

Ulnar nerve vulnerability at elbow

Using the Sensory Nerve Action
Potential

Amplitude

Ernest W Johnson MD. Emeritus professor, PM&R The Ohio State University

Stedman – 25th Ed.

extremitas (eks-trem'i-tas)

[L. fr. *extremus*, last, outermost] [NA].

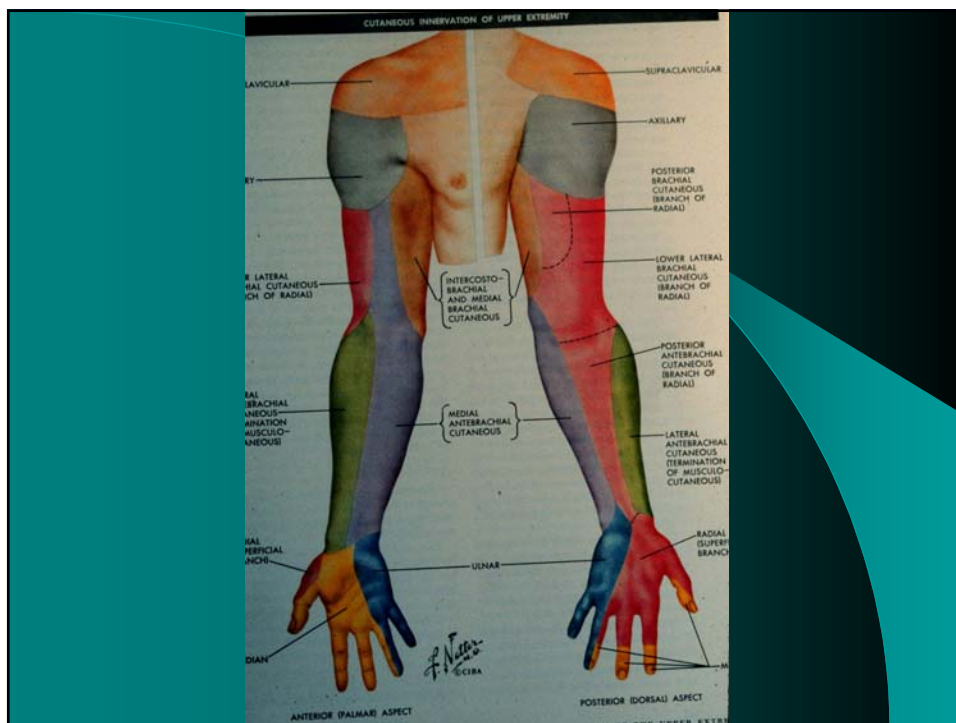
Extremity; one of the ends of an elongated or pointed structure.

Incorrectly used to mean Limb.

See membrum.

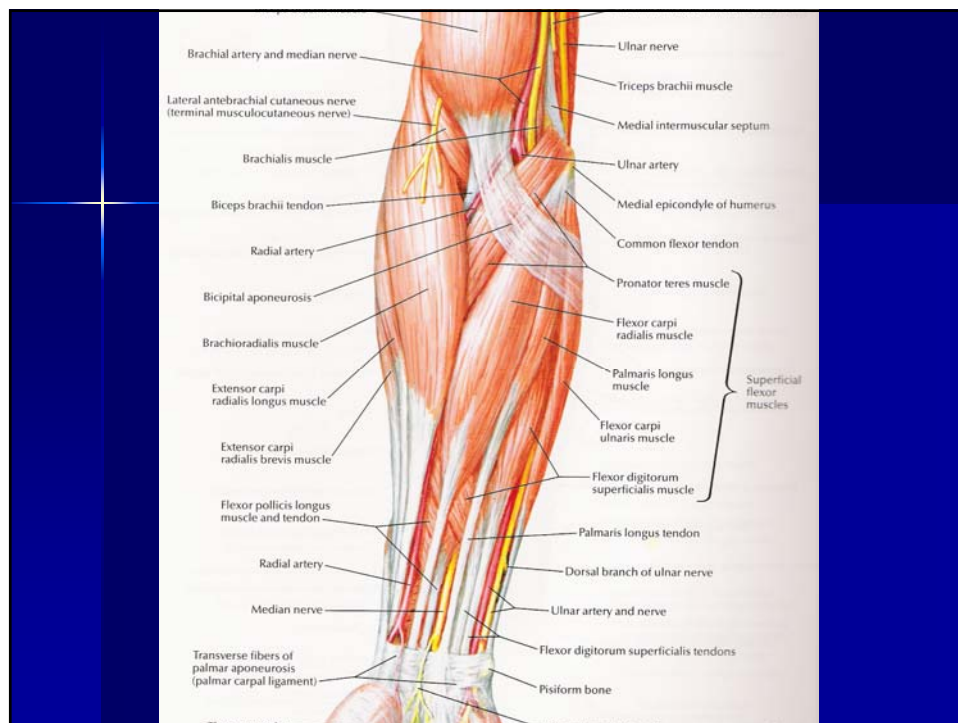
LIMBS - *not extremities*

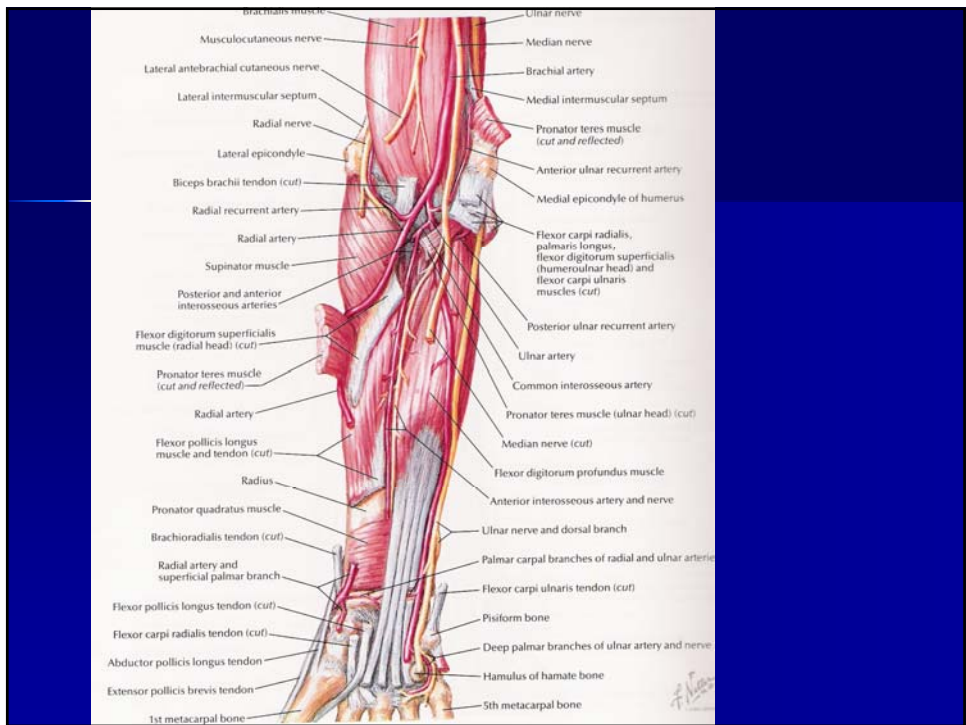
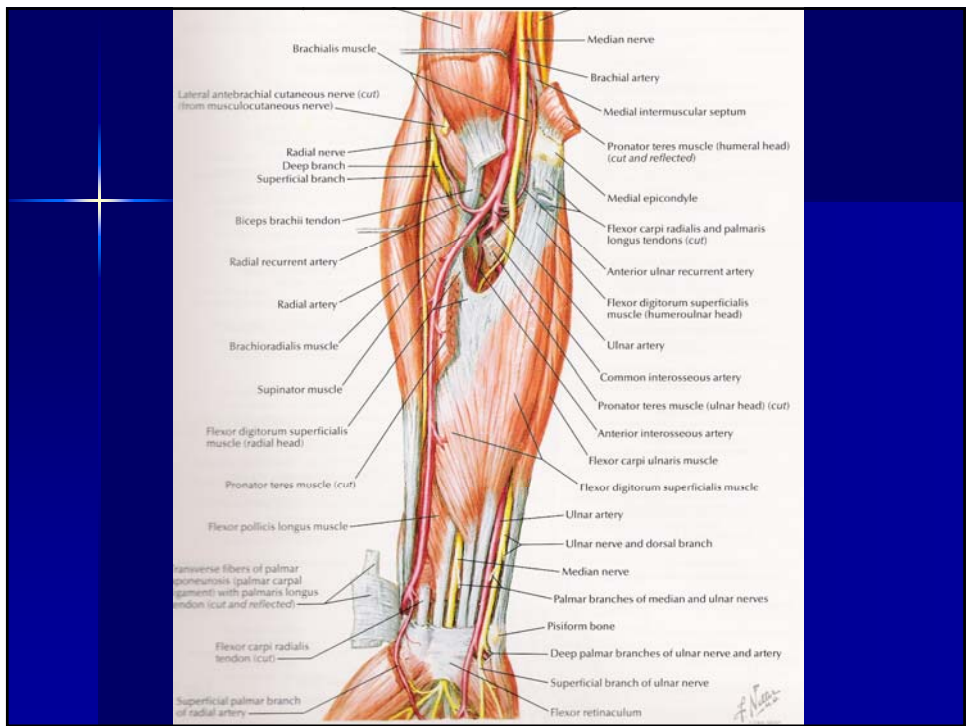
- Upper limb
 - Arm – shoulder to elbow
 - Forearm – elbow to wrist
 - Hand – this is end of limb

