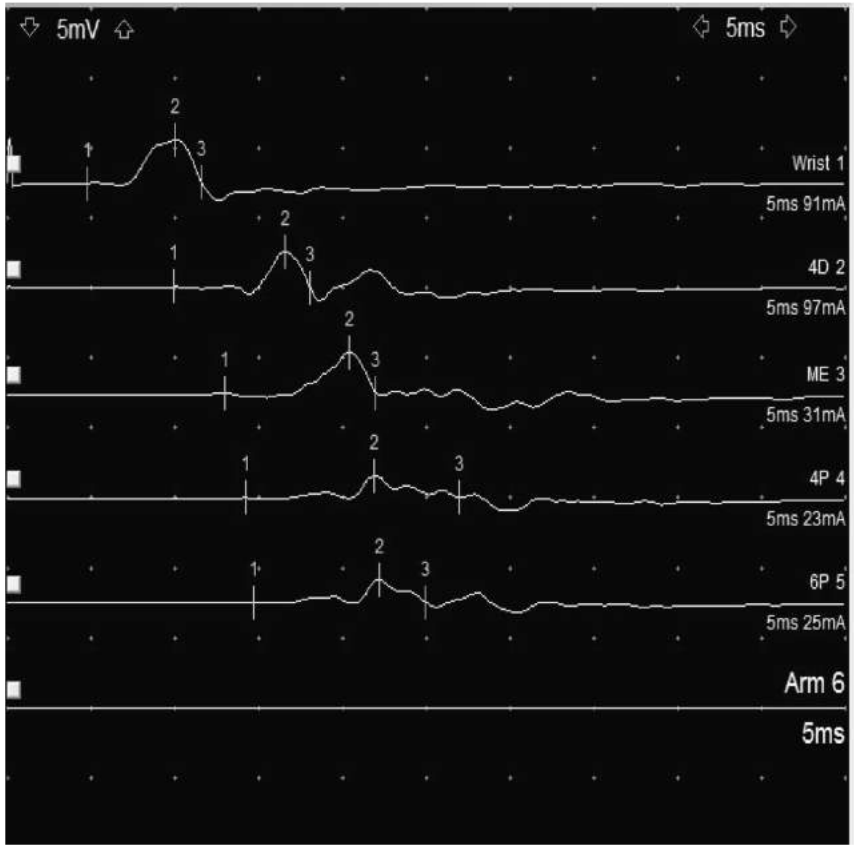


R Ulnar - Dig V

A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	Digit V	NR	NR	NR
	Ref.		≤4.0	≥15.0	
A2	BE	Digit V			
	Ref.				
A3	AE	Digit V			
	Ref.				

