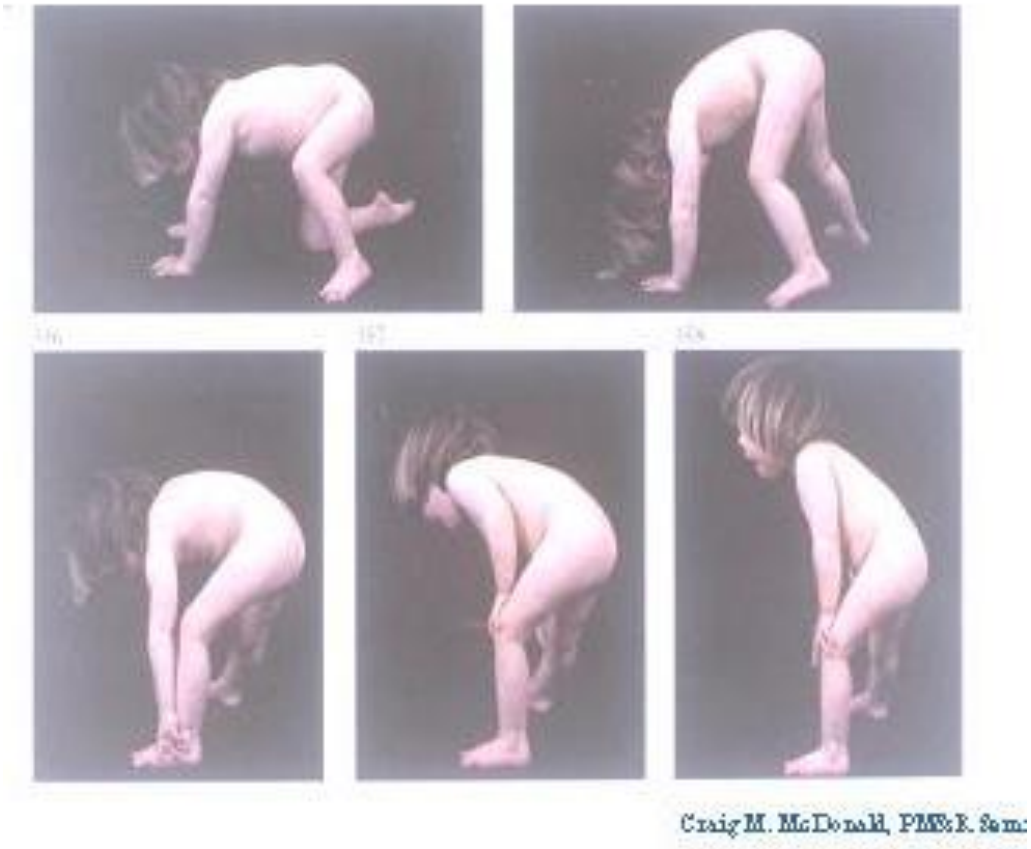
Anatomic Localization

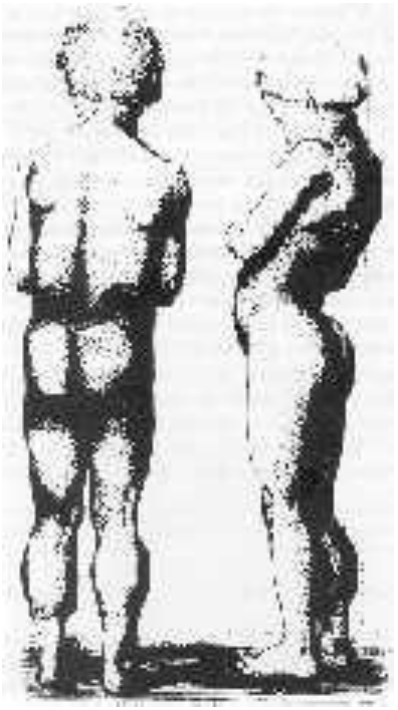
Renee B. Van Stavern, MD
Neurology

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

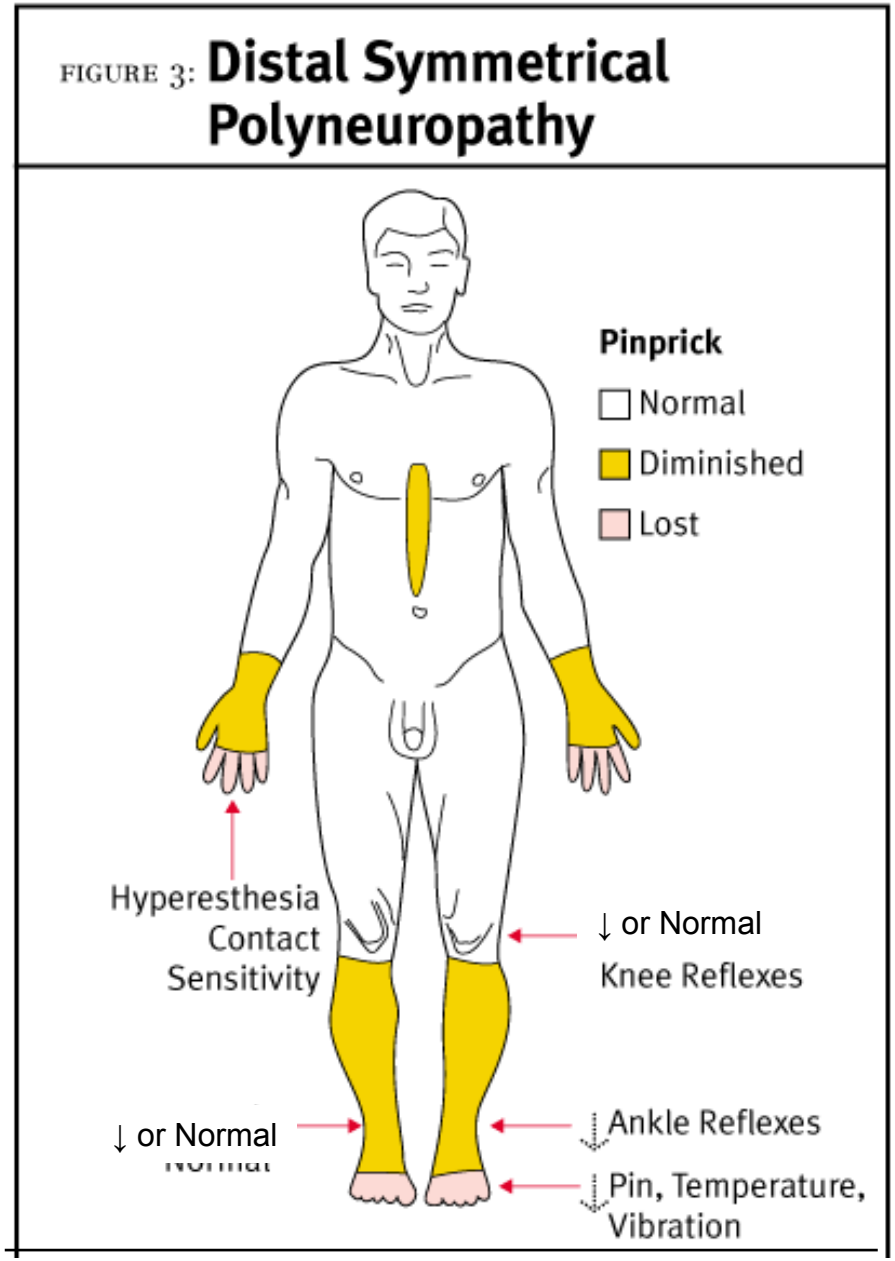
Close Your Eyes

Open Your Eyes – 0 min

Open Your Eyes – 2 min

Open Your Eyes – 5 min

www.emedicine.com/ oph/topic263.htm



http://www.prn.org/images/prn_nb_cntnt_images/vol5num3/page_23.gif

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

C5 and C6 Roots
Most frequently involved roots in cervical spondylosis. C7 involved occasionally. Others very rarely

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

Lower trunk of the brachial plexus
Cervical rib syndrome. Altered anatomy (outlet syndrome). Pancoast tumour of lung apex

Radial nerve in the axilla
Incorrect use of a crutch

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 interosseus 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

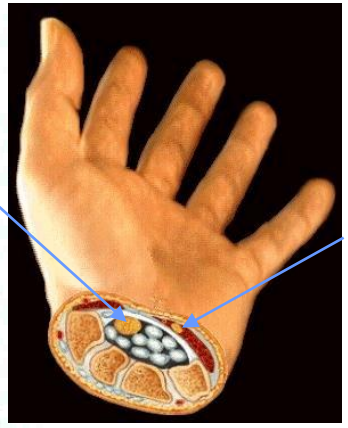
Ulnar nerve
Damage from repeated minor trauma
Prolonged bed rest
Delayed following fractures