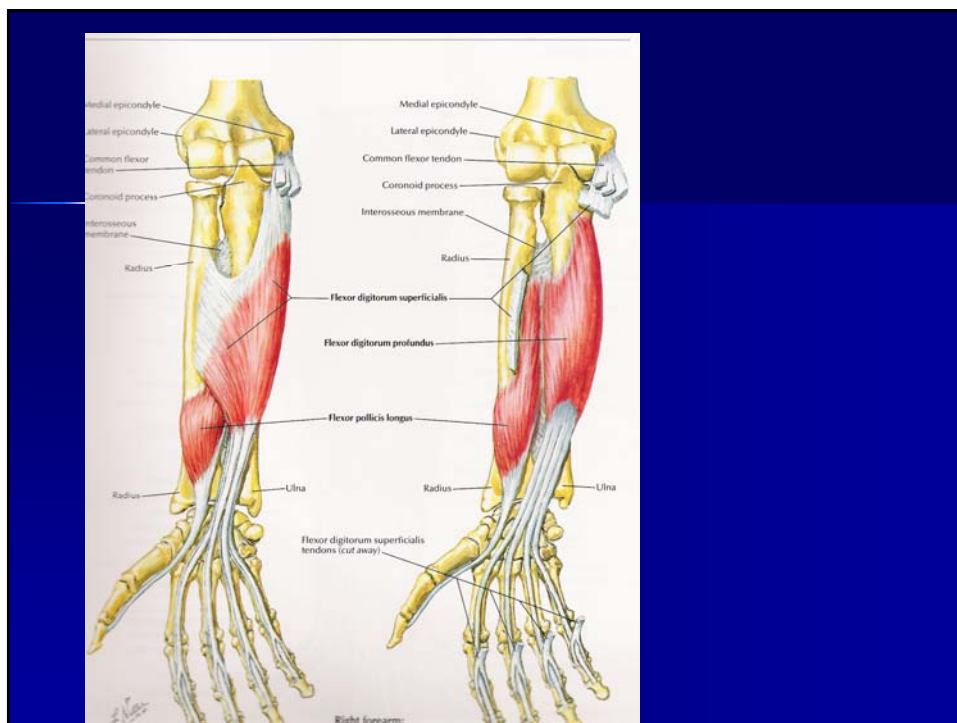
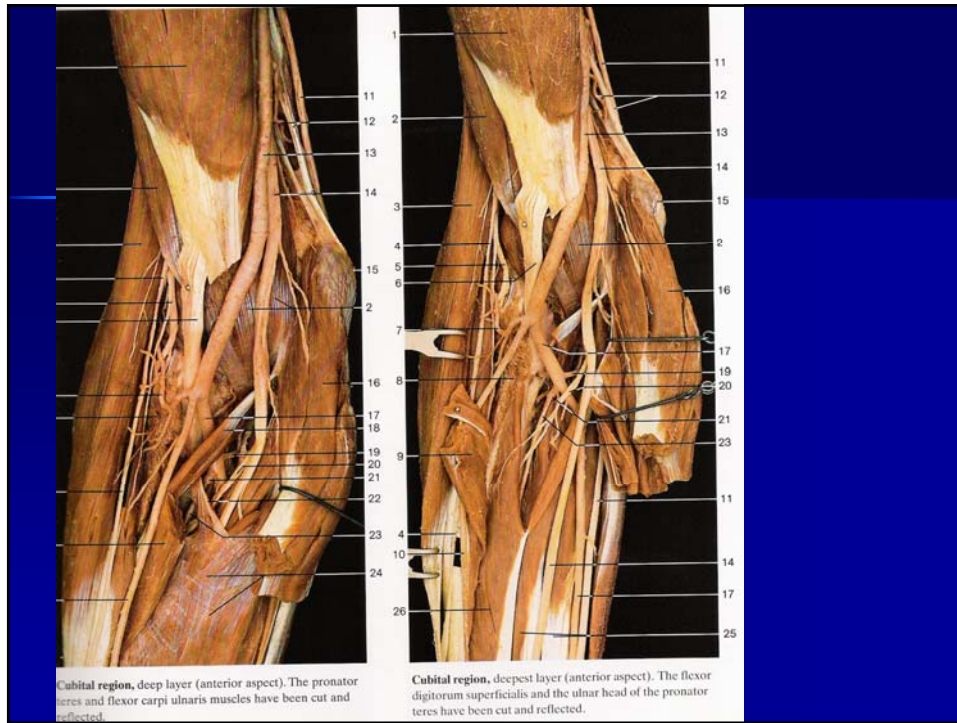


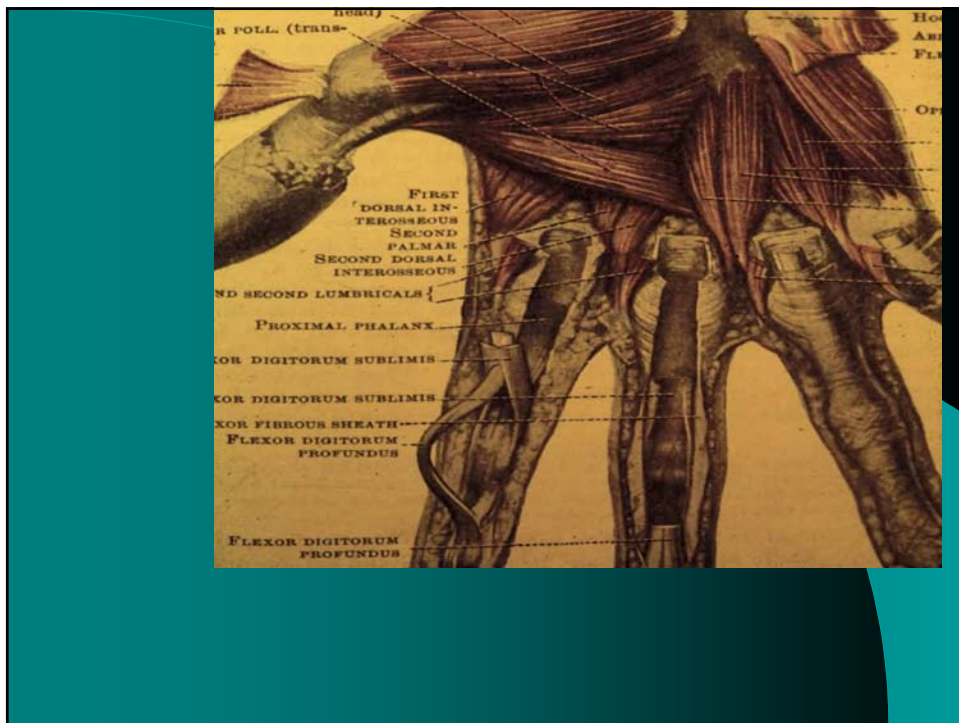
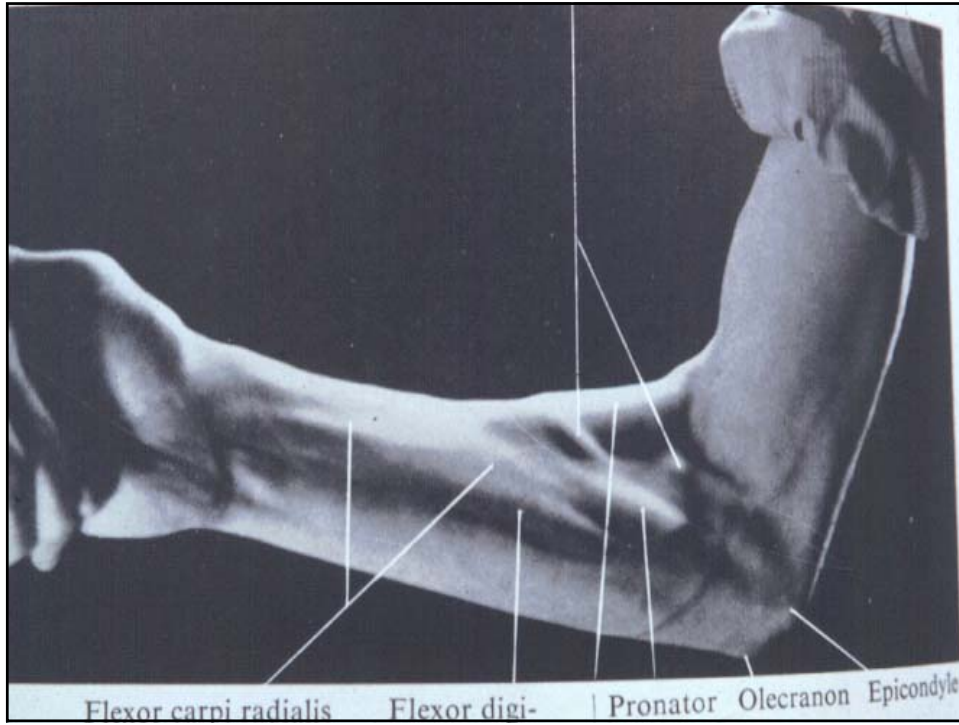
Possible entrapments