R Ulnar Motor: FDI
2 x 4cm



R Ulnar - FDI inching

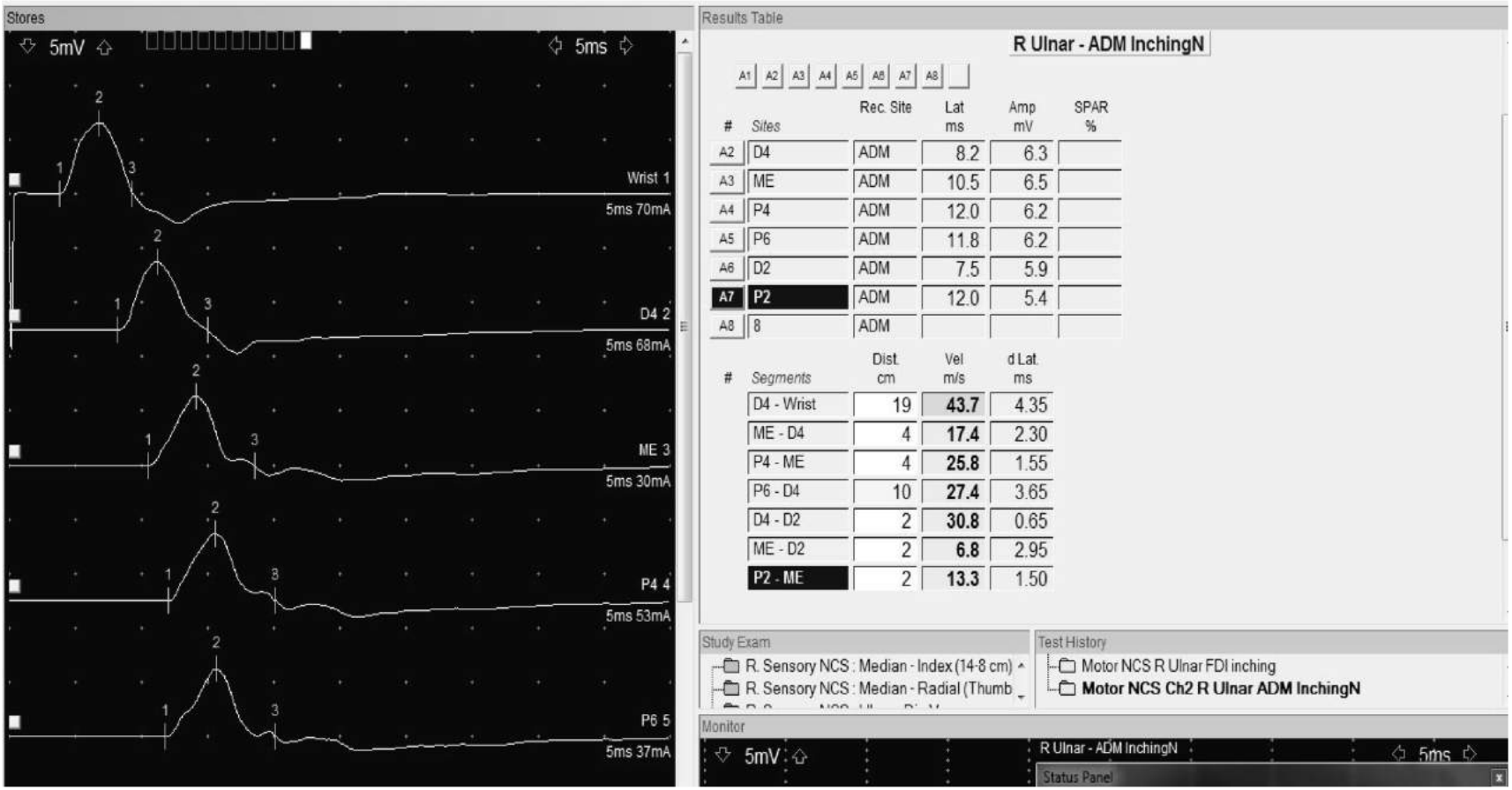
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.8	3.1	
A2	4D	FDI	10.0	2.5	
A3	ME	FDI	13.0	2.9	
A4	4P	FDI	14.2	1.6	
A5	6P	FDI	14.6	1.6	
A6	Arm	FDI			
A7	2D	FDI			
A8	2P	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist	19	36.5	5.20
	ME - 4D	4	**13.1**	3.05
	4P - ME	4	**33.3**	1.20
	6P - 4D	10	**21.5**	4.65
	Arm - 6P	10		
	2D - 4D	2		
	ME - 2D	2		

