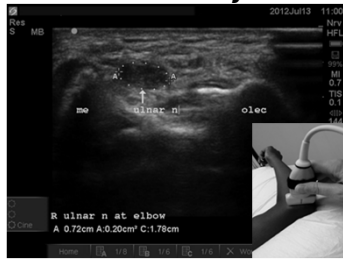
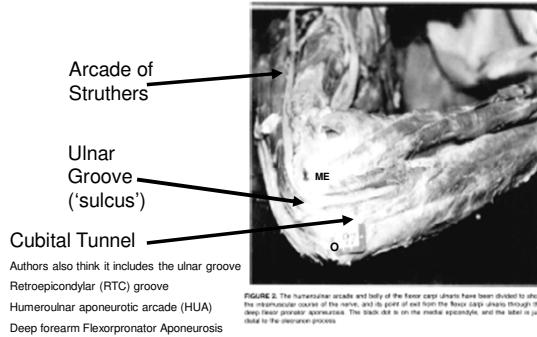


Ultrasound Imaging of the Ulnar Nerve Cubital Tunnel Syndrome



Benjamin M. Sucher, D.O., FAOCPRM-D, FAAPMR
EMG LABS of AARA
DrSucher@msn.com
North Phoenix, Mesa, Glendale, West Phoenix

Cubital Tunnel Anatomy

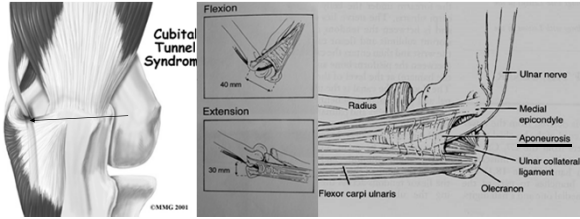


Why Ulnar Nerve is so Vulnerable at the Elbow?

1. Frequent motion exposes nerve to excess mechanical force
2. Flexion stretches/tethers nerve against medial epicondyle
3. Ulnar collateral ligament bulges medially against nerve
4. FCU aponeurosis tightens against nerve – adds to pressure
5. Subluxation exposes to friction against medial epicondyle
6. Less connective tissue protecting nerve funiculi; topography
7. Triceps intrusion compresses nerve and increases pressure
8. 'Snapping triceps' 'pushes' nerve out of the groove

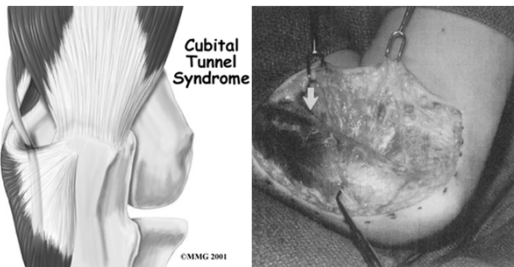


Cubital Tunnel



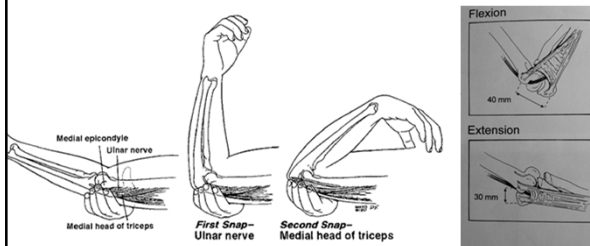
FCU - Proximal aponeurotic compression of ulnar nerve;
During elbow flexion, FCU tightens against nerve