- Wrist
 - Proximal palm
 - Deep branch (tunnel)
- Elbow
 - Ulnar groove
 - Cubital tunnel



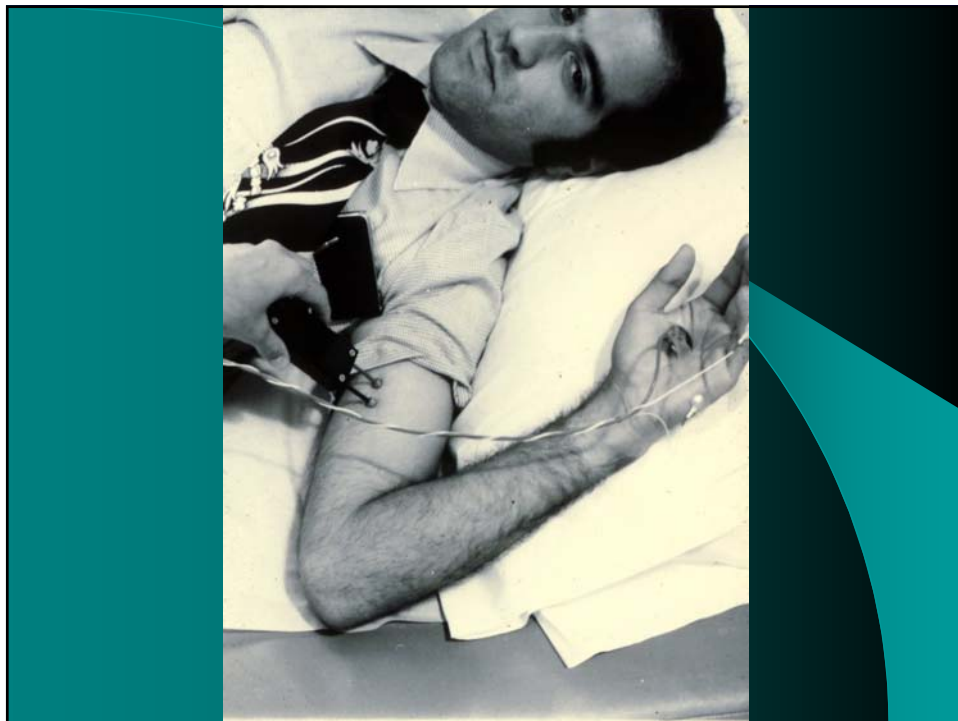






CV ulnar nerve across elbow

- Must do study with elbow flexed (70 degrees)
- Proximal conduction is **ALWAYS** faster
- Note the amplitude (reduced- if compromised at elbow)
- Include SNAP of digit 5





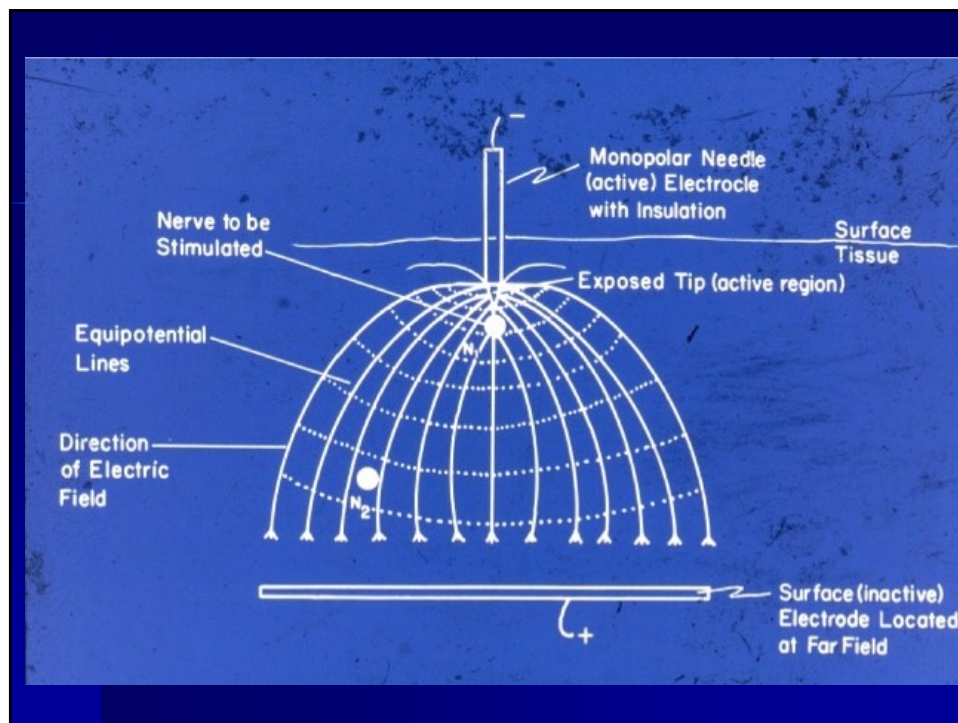
Measurement	Elbow Straight	Elbow Flexed 70°
Above to below elbow	14 cm	17 cm
Conduction Velocity		
Across elbow	47 m/s	57 m/s
Above elbow to wrist	52 m/s	62 m/s
Below elbow to wrist	56 m/s	_____

Use monopolar needle for stimulation

- Advantages –
 - Better localization
 - Less intense current (.05ms)
 - It's the duration that is painful
 - EMG'er hands are free

Monopolar needle stimulation

- Resistance can change –
 - Surface –inter-electrode of 300-400 K ohms
 - To needle – inter-electrode of 10-20 K ohms bypass cornium (high resistance)
 - Can reduce stim duration to .05 ms
 - NB. pulse duration is most painful