RD1-22

R ADM showing ME-D2

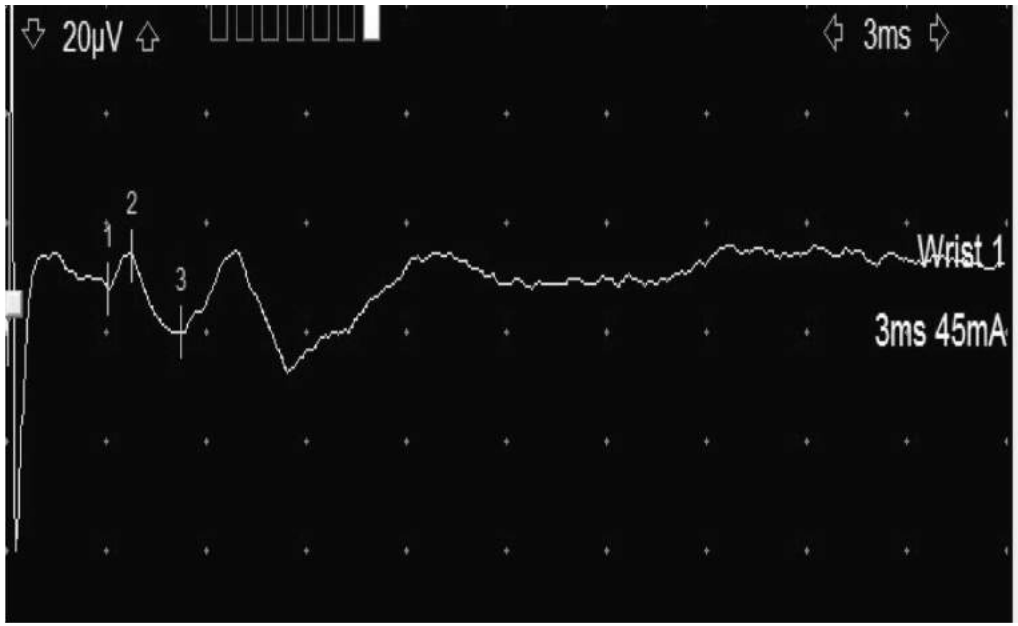


RD1-22

Impression (R side)

- Nerve conduction studies of the right upper extremity are consistent with severe axonal ulnar neuropathy at the elbow (UNE) localized to the humeroulnar arcade (cubital tunnel). Sensory conduction to digit V was not recordable. The ulnar motor conduction velocity is markedly slow across the elbow segment with low and dispersed amplitude (FDI). Needle EMG shows acute denervation and very poor recruitment in the FCU, ADM and FDI. Polyphasic units were noted in the FCU and FDI.

L Ulnar Sensory

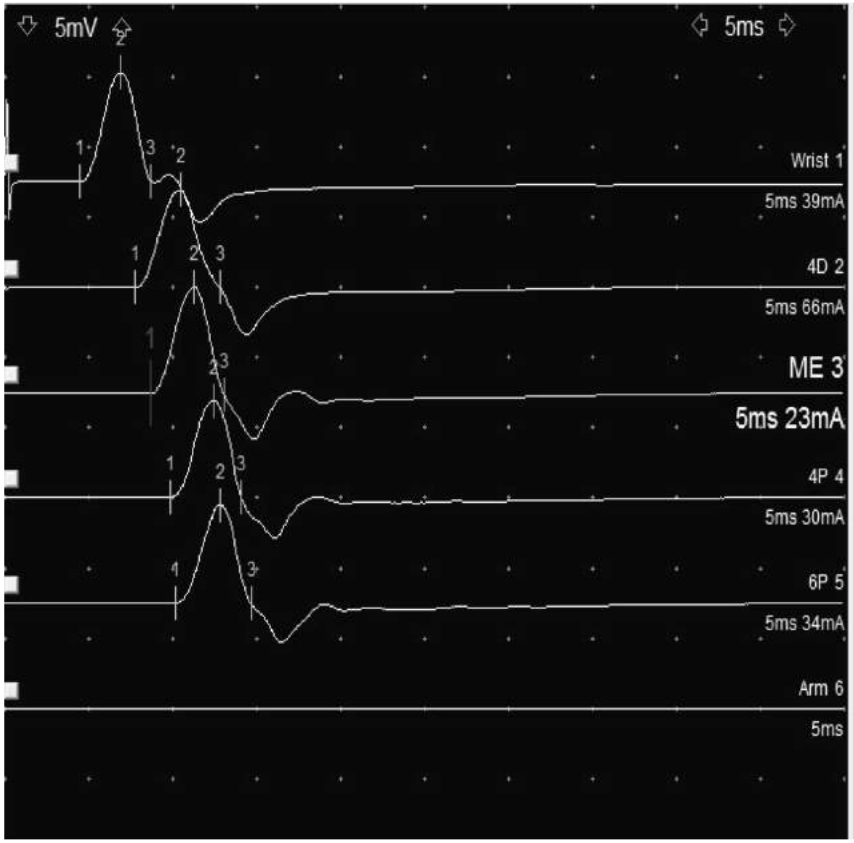


L Ulnar - Dig V

A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	Digit V	3.8	14.3	
	Ref.		≤4.0	≥15.0	
A2	BE	Digit V			
	Ref.				
A3	AE	Digit V			
	Ref.				