Cubital Tunnel Snapping Triceps



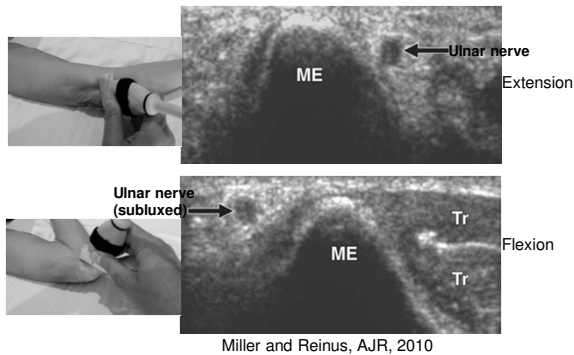
Spinner & Goldner, JBJS, 1998

Snapping Triceps Syndrome

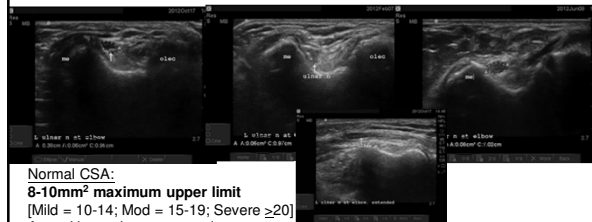


Spinner and Goldner, JBJS, 1998

Triceps Intrusion Into the Ulnar Sulcus and Ulnar Nerve Subluxation



DIAGNOSTIC ULTRASOUND of NORMAL Ulnar Nerves



Normal CSA:
8-10mm² maximum upper limit
 [Mild = 10-14; Mod = 15-19; Severe ≥20]
 Axonal loss = larger nerve size
 Bayrak, et al: M&N; 2010
 Beekman, et al: M&N; 2011
 Ormeje and Podnar: M&N; 2015 (8-11mm²)

Normal CSA:
<7mm² definitely normal in Females
<8mm² definitely normal in Males
 Peer and Bodner, 2008
 Strakowski, 2014

Normal CSA:
8-9mm² maximum upper limit
[9 = males; 8 = females]
 Cartwright, et al: Arch Phys Med Rehabil; 2007

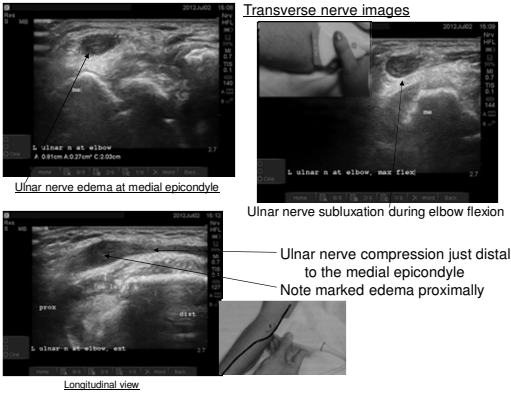
DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
 55 y/o male complains of pain, numbness and weakness in the hand for 4 months.
 Exam revealed intrinsic atrophy and weakness, decreased sensation in the medial hand and positive Tinel at the cubital tunnel

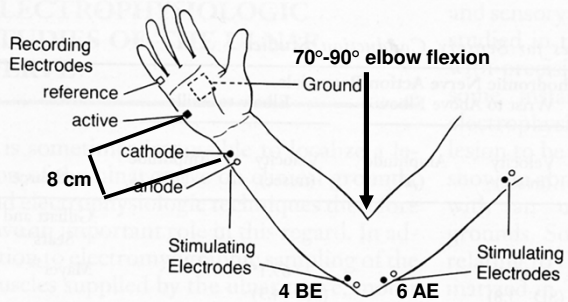
NCS:
 Ulnar motor amp = 1mV (median = 10mV)
 Forearm NCV = 49m/s
 Complete CB at elbow (No response prox stim AE)
 Ulnar sensory response unobtainable (D5 and DUC)

Needle EMG:
 2+ Fibs FDI and FCU
 Neurogenic MUPs

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury



Ulnar Motor NCV setup



NAME _____ DATE _____

ULNAR NERVE STUDY—SEGMENTAL STIMULATION TECHNIQUE

stim site	Latency (ms)	Amplitude (mV)	Segmental Conduction	Distal site/ Amp. decrement
A	_____	_____	_____	_____
B	_____	_____	_____	_____
C	_____	_____	_____	_____
D	_____	_____	_____	_____
E	_____	_____	_____	_____
F	_____	_____	_____	_____
G	_____	_____	_____	_____
H	_____	_____	_____	_____

W/L _____

Segmental Stimulation 'Inching' Technique

Latency change over a 2cm segment **>0.9 ms** is abnormal,
Or >2x all other segments

▽ = stim site
X = medial epicondyle
○ = olecranon

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

69 y/o male complains of pain, numbness and weakness in the left hand for the past several months.
Exam revealed positive Tinel at the cubital tunnel

NCS:

Ulnar motor amp = 9mV distally to elbow
6mV proximal
~30% conduction block

Needle EMG:

1+Fibs
Normal recruitment
[mild denervation]

Forearm NCV = 53m/s
Across Elbow NCV = 35m/s [moderate slowing]

Segmental ('Inching') Motor Study:

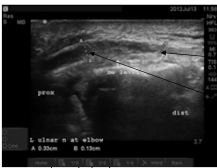
Max delay (+ amp loss) at medial epicondyle and just proximal