Monopolar needle stimulation of ulnar nerve above and below elbow

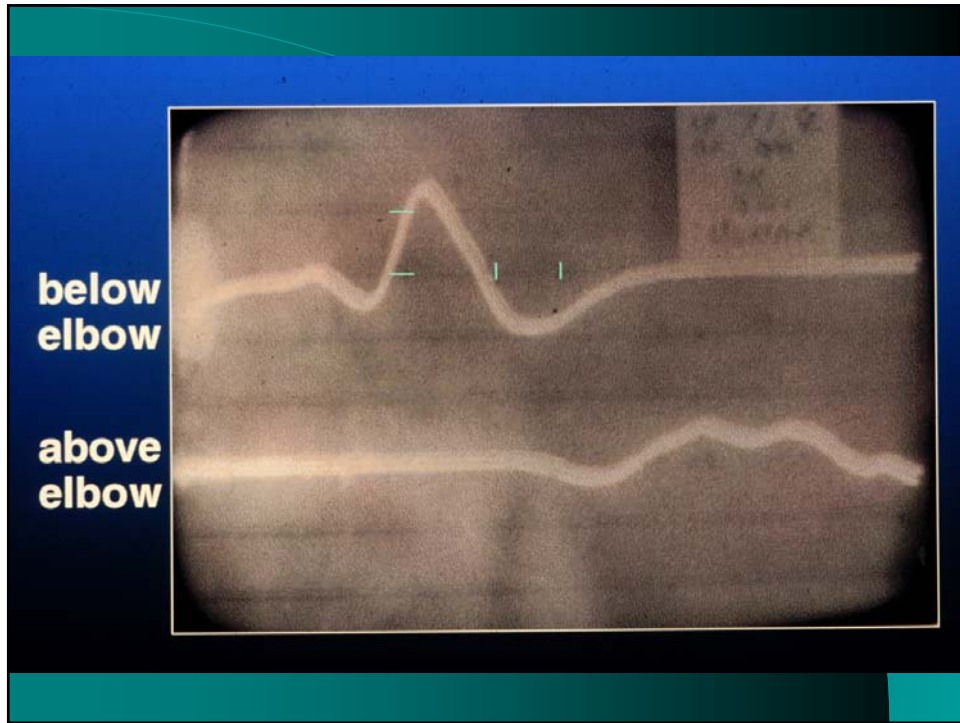
Note CMAP amplitude

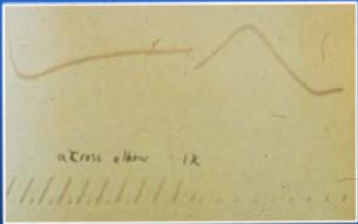
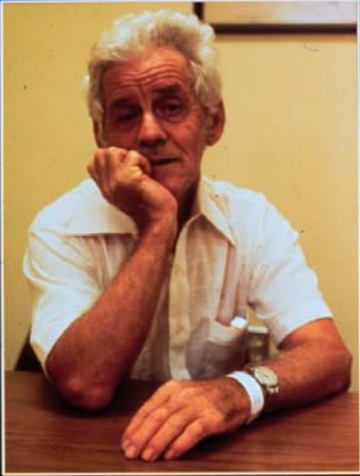
- And latency
- Conduction across elbow
- And *duration* of negative spike
- NOTE SNAP ALSO
 - Ring electrodes digit 5

Tardy ulnar nerve palsy

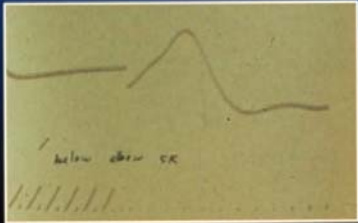
- Occurs late (15-20 years) after distal humeral fracture
- Gradual onset of weakness and numbness







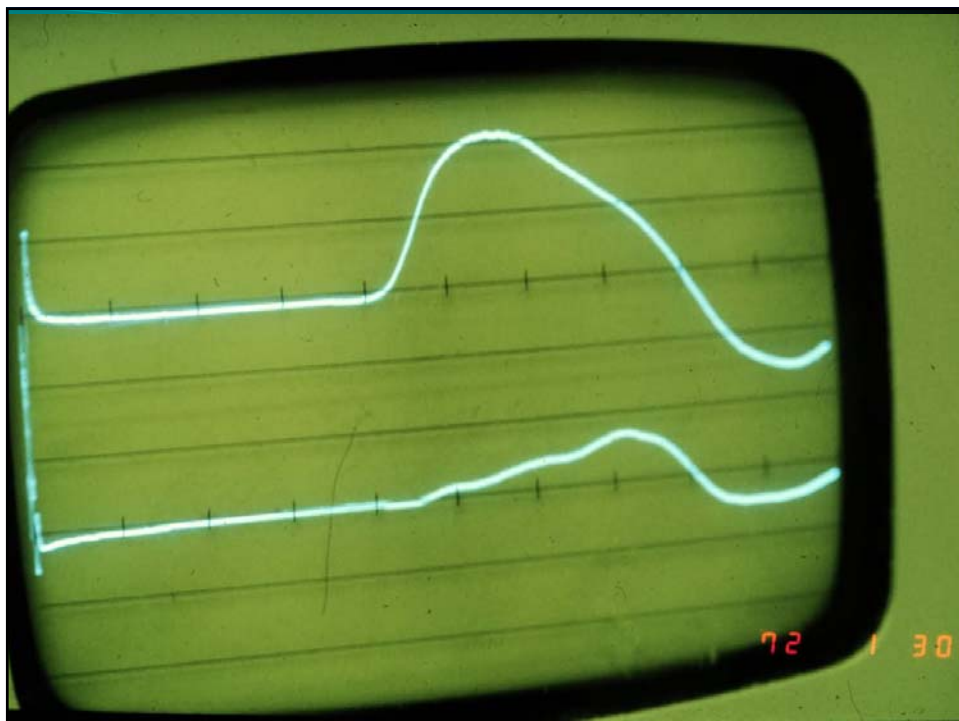
Above Elbow 1K



Below Elbow 5K

Swimmer with hand weakness

- 20 y/o backstroke swimmer
 - Put on special exercise to increase time
 - 3 months later c/o pain and weakness of hand and forearm
 - Team physician suggested tendinitis, later stress fx
 - Sent ot PM&R for consultation

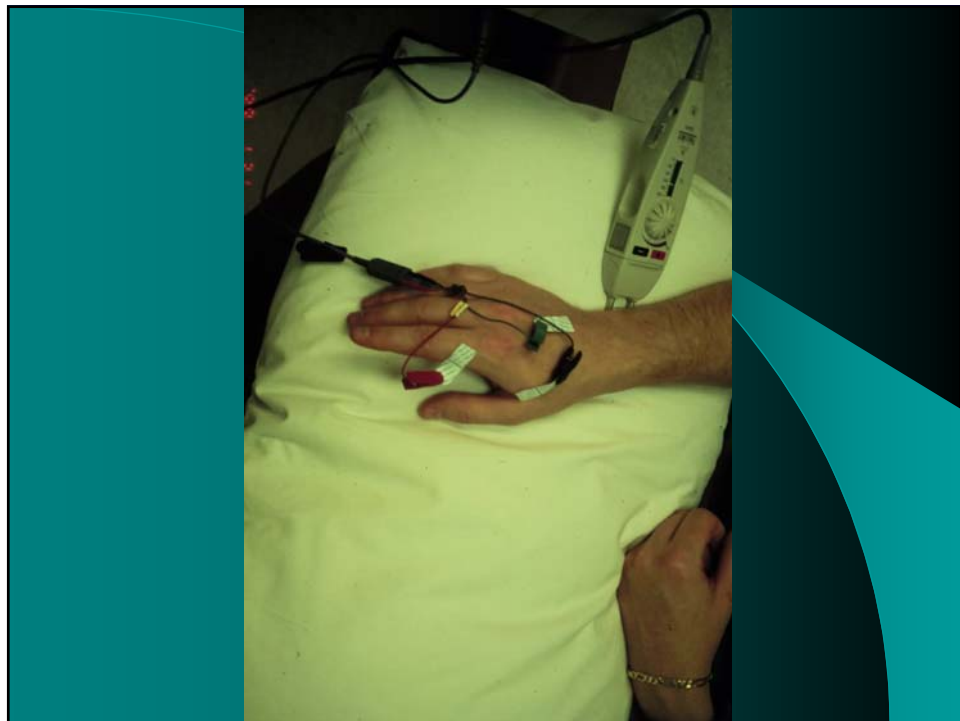
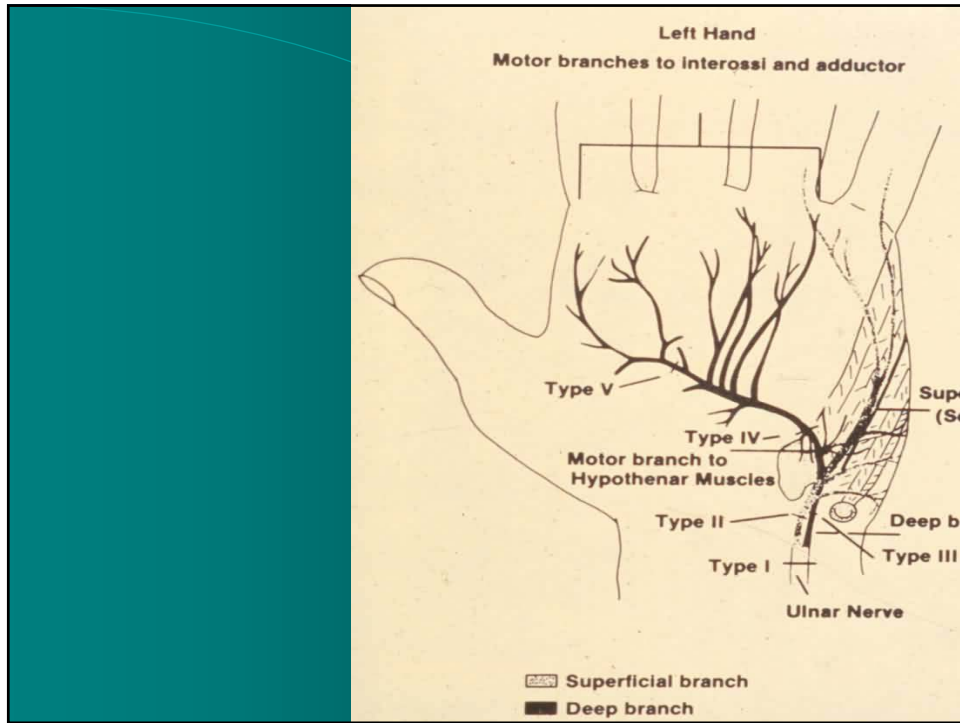