Left side: FDI 2 x 4cm



L Ulnar - FDI inching

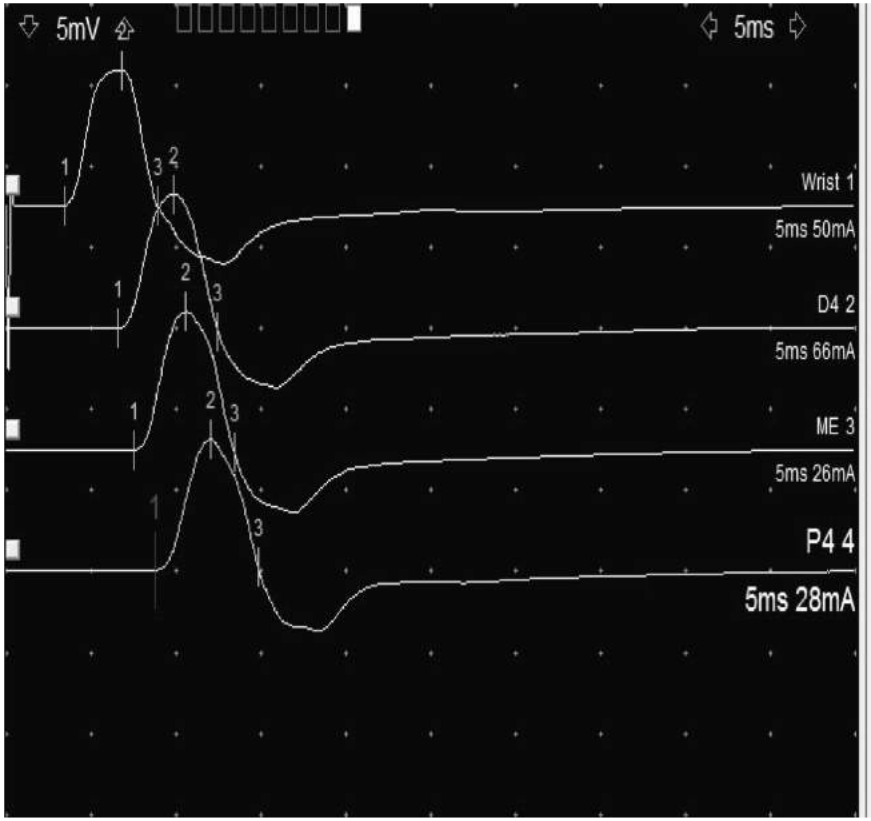
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	4.5	7.8	100
A2	4D	FDI	7.8	7.0	100
A3	ME	FDI	8.7	7.7	100
A4	4P	FDI	9.9	6.9	100
A5	6P	FDI	10.2	7.0	100
A6	Arm	FDI			
A7	2D	FDI			
A8	2P	FDI			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	4D - Wrist	19	57.6	3.30
	ME - 4D	4	**44.4**	0.90
	4P - ME	4	**33.3**	1.20
	6P - 4D	10	**41.7**	2.40
	Arm - 6P	10		
	2D - 4D	2		

RD1-22

Left side: ADM 2 x 4cm



L Ulnar - ADM InchingN

A1 A2 A3 A4 A5 A6 A7 A8

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	ADM	**3.4**	8.3	100
A2	D4	ADM	6.6	8.3	100
A3	ME	ADM	7.5	8.6	100
A4	P4	ADM	8.8	8.1	100
A5	P6	ADM			
A6	D2	ADM			
A7	P2	ADM			

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - ADM	8		
	D4 - Wrist	19	**60.3**	3.15
	ME - D4	4	**42.1**	0.95
	P4 - ME	4	**32.0**	1.25
	P6 - D4	10		
	D4 - D2	2		