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

(Anterior interosseous nerve)
Rarely damaged nerve lies very deep
Flexors of thumb and index finger are affected by damage to nerve

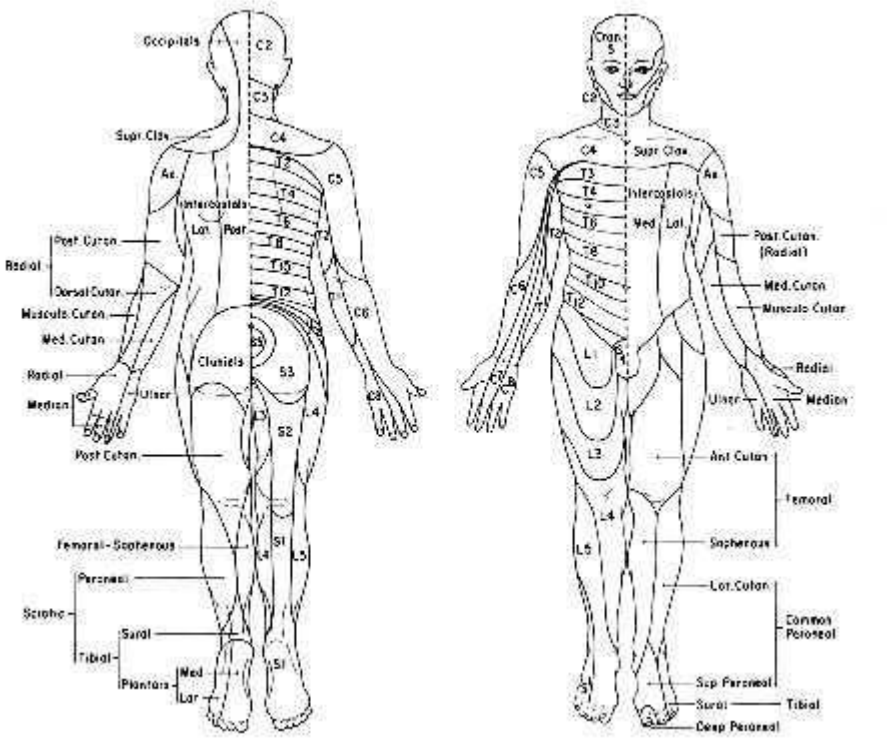
Median nerve (Carpal tunnel syndrome)
Nerve damaged by swelling or infiltration of tunnel it transverses. Transiently seen in pregnancy. Idiopathically in females. Complicates rheumatoid arthritis. Rarely seen in other systemic diseases