Ulnar sensory response = 7 mcv bilaterally

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury



Transverse nerve images



Longitudinal view

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

84 y/o male complains of pain, numbness and weakness in the right hand for several years.
Exam revealed mild right intrinsic weakness, Tinel at the cubital tunnel

NCS:

Ulnar motor amp = 5mV distally to elbow
4.5mV proximal

Needle EMG:

Normal
[no ulnar denervation]

Forearm NCV = 51m/s
Across Elbow NCV = 38m/s [mild-moderate slowing]

Segmental ('Inching') Motor Study:

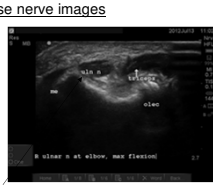
Max delay just distal to medial epicondyle

Ulnar sensory response = 4 mcv right [14mcv left]

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury



Ulnar nerve edema at medial epicondyle



No Ulnar nerve subluxation during elbow flexion
But triceps intrusion (no ulnar nerve compression)



Longitudinal view

Ulnar nerve compression just distal to the medial epicondyle
Note marked edema proximally

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
64 y/o female complains of pain and numbness in the left hand for the past several months.
Exam revealed decreased sensation in the left medial hand, and a positive Tinel test at the cubital tunnel

NCS:
Ulnar motor amp = 13mV distally to elbow
12.9mV proximal

Needle EMG:
Normal
[no ulnar denervation]

Forearm NCV = 62m/s
Across Elbow NCV = 55m/s [very mild, relative slowing]

Segmental ('Inching') Motor Study:
Max delay at medial epicondyle (1.2ms; all other segments .3ms)
No amplitude loss

Ulnar sensory response = 11 mcv left [13mV right]

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Transverse nerve images



Ulnar nerve edema at medial epicondyle

No Ulnar nerve subluxation during elbow flexion, but triceps intrusion (ulnar nerve compression)



Longitudinal view

Ulnar nerve edema medial epicondyle
Note enlargement proximally

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
 54 y/o male complains of weakness and tingling in the right hand for the past 3 months.
 Exam revealed right intrinsic atrophy and weakness, and a positive Tinel test at the cubital tunnel

NCS:
 Ulnar motor amp = 3.6mV distally to elbow
 3.3mV proximal

Needle EMG:
 2+ fibs FDI
 (and dec recruitment)

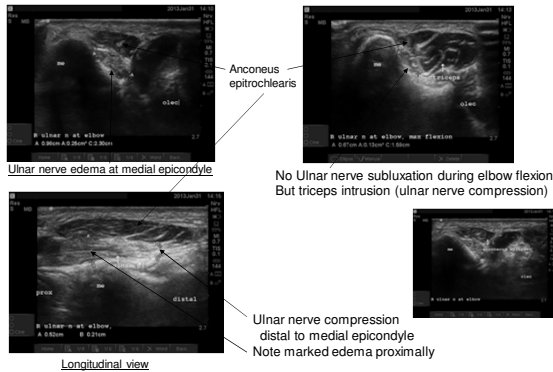
Forearm NCV = 56m/s
 Across Elbow NCV = 37m/s [moderate slowing]

Segmental ('Inching') Motor Study:
 Max delay at medial epicondyle (1.4ms; all other segments .4-.5ms)
 No amplitude loss

Ulnar sensory response = 2 mcv

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Transverse nerve images



DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
 48 y/o male complains of numbness/tingling in the left hand for the past 2 years.
 Exam revealed a positive Tinel test at the left cubital tunnel

NCS:
 Ulnar motor amp = 18mV distally to elbow
 18mV proximal

Needle EMG:
 normal

Forearm NCV = 55m/s
 Across Elbow NCV = 45m/s [mild slowing]

Segmental ('Inching') Motor Study:
 Max delay just proximal to medial epicondyle (.9ms; all other segments .3-.5ms)
 No amplitude loss

Ulnar sensory response = 25 mcv (28 mcv right)
 Mixed nerve latency = 7.6ms (right = 6.8ms) med-uln dif = 1.1ms left (.5ms right)

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Transverse nerve images

Ulnar nerve edema at medial epicondyle

Ulnar nerve partial subluxation during elbow flexion ('high-riding')
Triceps intrusion ('pushes' ulnar nerve over the medial epicondyle)

Ulnar nerve edema just proximal to the medial epicondyle
Note slight edema proximally

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
67 y/o female complains of numbness/tingling in the left hand for the past 2 months.
Exam revealed a positive Tinel test at the left cubital tunnel and decreased sensation in the left medial hand