RD1-22

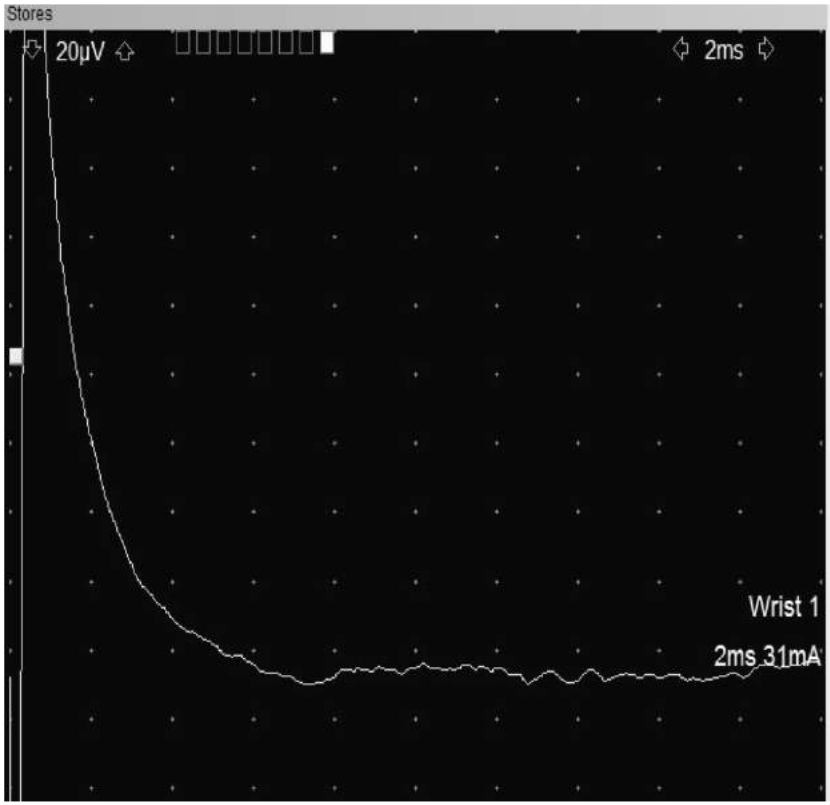
Impression (left side)

- Conduction studies of the left ulnar nerve are consistent with moderate UNE localized to the retroepicondylar groove. Conduction velocity across the elbow was marginally slow and ulnar sensory amplitudes marginally reduced. Needle EMG shows unstable muscle membrane in the ADM/FDI/FCU, with unsustained trains of positive waves and reduced recruitment patterns.

One last sample

- has complaints of bilateral hand pain with numbness for about one year. He has trouble sleeping and has severe pain in his shoulders, which he relates to his hand symptoms. He denies neck pain. He is a 15 year diabetic and is now taking insulin. He does not know his a1c. He can bring symptoms on by lying on his back or on his shoulder. He feels his whole hand goes to sleep and symptoms are worse on the right. He does not have any aggravating symptoms during the day. He does feel that he has lost some feeling and that is constant. He does not feel he is weaker. He works as a carpenter.

Median Sensory



Results Table

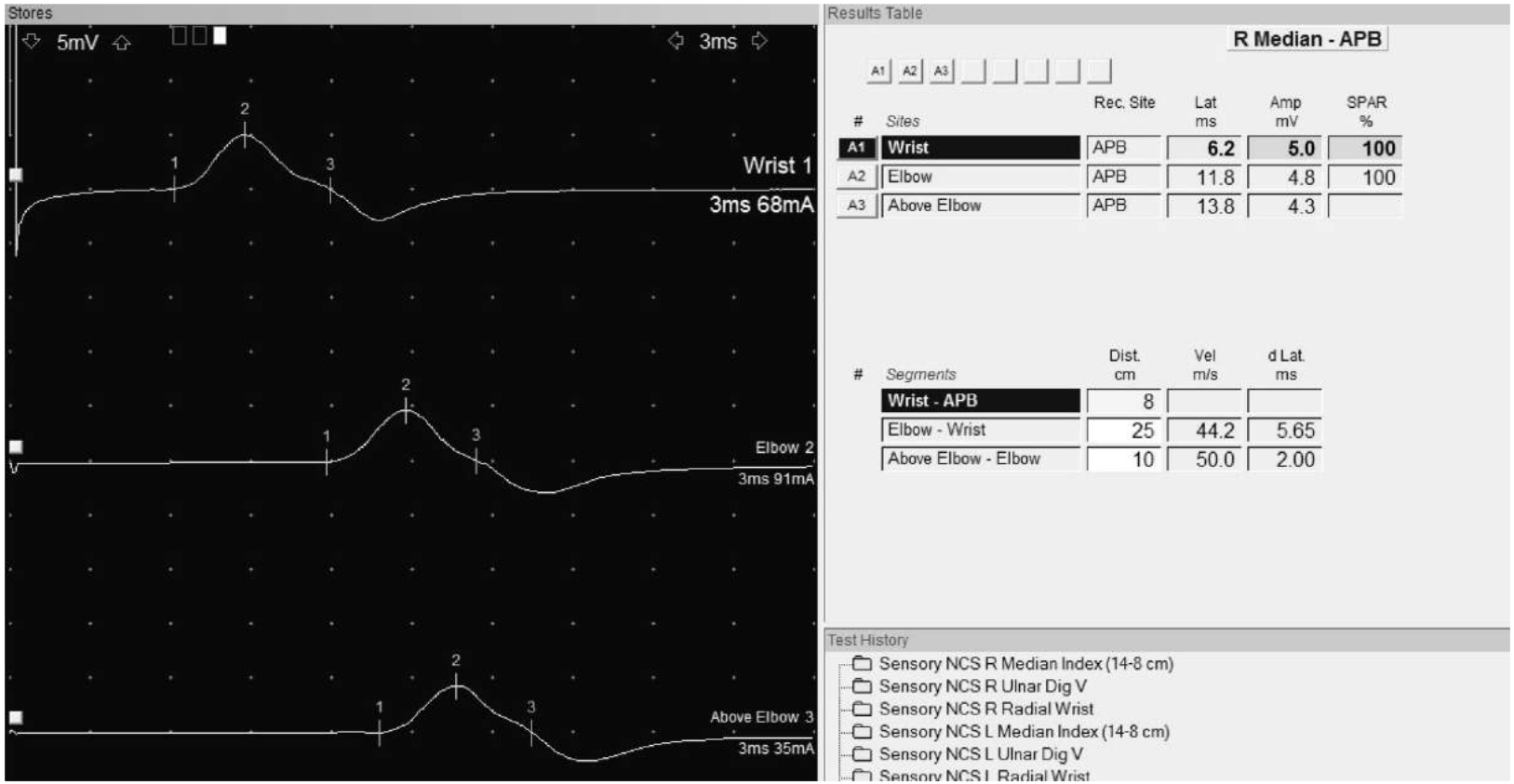
R Median - Index (14-8 cm)