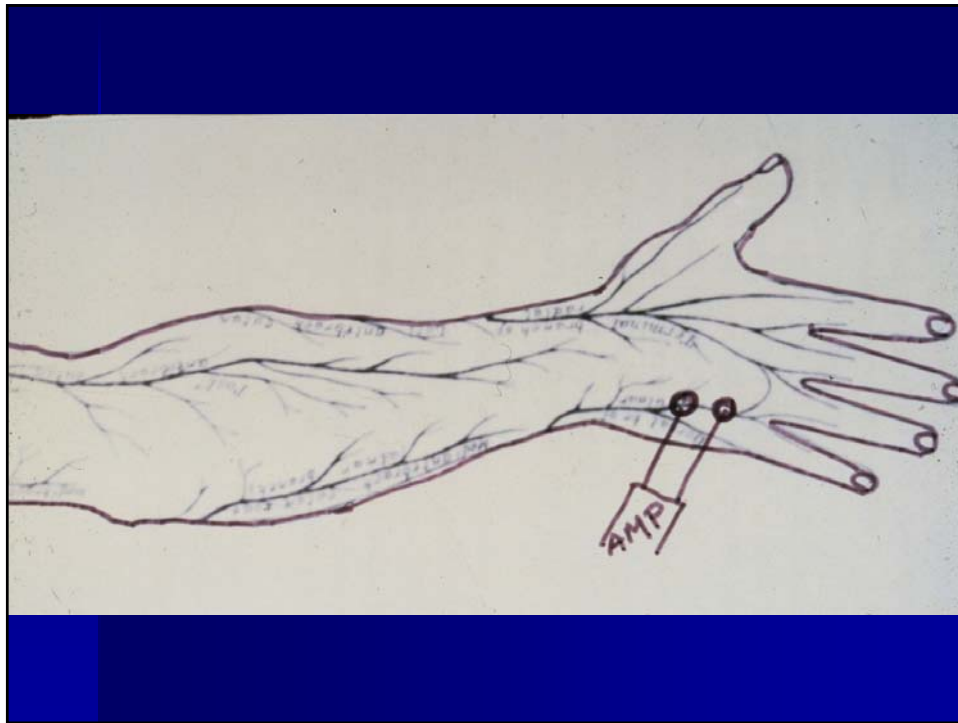
Ulnar nerve compromise at wrist

- Dorsal cutaneous branch of ulnar nerve will locate the lesion above the wrist
- SNAP of digit 5 will identify lesion at wrist (and CMAP of abd dig V)
- ***CMAP of 1st dorsal interosseus m will locate lesion at or distal to Guyon canal.***

38 y/o cyclist weakness right hand

- 100 mile trip
- Weakness right hand
- No sensory sx or deficit
- DX?????
 - What edx should be done?





Sensory SNAP

- Note the duration and amplitudes
 - Calculate the estimated loss of amplitude 2d to phase cancellation

Sensory CV

Can stimulate in only one place
Distance/Latency = CV

SENSORY NERVE CV

Can measure after the fact since
recording is directly from SNAP
(must subtract 'latency of
activation'-.1 ms)

Sensory CV

- Divide latency into distance
- To be precise, subtract .1ms from latency before division (latency of activation)
- Similar calculation for mixed nerve CV

Ulnar CV - Sensory

- Record –
 - *Digit 5 separate recording electrodes 4 cm*
 - Dorsal hand
 - *NB. If stimulating proximally also, factor in 'phase cancellation' when recording SNAP*

SNAP - antidromic

- 4 cm separation of recording

NB. Assume 50 M/s; this separation will *minimize phase cancellation*

AVERAGE: ON / STEP: 4 TEMP: 23.8 °C LEVEL: 167 U SWITCH: STIM / FREQUENCY: 0.5 Hz DURATION: 0.1 ms RECURRENT /

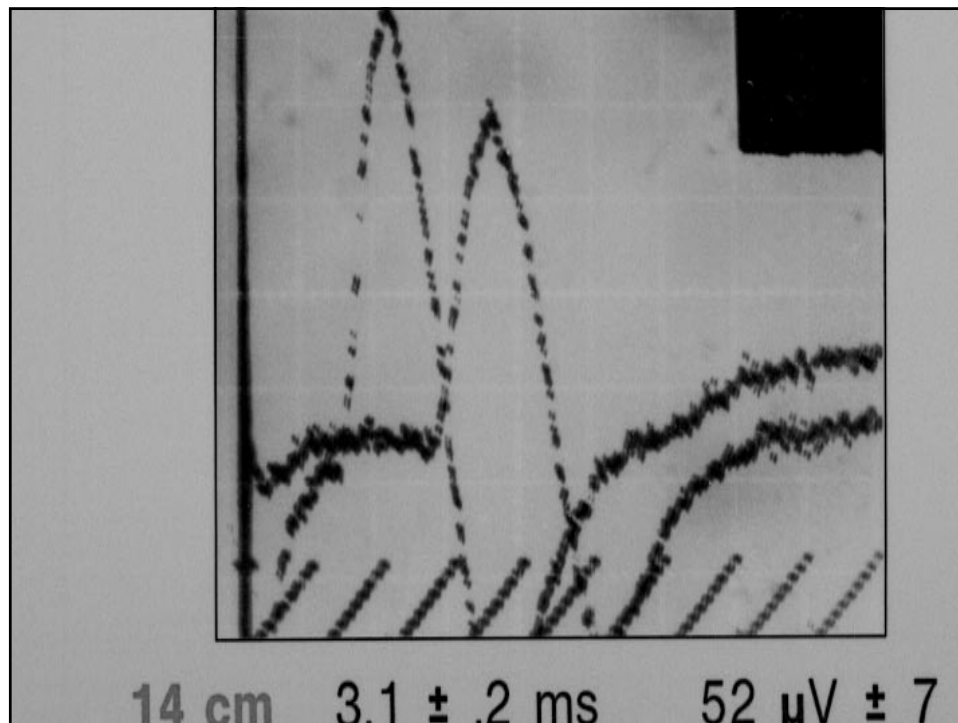


Recording Site: digit 3

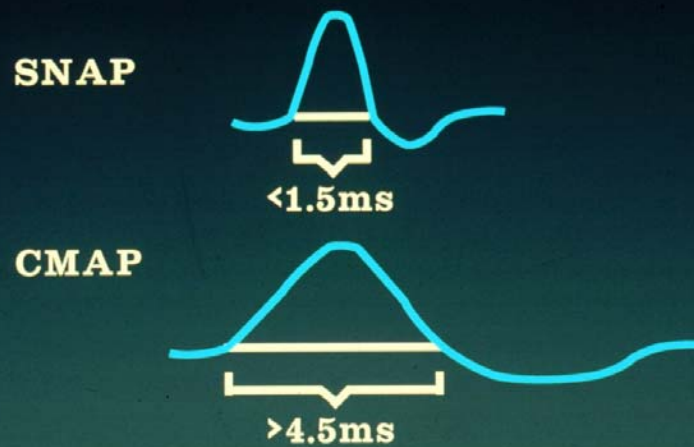
<u>Stimulus Site</u>	<u>Dur (ms)</u>	<u>Amp (µV)</u>
A1: 4 cm separation	1.7	39.74
A2: 3 cm separation	1.5	32.19
A3: 2 cm separation	1.2	29.79
A4: 1 cm separation	1.2	17.45

Cool hand will change ratio of latencies distal and proximal

- Normal – distal 7 cm is slightly more than $\frac{1}{2}$ (smaller diameter and cooler)
- If hand is very cool (sympathetic ++), distal latency > proximal latency
- Cold = increased amplitude, duration and latency

