Anatomic Localization

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Neurology

Most images from:

John Patten
Neurologic Differential Diagnosis, 2nd ed.
Springer 1996
http://disability.ucdavis.edu/training/lectures/mcdonald/

www2.unil.ch/dpharm/research.htm

Grown-ups: Get up and go test
Close Your Eyes

Open Your Eyes – 0 min

Open Your Eyes – 2 min

Open Your Eyes – 5 min

www.emedicine.com/ oph/topic263.htm
FIGURE 3: Distal Symmetrical Polyneuropathy

- Pinprick
  - Normal
  - Diminished
  - Lost

- Hyperesthesia
- Contact Sensitivity
- ↓ or Normal Knee Reflexes
- ↓ or Normal Ankle Reflexes
- ↓ Pin, Temperature, Vibration

The most frequently encountered causes of damage at the various sites are indicated.

**C7 Root**
- By far the most frequent "acute cervical disc lesion" occurs at this level. C6 and C5 less often. Other levels very rarely.

**Axillary nerve**
- Fracture of humeral neck
- Dislocation of the humerus
- Intramuscular injections

**Radial nerve in spiral groove**
- Direct blow laterally. During anaesthesia medially. While drunk medially ("Saturday night palsy"). Fractures of the humerus – immediate or delayed.

**Radial nerve (Posterior interosseous nerve)**
- Nerve enters forearm through supinator muscle. Occupational overuse of muscle may damage nerve. Also occurs idiopathically. Extensors of thumb and index finger mainly affected.

**Ulnar nerve**
- Damage from repeated minor trauma
- Prolonged bed rest
- Delayed following fractures

**Median nerve**
- At elbow. Rarely damaged by direct trauma or fracture

**Median nerve (Carpal tunnel syndrome)**
- Nerve damaged by swelling or entrapment of tunnel it traverses. Transiently seen in pregnancy. Idiopathically in females. Complicates rheumatoid arthritis. Rarely seen in other systemic diseases

**Ulnar nerve (Deep branch)**
- Trauma to heel of the hand. Idiopathically (often a ganglion found on exploration)
- No sensory loss in typical cases

**C5 and C6 Roots**
- Most frequently involved roots in cervical spondyloticis.
- C7 involved occasionally. Others very rarely.
Axillary nerve
Variable pain in area shown as is sensory loss. Does not radiate as low as C5 pain

Median nerve
In carpal tunnel syndrome pain is maximal in hand as shown, especially in middle finger. Radiation up forearm is quite commonly noted (See text)

