ULNAR NERVE

Course of ulnar nerve **(UN)**: (Dumitru pp 876-880)

Roots: (Grant p 476)

C8: From between the C7 and T1 vertebra

T1: From between the T1 & T2 vertebra. Posteriorly the T1 root is below the first rib, where the rib meets the vertebra. Anteriorly the T1 root is above the first rib, between the first rib inferiorly & the clavicle superiorly. **(Potential site of compression at apex of lung)**

Lower trunk: Formed by the C8 & T1 roots, after the roots pass between the anterior and middle scalene muscles, between the edge of the first rib inferiorly & clavicle superiorly **(Potential site of entrapment** between the anterior and middle scalene muscles [both insert into first rib] **)**

Anterior division of lower trunk: Begins after the lower trunk has crossed the first rib

Medial cord: Formed from the anterior division of the lower trunk in the axilla (Hollinshead p 226)

Ulnar nerve **(UN)** begins at lower border of pec minor near corocoid process

Descends arm medial to:

Distal axillary artery &

Brachial artery (The axillary artery becomes the brachial artery at the distal teres major)

With above arteries, the ulnar nerve located anterior to the intermuscular septum. The intermuscular septum passes between the humerus & the fascia surrounding the triceps muscle (epimysium) separating the arm into anterior and posterior compartments. Lies, and is covered and tightly bound to the medial head of triceps by arcade of Struthers (present in about 70% of individuals, Dumitru p876-9)

Passes through the intermuscular septum **(Potential site of entrapment)**, into posterior compartment of the arm, at distal end of the insertion of the corocobrachialis. At this point septum is called the internal brachial ligament.

In 0.7% to 2.7% of individuals , the ulnar nerve passes under **(Potential site of entrapment)**, a fibrous structure (ligament of Struthers) from an aberrant spur at the distal humerus to the medial epicondyle, located about 3-6 cm proximal to the medial epicondyle (Dumitru pp 861-2 & Dawson p 98).

Passes within the postcondylar (retroepicondylar) groove **(Potential site of entrapment)**, posterior to the medial epicondyle and medial to olecranon (at a line drawn bwtween the medial epicondyle and the olecranon). 18 % sublux (Campbell 1991 p 735)

Passes between the tendonous fibrous arch of the two heads of the flexor carpi ulnaris (FCU) **(Potential site of entrapment).** This arch is preferably called the humeroulnar arcade rather than the cubital tunnel. The arcade is located 0.3 to 2cm from the retrocondylar groove

Exits from the deep surface of the FCU at the the deep flexor pronator aponeurosis (DFPA) **(Potential site of entrapment)**. The exit of the ulnar nerve from the deep aspect of the FCU is from 2.8cm to 6.9cm from the retrocondylar groove (Campbell 1991 p 734)

Passes down the forearm between the FCU and flexor digitorum profundus

Proximal to the wrist the ulnar nerve gives off:

Palmar cutaneous branch arises from UN prox to dorsal cutaneous; supplies the ulnar palmar hand

Dorsal ulnar cutaneous which arises 5 to 10 cm. proximal to wrist from between ulna and FCU

Passes, with the ulnar artery, into hand between the pisiform and hook of the hamate superficial to the transverse carpal ligament (piso-hamate ligament) and beneath the thin volar carpal ligament and the palmaris brevis. The space between the transverse carpal ligament and the thin volar carpal ligament and the palmaris brevis is called Guyons canal **(Potential site of entrapment).** (Dumitru p 877-9)

At level of Guyon canal ulnar splits into deep & superficial branches **(Potential site of entrapments)**.

Muscles that should be tested to localize lesions related to ulnar nerve symptoms (Dumitru 877-9) **(MMT)**:

1. Weakness of ext dig longus (EDL) & ext carpi uln (ECU) places lesion at root or lower trunk level
2. Weakness of superficialis & median profundus places lesion at least at medial cord level
3. Ulnar nerve:
   a. None in arm (8% of cadavers, FCU supplied proximal to tip of medial epicondyle Campbell 1989p 965)
   b. FCU usually supplied just distal to medial epicondyle
   c. Flexor digitorum profundus supplied distal to FCU
   d. Superficial branch usually supplies the palmaris brevis; 25 % branch to
   e. Deep branch first usually (50%) supplies the abductor digiti minimi (ADM) (25% branch to ADM arises from UN prior to split into deep & superficial branch; 25% branch to ADM arises from between deep & superficial branch) and the flexor digiti minimi and then passes around the hook of the hamate to supply the remaining ulnar innervated hand muscles