A1 A2

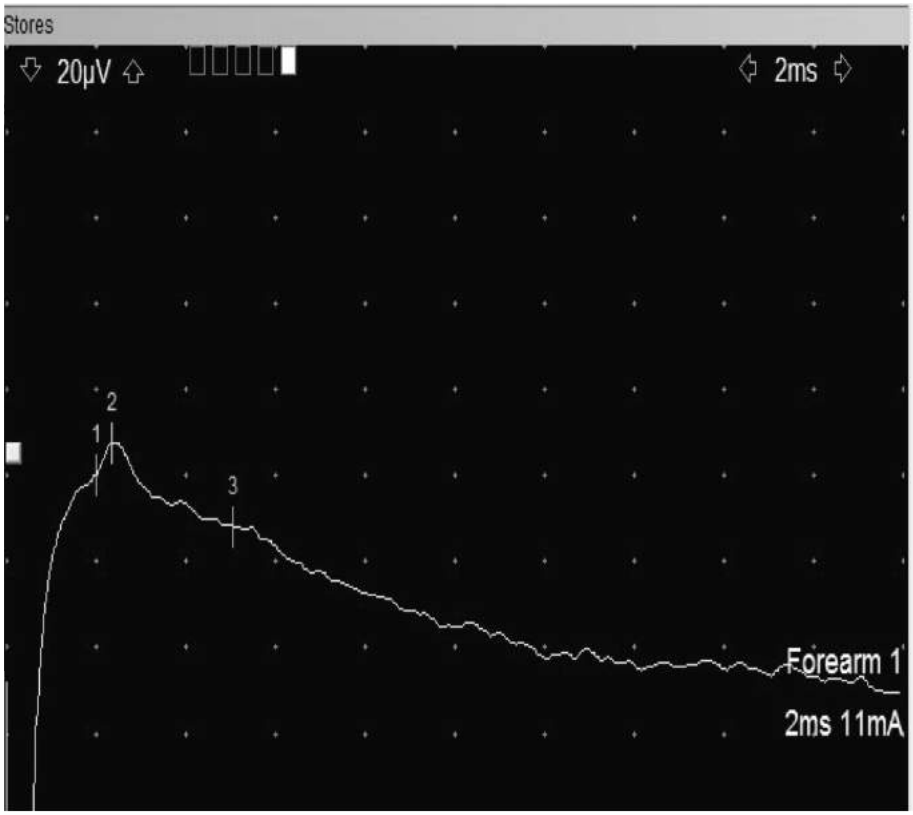
#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	**Wrist**	index	**NR**	**NR**	**NR**
	Ref.		≤3.8	≥15.0	
A2	Palm	Index			
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Wrist - index	14		**NR**	
	Ref.				
	Palm - Index	7			
	Ref.				
	Wrist - Palm		**NR**		
	Ref.		≤1.9		