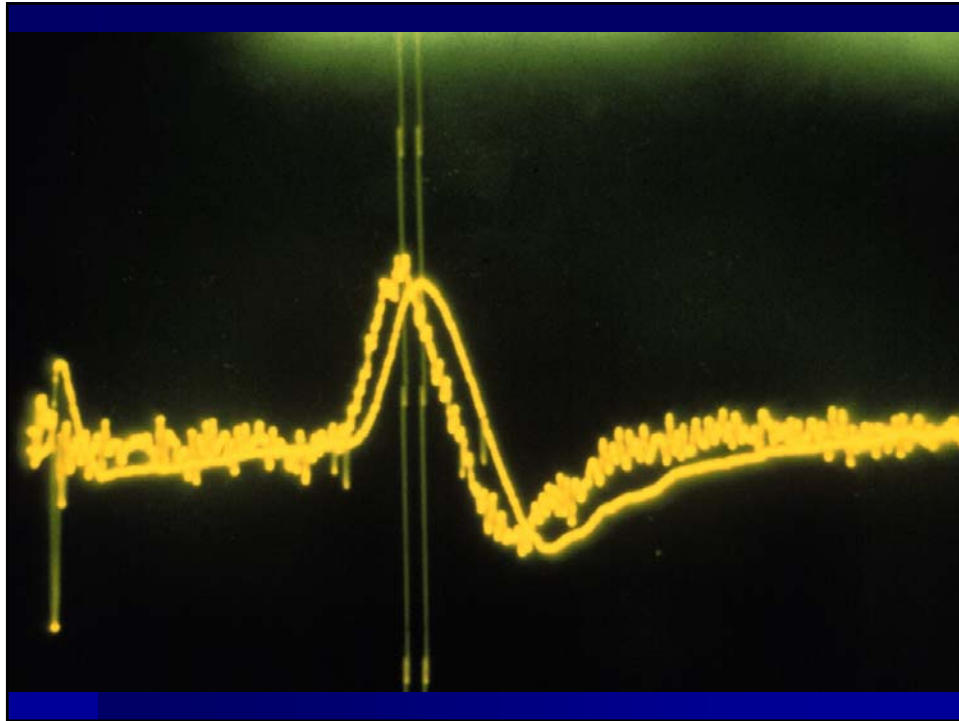


Differing SNAP and Volume Conducted CMAP



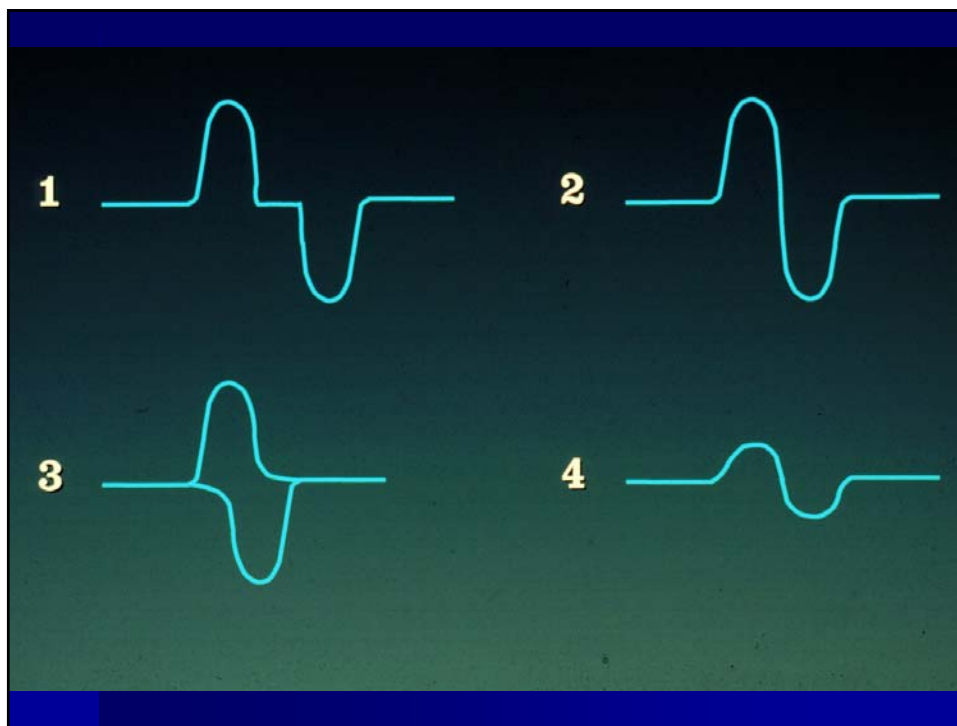
Filter settings - sensory

- Filters – open
- If use high frequency cut-off values change



Phase cancellation

- Recording from nerve directly will record from many axons
- Each axon conducts at a slightly different rate
- Slowest and fastest will cancel each other thus reducing the amplitude



Read SNAP - baseline to peak

Amplitude – baseline to peak

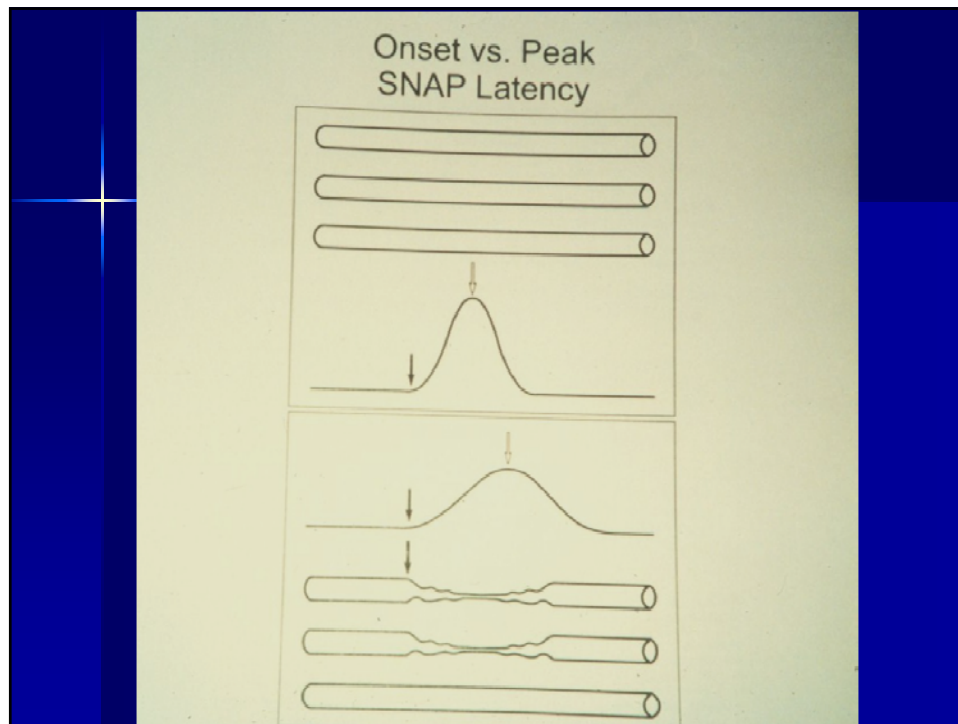
Latency to onset – fastest axons CV can be normal even if some axons conduct slowly

- If some axons are slow, PEAK latency will be longer (duration and rise time increased)



Sensory CV - measure

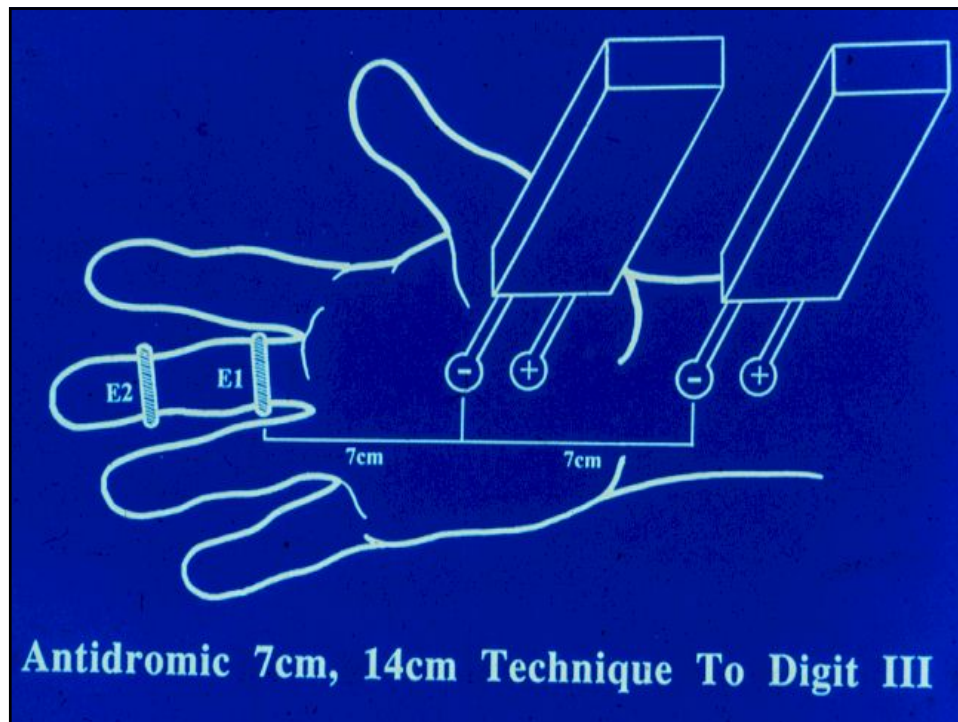
- Measure latency to peak rather than onset
 - If some axons in peripheral nerve are conducting normally and some slowly, onset will only measure the 'normal' axons
 - Peak will include the slow axons (as will rise time and duration of negative spike of SNAP)