Cutaneous supply **(Sensory Exam)**:

1. Medial brachial cutaneous supplies skin over medial arm
2. Medial antebrachial cutaneous supplies skin over medial aspect of forearm
3. Palmar cutaneous supplies skin over hypothenar muscles
4. Dorsal cutaneous supplies the dorsal ulnar skin over the back of the hand, the dorsum of the little finger to the base of the fingernail and the ulnar half of the ring finger to the middle phalanx
5. Superficial branch supplies: the palmar aspect of the little finger; ulnar half of the middle and distal phalanges of the ring finger (dorsal and palmar): and the dorsal tip of the little finger

Potential sites of involvement in the differential diagnosis of ulnar compression/entrapment

1. Proximal to elbow
   a. Roots: Apex of lung
   b. Plexus
      Between middle and anterior scalenes
      Between clavicle & first rib
   c. Intermuscular septum: Arcade of Struthers
   d. Ligament of Struthers
2. Elbow/Forearm
   a. Postcondylar groove = retroepicondylar groove
   b. Cubital tunnel (humeroulnar arcade)
   c. Deep flexor pronator aponeurosis where the ulnar nerve exits from the deep surface of FCU
3. Wrist (Modified from Shea 1969 by Oh 1993)
   Type I. Proximal Guyon canal (motor & sensory)
   Type II. Distal Guyon canal (motor including ADM; no sensory involvement)
   Type III. Hook of hamate (motor exclusive of ADM; no sensory involvement)
   Type IV. Within palmaris brevis (sensory only)

Clinical signs

C8 Root:

Decrease motor power (among other muscles):

Radial: ECU; EDL
Median: FDS; FDP; FPL; APB
Ulnar: FCU; FDP; ADM; Interossei; AddP
If posterior root involved: Decreased sensation ulnar fingers and forearm

T1 Root:
Horners
Decrease motor power
Median: FDS; FDP; FPL; APB
Ulnar: FCU; FDP; ADM; Interossei; AddP
If posterior root involved: Decreased sensation ulnar elbow and arm

Plexus:
Lower trunk
Decrease motor power
Radial: ECU; EDL
Median: FDS; FDP; FPL; APB
Ulnar: FCU; FDP; ADM; Interossei; AddP
Decreased sensation medial arm & forearm &ulnar aspect of hand & little & half of ring fingers

Medial Cord
Decrease motor power
Median: FDS; FDP; FPL; APB
Ulnar: FCU; FDP; ADM; Interossei; AddP
Decreased sensation medial arm & forearm &ulnar aspect of hand & little & half of ring fingers

Ulnar nerve
Arm between axilla & epicondyle at intermuscular septum or Ligament of Struthers
Decrease motor power: FCU; FDP; ADM; Interossei; AddP
Decreased sensation ulnar aspect of hand & little & half of ring fingers
Elbow/forearm at:retrocondylar groove, humeroulnar arcade & deep flexor pronator aponeurosis
Decrease motor power: FDP (sometimes); ADM; Interossei; AddP
Decreased sensation ulnar aspect of hand & little & half of ring fingers
Wrist:
Guyons canal (motor & sensory)
Decrease motor power: ADM; Interossei; AddP
Decreased sensation palmar ulnar half of ring finger and little finger
Within palmaris brevis (sensory): Decreased sensation palmar ulnar half of ring finger, little finger
Hook of hamate (motor): Decrease motor power: Interossei; AddP

Conduction studies in evaluating differential diagnosis of ulnar neuropathy
Proximal to elbow
Roots:
Motor
Abnormal amplitude if sufficient axon loss and done early
Normal CV
Sensory: Conduction studies only of value if the patient has decreased sensation. Then if amplitudes are normal the lesion must be proximal to the dorsal root ganglion.