Median to APB



16: Radial sensory



Results Table

R Radial - Wrist

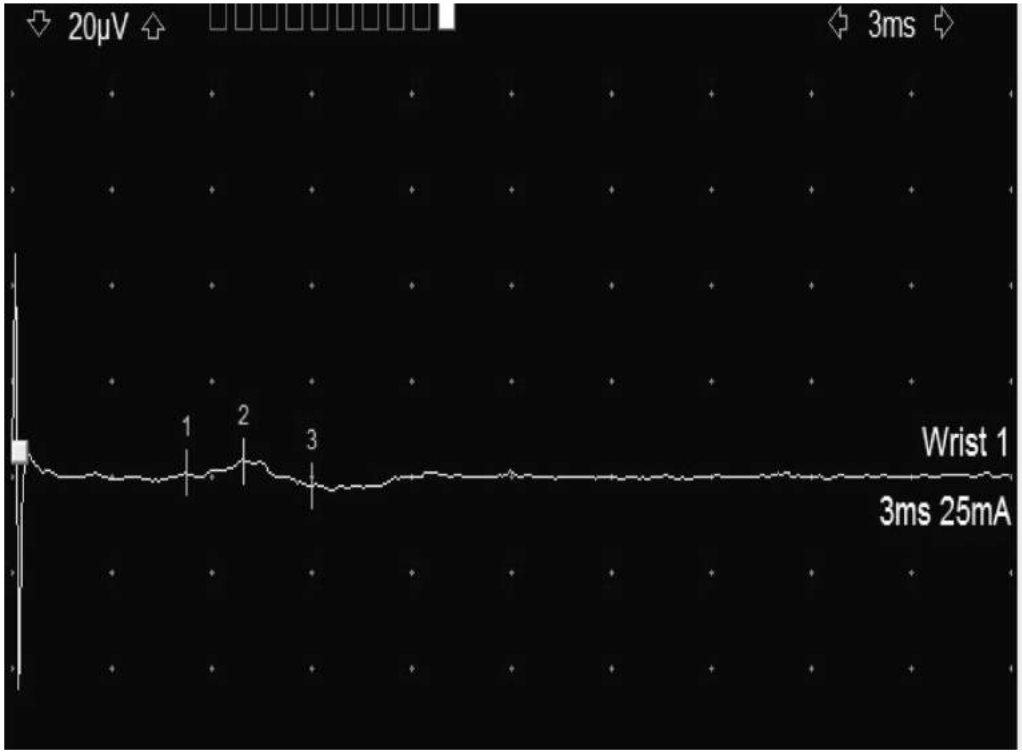
A1 A2

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Forearm	Wrist	2.4	19.5	62.5
	Ref.		≤2.8	≥11.0	
A2	2	Wrist			
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Forearm - Wrist	10		50.0	
	Ref.				
	2 - Forearm				
	Ref.				