Ulnar nerve
Involvement at elbow will lead to pain and paraesthesia in area indicated. BUT by no means in all cases. Classically a deep branch lesion cannot cause sensory features, but sensory nerve can be affected by same trauma as damaged the deep branch
<table>
<thead>
<tr>
<th>Nerves</th>
<th>Axillary</th>
<th>Musculo-cutaneous</th>
<th>Radial</th>
<th>Median</th>
<th>Ulnar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory supply</td>
<td>Over deltid</td>
<td>Lateral forearm to wrist</td>
<td>Lateral dorsal forearm and back of thumb &amp; index finger</td>
<td>Lateral palm Index, middle &amp; lateral half ring finger</td>
<td>Medial palm and fifth &amp; medial half ring finger</td>
</tr>
<tr>
<td>Sensory loss</td>
<td>Small area over deltid</td>
<td>Lateral forearm</td>
<td>Dorsum of thumb &amp; index (if any)</td>
<td>As above from skin crease at wrist</td>
<td>As above but often none detectable</td>
</tr>
<tr>
<td>Area of pain</td>
<td>Across shoulder tip</td>
<td>Lateral forearm</td>
<td>Dorsum of thumb &amp; index</td>
<td>Thumb index &amp; middle finger. Often spreads up forearm to elbow (reason unknown)</td>
<td>Ulnar supplied fingers &amp; palm distal to wrist. Occasionally pain along course of nerve up to elbow (can be confusing)</td>
</tr>
<tr>
<td>Reflex arc</td>
<td>None</td>
<td>Biceps jerk</td>
<td>Triceps jerk &amp; supinator jerk</td>
<td>Finger jerks (flexor digitorum sublimis)</td>
<td>None</td>
</tr>
<tr>
<td>Motor deficit</td>
<td>Deltoid (teres minor cannot be evaluated) usually very obvious</td>
<td>Biceps Brachialis (coracobrachialis weakness not detectable)</td>
<td>Triceps Wrist extensors Finger extensors Brachioradialis &amp; supinator of forearm</td>
<td>Wrist flexors Long finger flexors to thumb index &amp; middle finger Abductor pollicis brevis</td>
<td>All small hand muscles excluding abductor pollicis brevis. Flexor carpi ulnaris. Long flexors of ring &amp; little finger</td>
</tr>
<tr>
<td>Causative lesions</td>
<td>Fractured neck of humerus Dislocated shoulder Deep i.m. injections</td>
<td>Very rarely damaged</td>
<td>Crutch palsy Saturday night palsy Fractured humerus In supinator muscle itself</td>
<td>Carpal tunnel syndrome Direct trauma to wrist Suicide attempt Falling on glass Palmar space infection</td>
<td>Elbow Local trauma Bed rest (resting on elbow) Fractured olecranon</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Wrist Local trauma Ganglion at wrist joint</td>
</tr>
<tr>
<td>Nerves</td>
<td>Obturator</td>
<td>Femoral</td>
<td>Sciatic nerve</td>
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<tr>
<td></td>
<td>Medial surface of thigh to</td>
<td>Anteromedial surface of thigh and leg down</td>
<td>Peroneal division</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory supply</td>
<td>posterior axial line</td>
<td>to medial malleolus</td>
<td>Anterior leg, dorsum of ankle and foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Often none</td>
<td>Usually anatomical as above</td>
<td>Often only detectable dorsum of foot</td>
<td></td>
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</tr>
<tr>
<td>Sensory loss</td>
<td>Medial thigh</td>
<td>Anterior thigh and medial leg to ankle</td>
<td>Often painless dull ache</td>
<td></td>
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<tr>
<td>Area of pain</td>
<td>Adductor jerk</td>
<td>Knee jerk</td>
<td>Often painless</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflex arc</td>
<td>Adduction of thigh</td>
<td>Extension of knee</td>
<td>Very uncommon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor deficit</td>
<td></td>
<td>Dorsiflexion, inversion (tibialis anterior)</td>
<td>Plantar flexion and inversion of foot</td>
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</tr>
<tr>
<td></td>
<td>Pelvic neoplasm</td>
<td>(tibialis posterior) &amp; eversion of the foot</td>
<td>(tibialis posterior)</td>
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</tr>
<tr>
<td></td>
<td>Pregnancy</td>
<td>Lateral hamstrings</td>
<td>Medial hamstrings</td>
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<td></td>
<td>Pelvic surgery</td>
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<tr>
<td></td>
<td>Diabetes</td>
<td>Pressure palsy at fibula neck</td>
<td>Very rarely injured even in buttock</td>
<td></td>
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<tr>
<td></td>
<td>Femoral hernia</td>
<td>Hip fracture/dislocation</td>
<td>Peroneal division more sensitive to damage</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Retroperitoneal haematoma (</td>
<td>Penetrating trauma to buttock</td>
<td>(reason unknown)</td>
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<td></td>
<td>anticoagulants)</td>
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<tr>
<td></td>
<td>Femoral artery aneurysm</td>
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<tr>
<td></td>
<td>Posterior abdominal neoplasm</td>
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<tr>
<td></td>
<td>Psoas abscess</td>
<td></td>
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</tbody>
</table>
Lateral cutaneous nerve of thigh

Femoral nerve (damaged at this site by haematoma in the pelvis)

Sciatic nerve (before it leaves the pelvis via the greater sciatic foramen) damaged by malignant infiltration

Pressure on the lateral cutaneous nerve of thigh causes “meralgia paraesthetica”

Obturator nerve liable to damage during obstetric procedures

Femoral nerve in the femoral ring liable to local compression and possibly pressure palsy in diabetes mellitus
A lateral disc at L4 will predominantly affect L5 root. Note the displaced root pouch. But this disc may also affect the S1 root. This probably accounts for the ankle jerk often being abolished with disc lesions at L4/5.
**C5 Root**
Upper lateral arm never below elbow