Plexus
Abnormal (If axonal death of fastest conducting axons)
Distal sensory latency

Dorsal ulnar cutaneous
Medial antebrachial cutaneous
Extimated F wave based on motor conduction from elbow to wrist
(No faith in root stimulation)
Normal (if no axonal death of fastest conducting axons)
Sensory conduction across elbow
Motor conduction across elbow
Motor conduction from axilla to above elbow
Mixed conduction from above elbow to axilla

Arcade of Struthers (AS) & medial intramuscular septum (IMS)
Abnormal (If axonal death of fastest conducting axons)
Distal sensory latency
Dorsal ulnar cutaneous
Motor conduction from axilla to above elbow (distal to AS & IMS)
Mixed conduction from above elbow to axilla
Extimated F wave based on motor conduction velocity from elbow to wrist
Normal (if no axonal death of fastest conducting axons)
Sensory conduction across elbow
Motor conduction across elbow
Medial antebrachial cutaneous

Elbow/Forearm
Postcondylar (retroepicondylar) groove
Abnormal
Distal sensory latency
Dorsal ulnar cutaneous
Sensory conduction across elbow
Motor conduction across elbow
Mixed conduction from below elbow to axilla
Normal medial antebrachial cutaneous

Cubital tunnel (Humeroulnar arcade {HUA})
Abnormal
Distal sensory latency
Dorsal ulnar cutaneous
Sensory conduction across humeroulnar arcade
Motor conduction across humeroulnar arcade
Mixed conduction across the HUA from below elbow to axilla
Normal medial antebrachial cutaneous
Normal
Sensory conduction across elbow
Motor conduction across elbow
Mixed conduction from below elbow to axilla
Medial antebrachial cutaneous

Deep flexor pronator aponeurosis (DFPA)
Abnormal
Distal sensory latency
Dorsal ulnar cutaneous
Sensory conduction from below humeroulnar arcade to wrist
Motor conduction across from below humeroulnar arcade to wrist

Mixed conduction across the HUA from below elbow to axilla
Normal medial antebrachial cutaneous

Normal
Sensory conduction across retroepicondylar groove
Motor conduction across retroepicondylar groove
Mixed conduction from below retroepicondylar groove to axilla
Medial antebrachial cutaneous

Wrist:
Guyons canal (motor & sensory)
Abnormal:
Distal sensory latency
Distal motor latency
Normal: Dorsal ulnar cutaneous

Within palmaris brevis (sensory):
Abnormal: Distal sensory latency
Normal:
Dorsal ulnar cutaneous
Motor conduction
Hook of hamate (motor):
Abnormal:
Distal latency to first dorsal
(I have no faith in latency with recording over the first dorsal because of volume conduction from all other interossei and the addusator pollicis)
Normal:
Distal sensory latency to little finger
Distal motor latency to abductor digiti minimi

Needle EMG:
Abnormal in same muscles as anticipated clinical weakness.
With ulnar neuropathies FCU usually normal because (Campbell 1989 p 966-7)
Fascicles that innervate FCU are deep
Most distal muscles as the 1st dorsal are more likely abnormal

Ulnar
Stimulation (motor & sensory) with elbow bent 70 to 90 degrees (AAEM p409, Dawson p 145)
Wrist just lateral or medial to the FCU; 8cm proximal to G1
Elbow:
Distal: 3cm distal to retrocondylar groove
Proximal: > 10cm proximal to distal stim point but be sure not to stimulate median nerve
Axilla: Kimura 1989 pg. 114 ($\geq$54m/s)
Motor
Recording electrodes
G1 over middle of ADM
G2 over tendon of ADM
Response usually 2 humps because all the ulnar hand muscles contribute to the CMAP
Values:
Distal:

Latency <3.6 (Bushbacher 1999 p. S11), 3.3ms (@ 34º Falco 1992 & @ 32 degrees Olney 1985)
Amplitude greater than 2.8mV(Kimura 1989 p 114); & ≥ 5mV (Olney 1985 p 17)
Side to side difference:
Latency: 0.6ms (Bushbacher 1999 pg. S12); 0.8ms (Kimura 1989 pg 114)
Amplitude: 97th percentile- 25%; 100th percentile 39% (Bushbacher 1999 pg. S12)
Conduction velocity (C.V.)
50m/s below elbow to wrist (Kimura 1989 pg 114)
≥ 50 m/s across elbow (AAEM 1999 p 410 & ≥ 53 Kimura 1989 pg. 114)
≤ 10m/s difference between below & above elbow C.V. (AAEM 1999 p 410)
≥ 54 m/s axilla to above elbow (Kimura 1989 pg. 114)
Amplitude:drop across elbow: ≤ 20% (AAEM 1999 p 410); ≤ 25% (Dawson p 146)