Estimating SNAP amplitude w/prox stim

- Using wrist and mid palm stimulation and recording from digit 3 (median N)
 - 7 μ V per cm (amplitude)*
 - .2 ms per cm (latency)

*Wongsam et al: 1983. Arch Phys Med & Rehab. 64:16



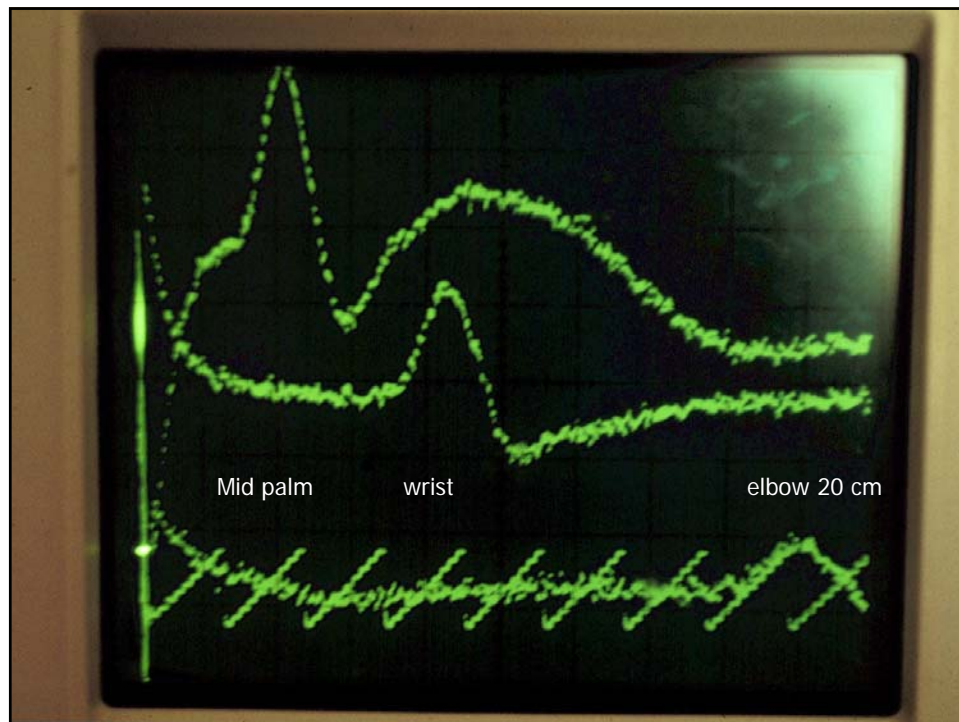
Dig 3 SNAP 7 & 14 cm

- Mean latency 1.6 ms; 3.1 ms (+/- .3ms)
- Mean amplitude 50 μ V; 40 μ V
- Cold increases amplitude and latency
- NB. Patients with Raynaud phenomenon or over-active sympathetics will have marked increases in ampl & latencies

Amplitudes										
Age group (years)	20 - 29		30 - 39		40 - 49		50 - 59		All	
No. of subjects	12		10		7		9		38	
	Mean (μ Volt)	Range (± 2 SD)	Mean (μ Volt)	Range (± 2 SD)	Mean (μ Volt)	Range (± 2 SD)	Mean (μ Volt)	Range (± 2 SD)	Mean (μ Volt)	
Wrist	L	58.1 26.7-89.5	54.5 19.6-89.4	53.7 22.3-85.1	44.8 24.6-65.0	51.0				
	R	53.1 25.4-80.1	50.6 30.4-70.8	48.0 27.6-68.4	42.0 26.0-58.0					
		(55.6)	(52.6)	(50.8)	(43.4)					
Palm	L	71.8 33.0-110.6	64.4 31.6-97.2	74.3 22.2-126.4	56.9 26.1-87.7	64.9				
	R	70.3 12.7-127.9	60.7 41.4-80.0	67.0 36.4-97.6	52.2 24.7-79.7					
		(71.0)	(62.6)	(70.6)	(54.6)					

Estimate loss of amplitude 2d to phase cancellation

- I used the data obtained in a study of median nerve SNAP latency and amplitudes from wrist and midpalm stimulation.
 - Measure baseline to peak



SNAP amplitude – phase cancellation

- SNAP at wrist – 40 uV
- SNAP at elbow – 10uV
 - 30 uV/ 20 cm = 1.5 uV –per cm
 - WNL

sensory amplitudes with proximal stimulations

- Divide distance into the difference in SNAP at midpalm and wrist
 - Estimation of phase cancellation loss of amplitude on proximal stimulation
 - *In possible compromises also note the duration of the SNAP negative spike*

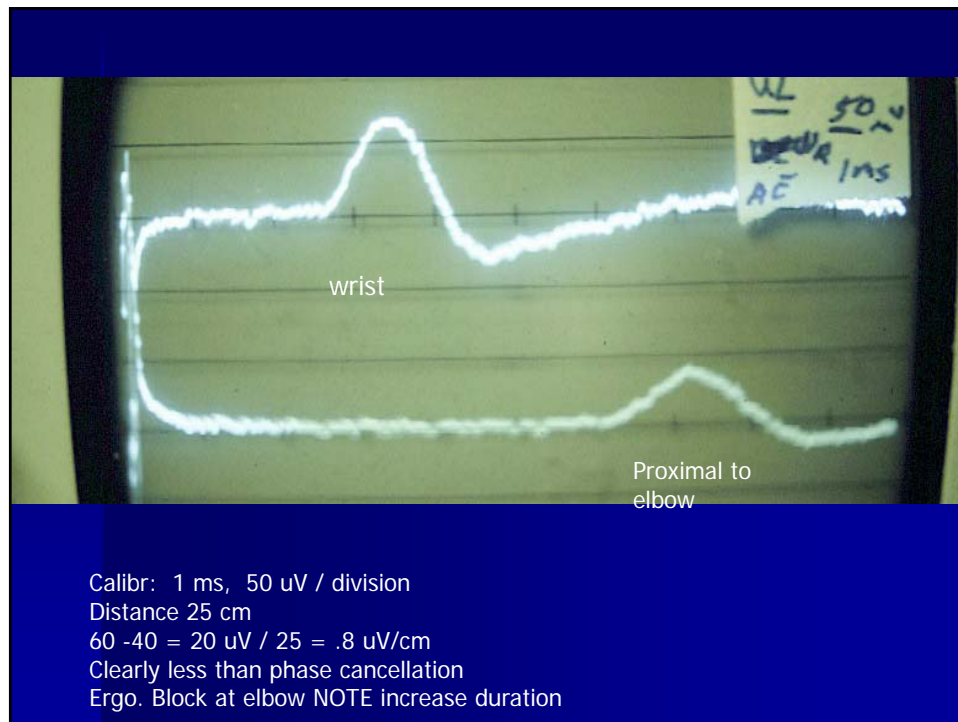
Phase cancellation and SNAP amplitudes

- Over 3 cm distance 18 μ V
- Over 2 cm distance 7-8 μ V
- Over 1 cm distance 2-3 μ V
 - *This would average to 2+ μ V/cm*
- NB. .2 ms/cm is peak latency change
In normal state

