Ultrasound Imaging of the Ulnar Nerve Cubital Tunnel Syndrome

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

Cubital Tunnel Anatomy

Arcade of Struthers
Ulnar Groove (‘sulcus’)
Cubital Tunnel

Authors also think it includes the ulnar groove
Retroepicondylar (RTC) groove
Humeroulnar aponeurotic arcade (HUA)
Deep forearm Flexorpronator Aponeurosis

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

Spinner & Goldner, JBJS, 1998

Cubital Tunnel
Snapping Triceps

Snapping Triceps Syndrome

Spinner and Goldner, JBJS, 1998
Triceps Intrusion Into the Ulnar Sulcus and Ulnar Nerve Subluxation

Miller and Reinus, AJR, 2010

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
Omejec and Podnar: MBN, 2015 (8-11mm²)

Normal CSA:
8-9mm² maximum upper limit
[9 = males; 8 = females]

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)
Foresarm NCV = 49m/s
Complete CB at elbows (No response prox stim AE)
Ulnar sensory response unobtainable (DS and DUC)

Needle EMG:
2+Fibs PDI and FCU
Neurogenic MUPs
**DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury**

- Transverse nerve images
- Ulnar nerve edema at medial epicondyle
- Ulnar nerve subluxation during elbow flexion
- Ulnar nerve compression just distal to the medial epicondyle
- Note marked edema proximally

**Ulnar Motor NCV setup**

- Recording Electrodes
- Reference Electrode
- Active Electrode
- Cathode
- Anode
- 70°-90° elbow flexion
- 8 cm
- 4 BE
- 6 AE
- Stimulating Electrodes

**Segmental Stimulation ‘Inching’ Technique**

- Latency change over a 2cm segment
- >0.8 ms is abnormal
- Or >2x all other segments
**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

**NCV:**
- 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

**Needle EMG:**
- T+Fib
- Normal recruitment ['mild denervation']

**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 and ulnar nerve compression

- Ulnar nerve compression just distal to the medial epicondyle
- Note nerve enlargement proximally (and loss of fascicular echotexture)

**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

**NCV:**
- 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]

**Needle EMG:**
- Normal
- [no ulnar denervation]
DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Longitudinal view

Ulnar nerve edema at medial epicondyle

Note marked edema proximally

Transverse nerve images

Ulnar nerve edema at medial epicondyle

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

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
- 12.3mV proximal

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 [13mcv right]

Needle EMG:
- Normal
  [no ulnar denervation]

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)

Ulnar nerve edema at 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.
- 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 0.4-0.5ms)
  - No amplitude loss
- Ulnar sensory response = 2 mcv

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

### Ulnar Nerve Injury
- **Longitudinal view**
  - Ulnar nerve compression distal to medial epicondyle
  - Note marked edema proximally

### Transverse Nerve Images
- Ulnar nerve edema at medial epicondyle
- No Ulnar nerve subluxation during elbow flexion
- But triceps intrusion (ulnar nerve compression)
- Anconeus epitrochlearis

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## 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
- Forearm NCV = 55m/s
- Across Elbow NCV = 45m/s ['mild slowing']
- Segmental ('Inching') Motor Study:
  - Max delay just proximal to medial epicondyle (0.9ms; all other segments 0.3-0.5ms)
  - 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)

### Needle EMG:
- Normal

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**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

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**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 hand.

**NCS:**
- Ulnar motor amp = 9mV distally to elbow
- 7mV proximal
- 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 diff = 1.3ms

**Needle EMG:**
- normal

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**DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury**

**Longitudinal view**

- Ulnar nerve edema at medial epicondyle

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**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 [10mV opposite side]
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]

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

DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury

Diagnosis: Ulnar nerve injury

Longitudinal view

Ulnar nerve, edema at medial epicondyle

Transverse nerve images

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

Ulnar nerve 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]
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]

Needle EMG:
Normal to FDI and FCU

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 = 15mV (proximal and distal) [17mV opposite side]
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]
**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”

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**DIAGNOSTIC ULTRASOUND OF Ulnar Nerve Injury**

Transverse nerve images

Longitudinal view

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

Ulnar nerve edema at medial epicondyle

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**DIAGNOSTIC ULTRASOUND – Triceps STRESS Test**

Transverse nerve images

Longitudinal view

Ulnar nerve: Triceps intrusion, a/o mild nerve compression, worse with isometric test during isometric contraction

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 = 4m/s

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, MN 2011; Spinner, JBJS, 1998

Ultrasound Imaging of the Ulnar Nerve

At the Wrist

Benjamin M. Sucher, D.O., FAOCPMR-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 #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

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**Ultrasound Imaging of the Ulnar Nerve At the Wrist**

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**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

Key References:
4. Ahuja AT: Diagnostic and Surgical Imaging Anatomy Ultrasound. Salt Lake City, Amirys, 2007

References:
References (cont):


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