Inching from 6 cm above medial epicondyle to 8 cm below medial epicondyle
≤ .4ms between two successive 1 cm segments (Campbell 1992 p 1053)
≤ .63 ms between two successive 2 cm segments (Kanakamedala 1988)

Sensory
Recording
G1 at PIP crease
G2 as far distal without ring falling off finger
Spread fingers to prevent volume conduction from ring interossei
Values:
Distal:
Peak latency ≤ 3.5ms (amp ≥ 10uV Nesathurai Arch Phys Med Rehabil 1999; 80:756)
(Buschbacher 1999 p S65: latency ≤ 4.1)
Side to side difference: Buschbacher 1999 p S65: peak latency ≤ 0.5ms & peak to peak drop in amp: 97th percentile= 64%; 100th percentile = 74%
Conduction velocity above elbow -wrist ≥ 50m/s (Melvin 1950 Table 2, ≥ 53 Kimura 1989p114)

Conduction to electrode over first dorsal (I do not perform this conduction)
Recording electrodes (Olney 1985)
G1 over middle of 1 st dorsal where the amplitude is maximal
G2 over second metacarpalphalangeal joint (MCP)
Values:
Latency: <4.4ms @ 32º latency variable from 20 to 70 yrs of age (Olney 1985 p17)
≤ 2ms more than latency to ADM
Amplitude ≥ 6 mV (Olney 1985 p 17)

Medial antebrachial cutaneous (MABC)
Stimulation: 5 cm proximal to halfway point between bicipital tendon & medial epicondyle. Use 0.1 ms pulse and hold cathode lightly on skin
Recording:
Use bar
G1: 8 cm from the halfway point between the bicipital tendon & medial epicondyle on a line drawn from cathode to pisiform
Onset latency: < 2.7 ms
Peak to peak amplitude: ≥ 8 uV (Ma 1983 pg 146)

Dorsal ulnar cutaneous (DUC)
Stimulation:
Between flexor carpi ulnaris and ulna
Cathode 8 cm proximal to G1with 0.1ms pulse duration
Recording:

Bar recording
G2 at base of "V" between the 4th & 5th metacarpal phalangeal joints
G1 proximal to G2 between 4th & 5th metacarpals

Latency to negative peak < 2.6 ms;

Amplitude: (onset to peak) ≥ 8uV (Jabre's methode from Oh p 201) & compare to uninvolved side
< 6uV peak to peak and interside ratio >1.66 (Seror 2002)

Use when consideration is: Where is ulnar lesion wrist or elbow?)

1. if DUC normal & conventional distal ulnar cutaneous is abnormal this confirms ulnar lesion at wrist
2. if DUC is abnormal then the ulnar lesion is at the elbow

F wave (Modified from Mayo Course Handout)

Stimulation

Pulse duration: Use same as for motor conduction studies

Pulse frequency: no more frequent than 1 per 2 sec (Fisher 1992)

Cathode placed same as for motor conduction studies

Recording

G1, G2 & ground electrodes positioned same as for motor conduction studies

Sensivity (Gain)

M wave: 1mV to 10mV per vertical division

F wave: 0.2mV to 0.5mV per vertical division

Sweep speed

Uppers: 5ms per horizontal division

Lowers: 10 ms per horizontal division

Response

Fastest latency of 10 responses (Fisher 1992)

Abnormal side-to-side difference stimulating & recording distally:

> 2ms (Dumitru p195)

>3ms Mayo course

Absolute

Stimulation site: Wrist 8cm from G1

Record: ADM or APB

Measurements (Weber&Piero1978 p467)

Arm: 30 deg abd

Measure from C7 spinous process to ulnar styloid

Measure forearm CV from elbow to wrist

Add 5msec to normagram (see next page)for upper limit of normal:

F wave

(Mayo Course Handout)

Stimulation site: 8cm from G1

Record: APB or ADM

Distance: From Sternoclavicular joint to cathode stimulation point at wrist

F wave latency should be no more than 3msec longer than estimated F wave (F est)

$$\text{F est} = \frac{2 \times \text{distance to wrist stimulation site from sternoclavicular joint (mm)}}{\text{conduction velocity (mm/ms)}} + \text{DL(ms)}$$

i.e. Abnormal upper extremity F wave using hand muscles with wrist stimulation:

$$> \frac{2 \times \text{distance to wrist stimulation site from sternoclavicular joint (mm)}}{\text{conduction velocity (mm/ms)}} + \text{DL(ms)} + 3\text{ms}$$