**C6 Root**
Lower lateral arm, into thumb if pain goes into the hand

**T1 Root**
Deep pain in the axilla and shoulder with some radiation down inside of arm

**C8 Root**
Pain in medial forearm and into the two medial fingers (Note: Ulnar nerve pain in fingers and medial palm only)

**C7 Root**
Deep pain in triceps area. Front and back of forearm and into middle finger especially

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**Note:** L5 supplies the dorsum and sole of the foot
<table>
<thead>
<tr>
<th>Roots</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory supply</td>
<td>Lateral border upper arm to elbow</td>
<td>Lateral forearm including thumb &amp; index</td>
<td>Over triceps, mid-forearm &amp; middle finger</td>
<td>Medial forearm to include little finger</td>
<td>Axilla down to the olecranon</td>
</tr>
<tr>
<td>Sensory loss (Main location)</td>
<td>As above over deltoid</td>
<td>As above over thumb &amp; radial border of hand</td>
<td>Middle fingers</td>
<td>Little finger</td>
<td>In axilla (usually minimal)</td>
</tr>
<tr>
<td>Area of pain</td>
<td>As above and medial scapula border</td>
<td>As above, esp. thumb &amp; index finger</td>
<td>As above and medial scapular border</td>
<td>As above (up to elbow)</td>
<td>Deep aching in shoulder &amp; axilla to olecranon</td>
</tr>
<tr>
<td>Reflex arc</td>
<td>Biceps jerk</td>
<td>Supinator jerk</td>
<td>Triceps jerk</td>
<td>Finger jerk</td>
<td>None</td>
</tr>
<tr>
<td>Motor deficit (muscles most involved and easily tested)</td>
<td>Deltoïd</td>
<td>Pronators and supinators of forearm</td>
<td>Triceps</td>
<td>Finger flexors</td>
<td>All small hand muscles (thenar muscles via C8 in rare patients)</td>
</tr>
<tr>
<td>Causative lesions</td>
<td>Brachial neuritis</td>
<td>Cervical spondylosis</td>
<td>Acute disc lesions or spondylosis</td>
<td>Rare in disc lesions or spondylosis</td>
<td>Cervical rib</td>
</tr>
<tr>
<td></td>
<td>Cervical spondylosis</td>
<td>Cervical spondylosis</td>
<td>Cervical spondylosis</td>
<td>(See T1 usually affected by same pathology)</td>
<td>Altered anatomy of first rib</td>
</tr>
<tr>
<td></td>
<td>Upper plexus avulsion</td>
<td>Acute disc lesions</td>
<td>Cervical spondylosis</td>
<td>Pancoast tumour</td>
<td>Metastatic carcinoma in deep cervical nodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Metastatic carcinoma in deep cervical nodes</td>
<td>Outlet syndromes</td>
</tr>
<tr>
<td>Roots</td>
<td>L2</td>
<td>L3</td>
<td>L4</td>
<td>L5</td>
<td>S1</td>
</tr>
<tr>
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<td>-----------------------------------------</td>
</tr>
<tr>
<td>Sensory supply</td>
<td>Across upper thigh to posterior axial line</td>
<td>Across lower thigh to posterior axial line</td>
<td>Across knee to medial malleolus</td>
<td>Lateral leg to dorsum and sole of foot and great toe</td>
<td>Behind lateral malleolus to lateral foot and little toe</td>
</tr>
<tr>
<td>Sensory loss</td>
<td>Often none</td>
<td>Often none</td>
<td>Medial leg below knee to medial malleolus</td>
<td>Dorsum of foot to great toe</td>
<td>Behind lateral malleolus and lateral border of foot</td>
</tr>
<tr>
<td>Area of pain</td>
<td>Across thigh diagonally</td>
<td>Across thigh diagonally</td>
<td>Down to medial malleolus. Often severe at knee round patella</td>
<td>Back of thigh lateral calf, dorsum of foot and great toe</td>
<td>Back of thigh back of calf lateral foot to little toe</td>
</tr>
<tr>
<td>Reflex arc</td>
<td>None</td>
<td>Adductor reflex</td>
<td>Knee jerk</td>
<td>None</td>
<td>Ankle jerk and hamstring jerks</td>
</tr>
<tr>
<td>Motor deficit</td>
<td>Hip flexion</td>
<td>Knee extension</td>
<td>Inversion of the foot</td>
<td>Dorsiflexion of toes and foot (latter L4 also)</td>
<td>Plantar flexion &amp; eversion of foot</td>
</tr>
<tr>
<td>(most readily demonstrated)</td>
<td>Thigh adduction</td>
<td>Thigh adduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Causative lesions</td>
<td>L2 / L3 / L4</td>
<td>Neurofibroma</td>
<td></td>
<td></td>
<td>Disc lesions</td>
</tr>
<tr>
<td>(in order of frequency)</td>
<td></td>
<td>Meningioma</td>
<td></td>
<td></td>
<td>Metastatic malignancy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neoplastic disease</td>
<td></td>
<td></td>
<td>Neurofibromas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disc lesions very rare</td>
<td></td>
<td></td>
<td>Meningiomas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(except L4 &lt; 5% all)</td>
<td></td>
<td></td>
<td>Congenital lesions affecting cauda equina</td>
</tr>
</tbody>
</table>
Note. C4/T2 boundary due to C5/T1 being pulled out into the arm