NCS:
Ulnar motor amp = 9mV distally to elbow
7mV proximal

Needle EMG:
normal

Forearm NCV = 53m/s
Across Elbow NCV = 43m/s [mild slowing]

Segmental ('Inching') Motor Study:
Max delay at medial epicondyle (1.1ms; all other segments .3-.5ms)
Amplitude loss 1.1mV across 2cm segment at medial epicondyle

Ulnar sensory response = 10 mcv
Mixed nerve latency = 5.8ms; med-uln dif = 1.3ms

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Transverse nerve images

Ulnar nerve edema at medial epicondyle

Ulnar nerve partial subluxation during elbow flexion ('high-riding')
Triceps intrusion ('pushes' ulnar nerve over the medial epicondyle)

Longitudinal view

Ulnar nerve edema at medial epicondyle
Note edema proximally

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

52 y/o male complains of numbness, tingling and weakness in the left hand for the past 2 years.
Exam revealed mild left hand intrinsic atrophy and weakness, sensory loss in the left medial hand, and a positive Tinel test over the medial elbow

NCS:

Ulnar motor amp = 8.8mV distal to elbow
[15mV opposite side]

Needle EMG:

2+ fbs FDI
(and dec recruitment)

Forearm NCV = 56m/s

Across Elbow NCV = 38m/s [moderate slowing]

Segmental ('Inching') Motor Study:

Max delay just distal to medial epicondyle (2.0ms; all other segments .3-.5ms)

No amplitude loss across elbow

Ulnar sensory response = 4.6 mcv [11.9mcv opposite side]

Ulnar mixed nerve latency across elbow = 8.3ms [median = 6.5ms]

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Transverse nerve images

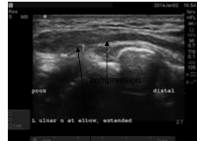


Ulnar nerve

Longitudinal view



Ulnar nerve subluxation during elbow flexion
Triceps intrusion ('pushes' ulnar nerve over the medial epicondyle)



Ulnar nerve edema at medial epicondyle

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

68 y/o male complains of pain, numbness and tingling in the right medial hand for the past several years.
Exam only revealed a mild positive Tinel test over the right medial elbow

NCS:

Ulnar motor amp = 15mV (proximal and distal)
[17mV opposite side]

Needle EMG:

Normal to FDI and FCU

Forearm NCV = 60m/s

Across Elbow NCV = 63m/s [no amplitude drop proximal to elbow]

Ulnar sensory response = 12mcv [13mcv opposite side]

Ulnar mixed nerve latency across elbow = 6.6ms [median = 6.0ms]

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury
Transverse nerve images

Ulnar nerve

Ulnar nerve subluxation during elbow flexion; Triceps intrusion ('pushes' ulnar nerve over the medial epicondyle)

Longitudinal view

Ulnar nerve edema at medial epicondyle

THE ELECTRODIAGNOSTIC REPORT

Report the abnormality (Interpretation):
 "...mild-moderate ulnar motor slowing across the elbow, and moderate loss of response amplitude (55%) from stimulation proximal to the elbow, consistent with a focal demyelinating conduction block lesion. Low amplitude ulnar sensory response is consistent with axon loss injury"

Diagnostic ultrasound imaging (high resolution, 4-15MHz linear transducer) of the right elbow reveals moderate-marked increase in the cross-sectional area of the ulnar nerve (18mm²; normal <9mm²) at the level of the medial epicondyle (transverse imaging), and partial loss of fascicular echotexture, consistent with nerve edema. Longitudinal imaging does not reveal any significant focal narrowing or compression of the ulnar nerve, but marked increase in ulnar nerve diameter (and loss of fascicular echotexture) is noted at the level of the medial epicondyle and just proximally. Motion studies (transverse imaging) reveal ulnar nerve subluxation during elbow flexion (>90 degrees) and prominent triceps muscle intrusion into the ulnar sulcus at maximum flexion (with moderate ulnar nerve compressive effect).