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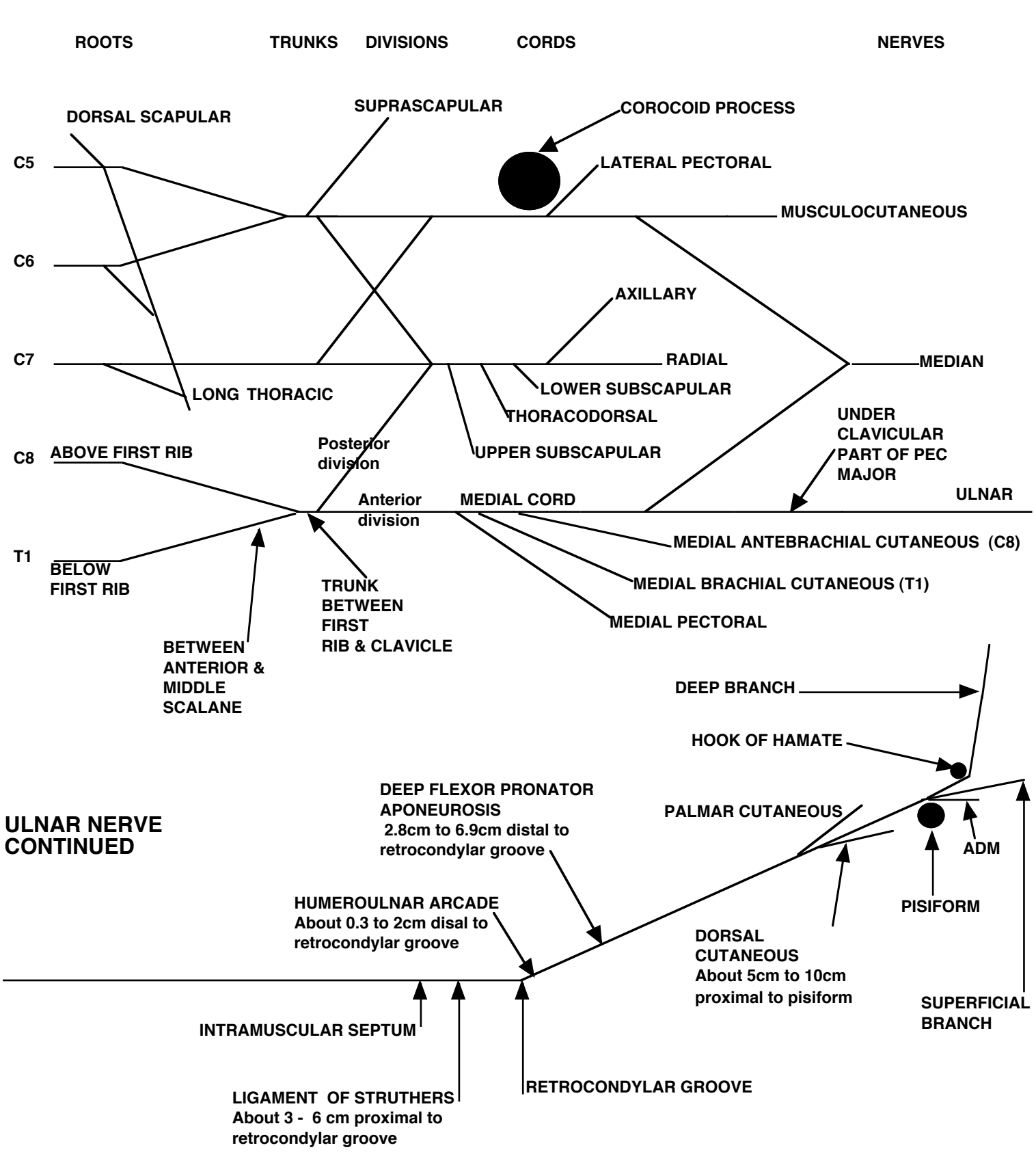

ULNAR NERVE CONTINUED