Bank teller

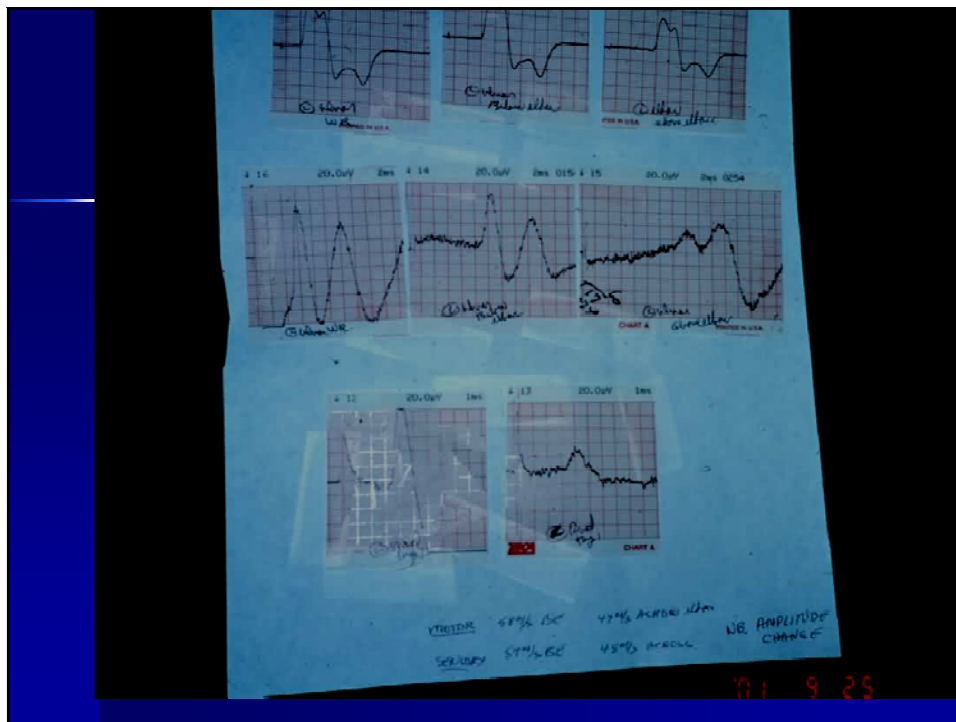
- Leaning on elbow
- Ulnar nerve traumatized between medial epicondyle and hard surface





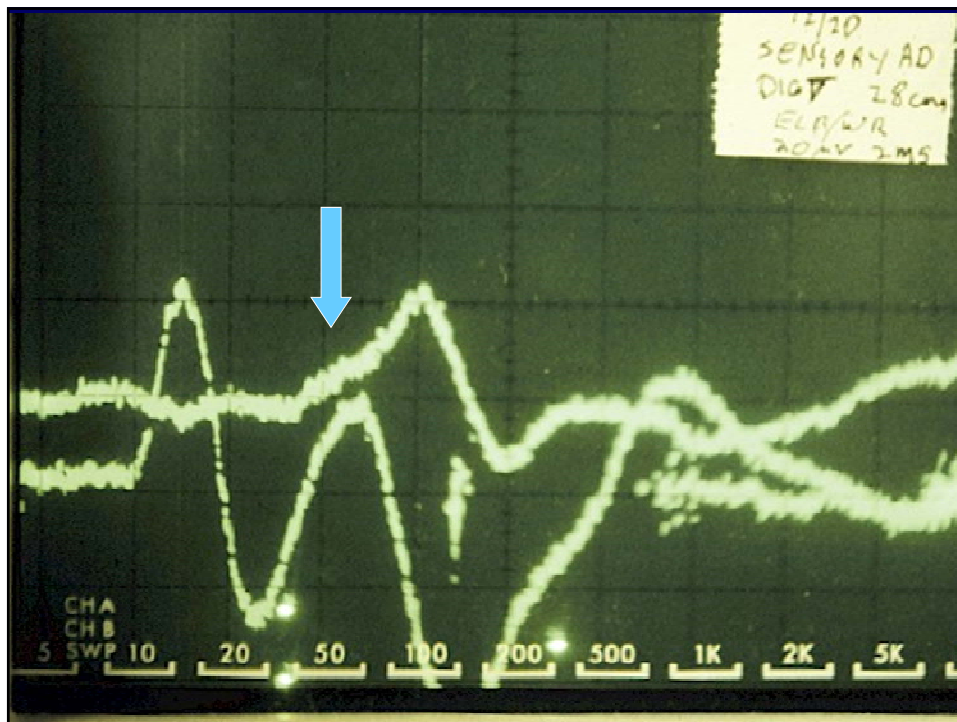
Volleyball player

- 17 y/o c/o pain in wrist for 2 months
- All imaging studies normal
- Px – slight weakness in ulnar intrinsics
- Referred for EDX
- NB. SNAP above elbow



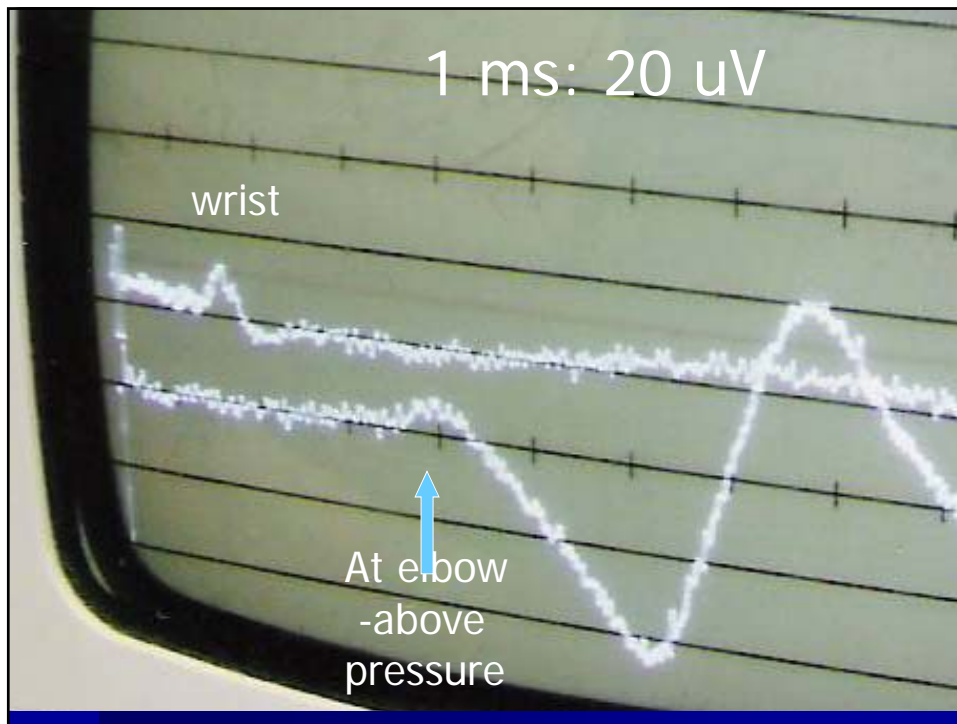
48 y/o man w/numb digit 5

- Weight lifter
 - Elbow & wrist curls
 - Left hand dominant
 - Needle EMG – fibrillation potentials and positive waves in ulnar intrinsic muscles



43 y/o truck driver

- C/O numbness left hand (digits 4,5)
- PX – ulnar nerve subluxes with elbow flexion
- MCV 53 M/sec forearm (5K); 30 M/sec across elbow (2.3 K)
- SNAP wrist 30 μ V above elbow NR



8 y/o son

- PX – ulnar nerve subluxes with elbow flexion bilaterally
- SNAP wrist 20 μ V; AE 10 μ V
- NO SX

Other techniques

- Short segment stimulation
 - Problems 'location of nerve'
 - Conduction block if <20% CMAP or <10uV over .5 ms segment*
- Stimulation median/ulnar nerves at wrist – record CNAP
 - Problems – both nerves lie close together above elbow

*Hermann et al: Mus & Nerve. 2001 24:698

CNAP – short segment across elbow

- Can record proximal or distal to compromise fo ulnar nerve
- NOTE
 - Amplitude, latency, duration of *compound nerve action potential*

SNAP amplitude & latency short segment

- Record SNAP digit V
- Adjust for distance: 1-2 $\mu\text{V}/\text{cm}$
 - Note increase of latency - .2 ms/cm
 - Note loss of amplitude – 1-2 $\mu\text{V}/\text{cm}$
 - Note duration of negative spike of SNAP

Take home message I

- Use the SNAP for nerve entrapments
 - Amplitude absent or markedly reduced if block at elbow (est. phase cancellation)
 - Negative spike duration
 - And.....latency
 - NB. *Motor CV can be misleading and less sensitive!*

Take home message

- Try monopolar needle stimulation
 - Anode must be just opposite cathode
- Ensure recording electrodes are separated by 4 cm
- Open the filters!
- Needle stimulation will bypass the cornium and reduce resistance from 400+K to 10K
(and can reduce to .05ms duration stimulation – less painfu)