Summarize with 'Impressions' or 'Conclusions':
 "Ulnar mononeuropathy – localized at the elbow (medial epicondyle); consistent with cubital tunnel syndrome; moderate, electrically"

DIAGNOSTIC ULTRASOUND – Triceps STRESS Test
Transverse nerve images

Ulnar nerve

Ulnar nerve; Triceps intrusion, and mild nerve compression, worse with stress test during isometric contraction

Longitudinal view

Compression distally (cubital tunnel)

Ulnar nerve edema at medial epicondyle

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:
75 y/o male complains of pain, numbness and tingling in the left medial hand for the past year. He admits to leaning heavily on his elbow frequently. Exam revealed intrinsic atrophy and weakness, positive Tinel at medial elbow

NCS:
Ulnar motor amp = 6.3mV (4.8mV proximal; mild CB) [9.5mV opposite side]

Needle EMG:
1+ fibs FDI
Neurogenic firing

Forearm NCV = 53m/s
Across Elbow NCV = 36m/s [24% amplitude drop proximal to elbow]
Segmental ('inching') – max delay just distal to ME at cubital tunnel [1.3ms delay; other segments .3-.7ms]

Ulnar sensory response = 4mcv

Treatment Implications

Multi-faceted:

1. Avoid excessive elbow flexion (tape or brace into extension at night)
2. Avoid external pressure to medial elbow (padded sleeve for daytime use)
3. Avoid repetitive flexion-extension activities ('friction neuritis')
4. Discontinue triceps strengthening (no 'bulk-building')
5. Steroid injection (due to edema), just proximal to medial epicondyle
6. Surgery - decompression/release, transposition, muscle resection, osteotomy?
7. Consider Botox injections??

Rampen, M&N 2011; Spinner, JBJS, 1998

Ultrasound Imaging of the Ulnar Nerve At the Wrist



Benjamin M. Sucher, D.O., FAOCPRM-D, FAAPMR
EMG LABs of AARA
DrSucher@msn.com
North Phoenix, Mesa, Glendale, West Phoenix

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

44 y/o male complains of right hand pain, numbness and tingling, involving the medial hand and digit #s 4-5, for the past year, worse with gripping activity.

Exam revealed positive Tinel over the right medial wrist and decreased sensation in the right medial hand.

NCS:

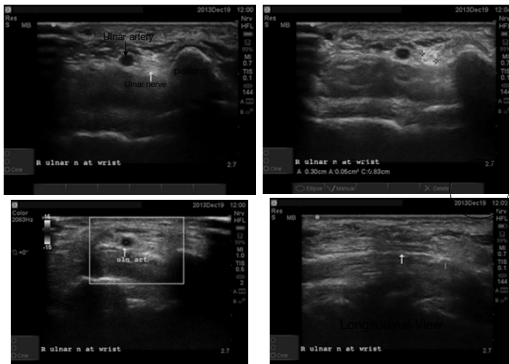
Ulnar motor amp to ADM = 13mV [No slowing or block at elbow]
Ulnar motor amp to FDI = 9.4mV palmar stim; 8.8mV wrist stim
[No conduction block]

Ulnar sensory response to D5 = 4mcv [opposite side = 13mcv]
Dorsal Ulnar Cutaneous response = 6 mcv bilaterally

Needle EMG:

Normal

Ultrasound Imaging of the Ulnar Nerve At the Wrist



DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Patient H&P:

81 y/o female complains of right hand pain and weakness, for the past several years, worse with gripping activity.

Exam revealed prominent atrophy in the right hand 1st web space and moderate intrinsic muscle weakness.

NCS:

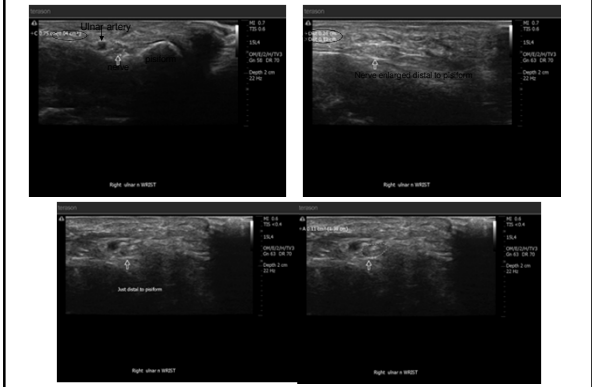
Ulnar motor amp to R ADM = 6.5mV [No slowing or block at elbow]; 9.1mV left
Ulnar motor amp to FDI = 4.2mV palmar stim; 2.4mV wrist stim
[moderate conduction block; 43% amplitude loss]

Ulnar sensory response to D5 = 9.2mcv [opposite side = 8.9mcv]

Needle EMG:

2+ fibs and neurogenic firing in FDI; normal ADM, FCU, OP, EDC, FPL, etc.

Ultrasound Imaging of the Ulnar Nerve At the Wrist



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