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

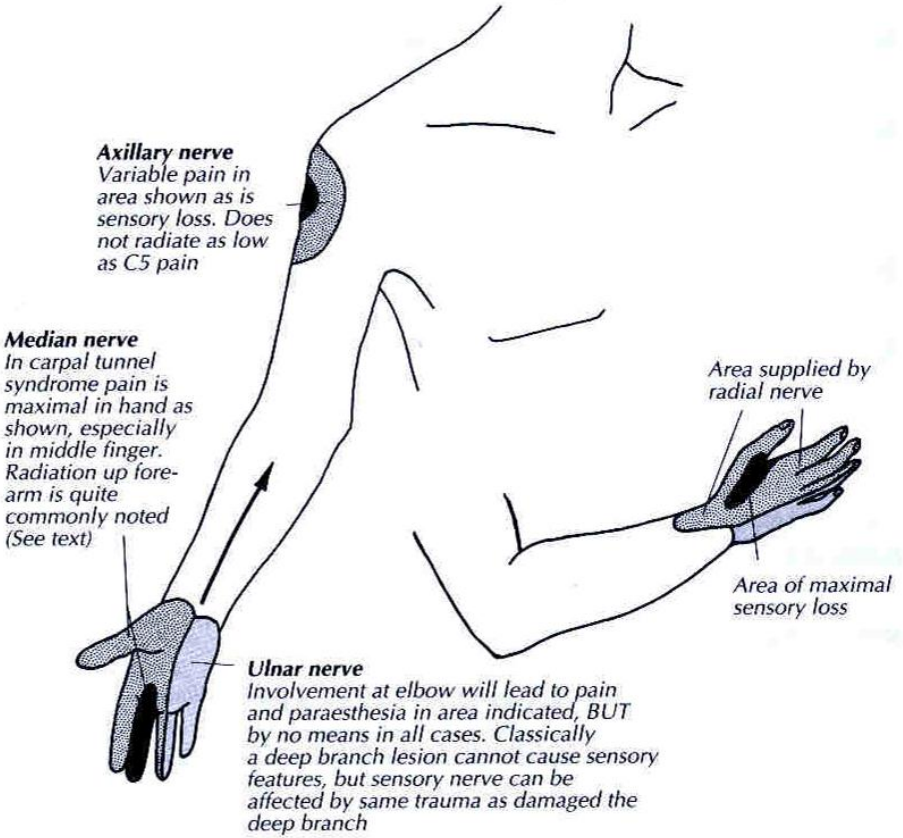


http://www.orthoteers.co.uk/

"Canal of Guyon"



www.sci.uidaho.edu/ med532pathways/peripher.htm



NAVY

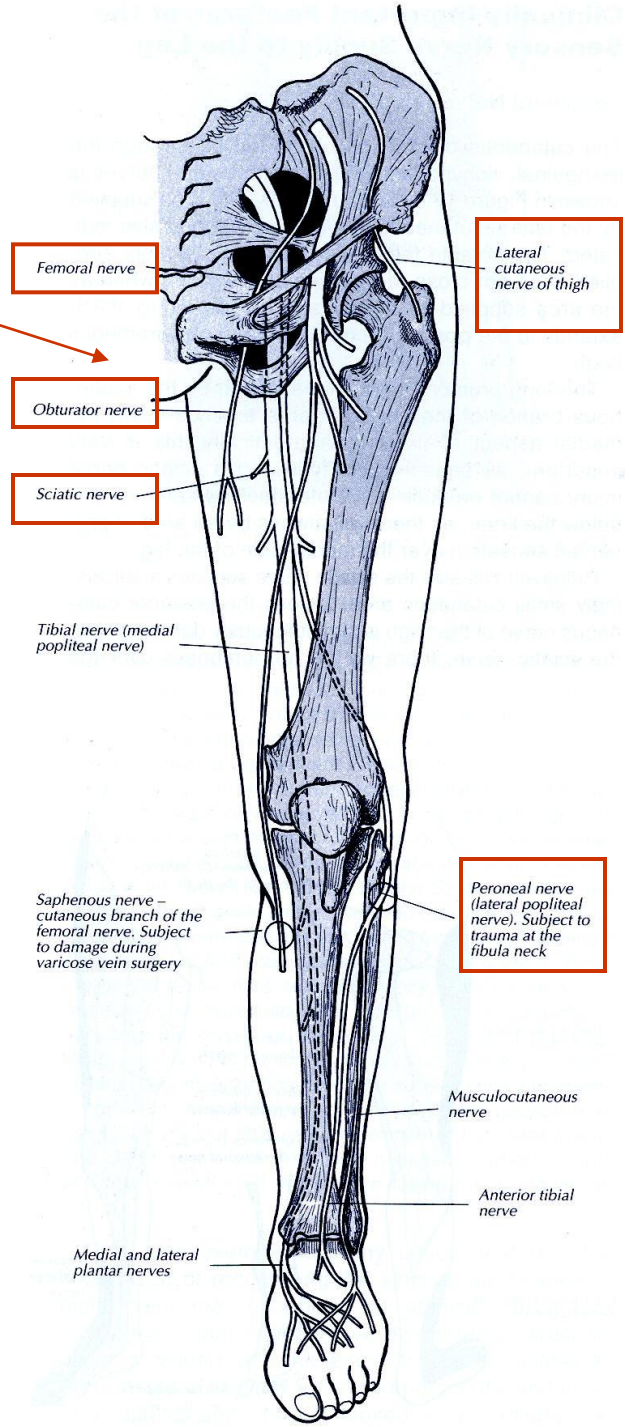

Femoral nerve
Lateral cutaneous nerve of thigh
Obturator nerve
Sciatic nerve
Tibial nerve (medial popliteal nerve)
Saphenous nerve – cutaneous branch of the femoral nerve. Subject to damage during varicose vein surgery
Peroneal nerve (lateral popliteal nerve). Subject to trauma at the fibula neck
Musculocutaneous nerve
Anterior tibial nerve
Medial and lateral plantar nerves