T4 – line of nipple (in males)

T10 – through the umbilicus

T2 – into groin

External genitalia in both sexes supplied by extension of S2/3 through the perineum

13.9 Normal dermatomes.
Clinical signs of Brown-Sequard lesion (at C7–8 level on left side).
SPINAL CORD SYNDROMES

A.
B.
C.
D.
E.
F.
G.
H.
14.8 Evolution of central cord lesion.

This picture would be seen in syringomyelia, ependymoma, and intrinsic glioma or astrocytoma. The progress of the signs relates directly to degree of involvement shown in the cord sections.

A.
- Cervical sympathetic damaged - Horner's syndrome
- Reflex arc blocked
- Central lesion causes spontaneous pain and band of pain loss over involved segments

B.
- Lesion extending into right half of the cord damaging the sympathetic and reflex arcs
- Sacral fibres still intact
- If spinothalamic tract itself involved sensory levels spread down
- Horner's syndrome (now bilateral and very difficult to diagnose)

C.
- Some local involvement of entering dorsal column fibres
- Early pyramidal lesion
- Lesion spreading to involve both corticospinal tracts and into the right spinothalamic tract and into right dorsal horn

A.
- Spontaneous pain
- Arm reflexes may be depressed or absent
- Deep nagging pain in shoulder
- Sensory loss may be found by accident by patients
- No signs except thin band of pain loss

B.
- A right Horner's syndrome has developed
- Pain and temperature loss
- Arms and hands waste
- Arm reflexes abolished on right side
- Spinal paraparesis develops
- Pain may persist
- Frequent burns and non-healing cuts on hands
- Definite pain/temperature loss but touch usually normal
- Arm reflexes absent
- Abdominals go, and leg jerks brisk
- Some pyramidal leg weakness and extensor planter
- Leg reflexes brisk, plantars now extensor
- Late stages
- Whole body may have lost pain as spinothalamic tracts involved from inside out - hence outer sacral fibres affected last (sacral sparing)
- Local involvement of dorsal root zone may produce joint position sense loss in the upper limbs
- Bladder involved

C.
- Spinothalamic sensory loss extends into face (See chapter 15)
- If the lesion extends into the dorsal horns loss of joint position sense and light touch may be found in the hands
- Sacral sparing
- Spinothalamic loss starts to extend downwards as the tract is invaded
Midbrain: CN (I, II) III, IV

Pons: CN V, VI, VII, VIII

Medulla: CN IX, X, XI, XII

RD Collins. Illustrated manual of Neurologic Diagnosis. 1962.
Vascular Territories
Neuroanatomy to Know Right Away

• Pathways (location, function, decussation)
  – Corticospinal
  – Spinothalamic
  – Dorsal column – Medial Lemniscus

• Brainstem
  – Major sections
  – CN nuclei, pathways, and functions

• Lobes
  – Neurological and behavioral functions of each lobe