TM1-13

16: Ulnar Sensory



R Ulnar - Dig

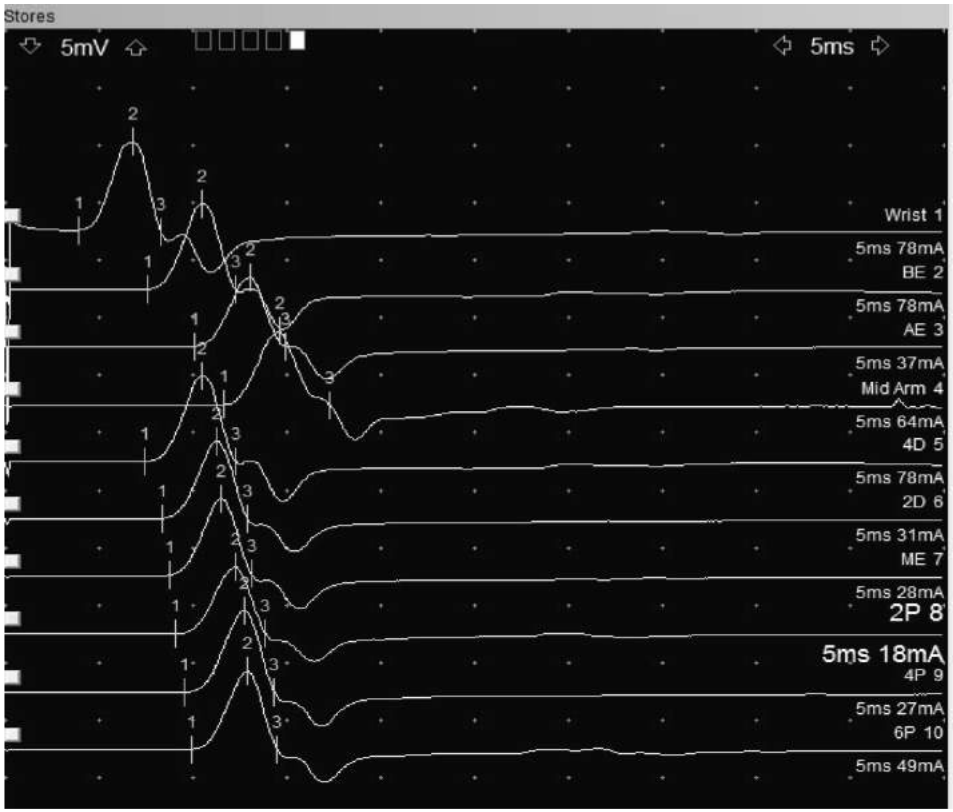
A1 A2 A3

#	Sites	Rec. Site	Peak Lat ms	PP Amp µV	SPAR %
A1	Wrist	Digit V	**7.0**	**5.6**	30.5
	Ref.		≤4.0	≥15.0	
A2	Wrist	Digit V	7.0	5.6	30.5
	Ref.				

#	Segments	Distance cm	Peak Diff ms	Vel. m/s	Temp. °C
	Wrist - Digit V	14		26.7	
	Ref.				

TM1-13

16: HUA: FDI with 5x2cm study



Results Table

R Ulnar - FDI inching

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10

#	Sites	Rec. Site	Lat ms	Amp mV	SPAR %
A1	Wrist	FDI	3.9	7.7	95.8
A2	BE	FDI	7.6	7.4	100
A3	AE	FDI	10.1	6.0	100
A4	Mid Arm	FDI	11.7	6.4	
A5	4D	FDI	7.5	7.4	
A6	2D	FDI	8.3	6.7	
A7	ME	FDI	8.8	6.7	
A8	2P	FDI	9.1	5.8	
A9	4P	FDI	9.5	7.1	

#	Segments	Dist. cm	Vel m/s	d Lat. ms
	Wrist - FDI	8		
	BE - Wrist	20	54.1	3.70
	ME - 4D	4	**30.8**	1.30
	4P - ME	4	**53.3**	0.75
	2D - 4D	2	**22.2**	0.90
	ME - 2D	2	**50.0**	0.40
	2P - ME	2	**66.7**	0.30
	4P - 2P	2	**44.4**	0.45
	6P - 4P	2	**50.0**	0.40

Summary of Clinical Pearls

- 2 x 4cm technique from FDI is recommended. Follow up with hybrid 4 x 2cm if needed and/or ADM
  - 4cm: >33 m/s
  - 2cm: > 31 m/s
  - Add location to your report (RTC or HUA or…)
- Most lesions at RTC, P2-ME (likely focal demyelination)
  - Then HUA, ME-D2 (increased severity, axonal changes more likely)
- Look for low amplitude or absent ulnar sensory response with UNE
- Overstimulation will lead to false neg studies!
- Map nerve path with submax stimulation
- Elbow position: Be consistent!
- Observe waveforms for subtle shape changes
- Place reference electrode on Thumb when using FDI to get rid of + deflection
- Inspect auto markers
  - Reset/restim any non physiologic velocities (>70 m/s)

Bibliography

Go to: www.Zotero.org
Search: Ulnar Neuropathy CSM 2018

You can download the citation list to your own Zotero library.

Or follow this link:
https://www.zotero.org/groups/2074454/ulnar_neuropathy_csm_2018