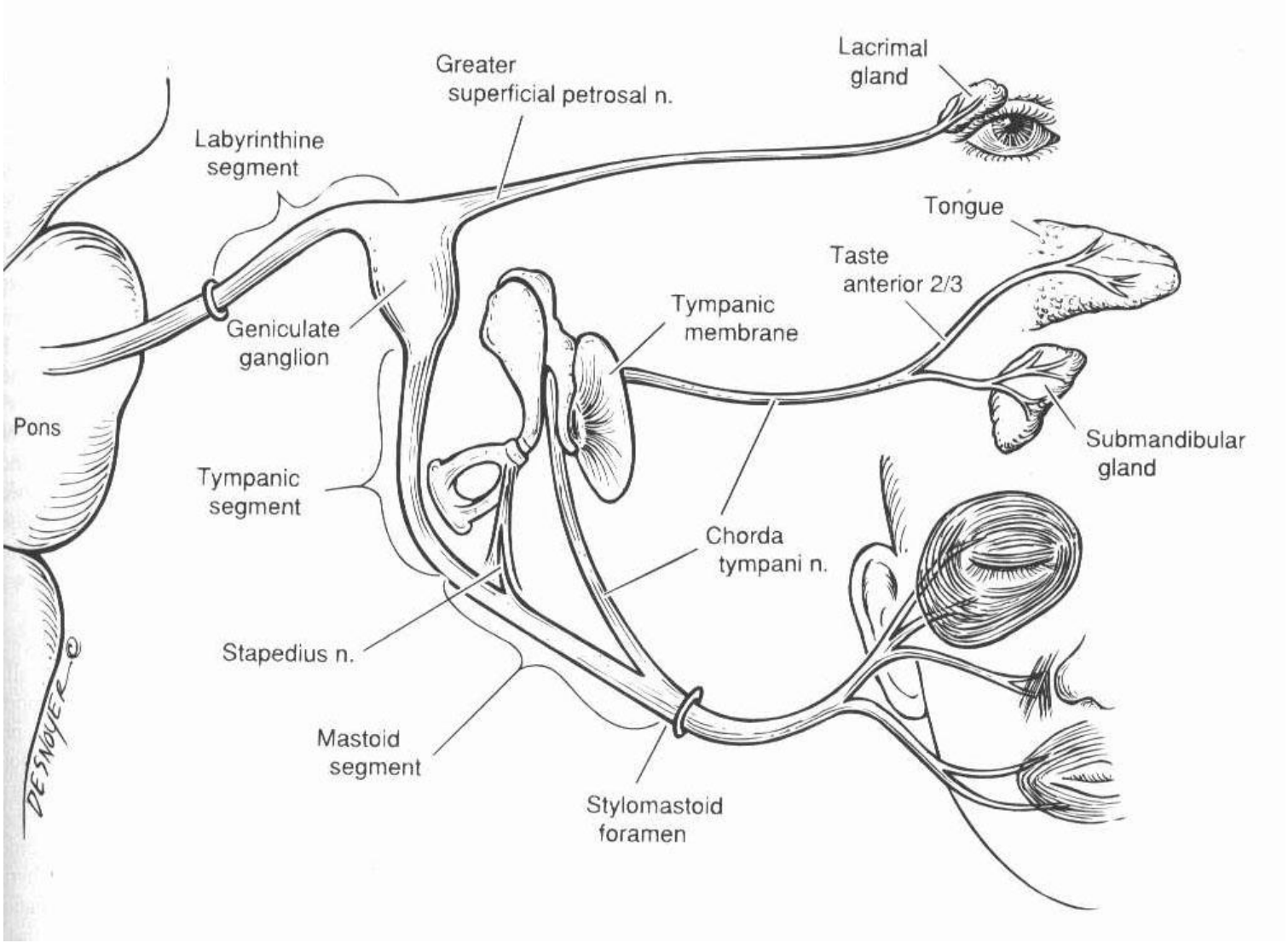
Table 16.2 Comparative data – nerve lesions in the arm

Nerves	Axillary	Musculo-cutaneous	Radial	Median	Ulnar
Sensory supply	Over deltoid	Lateral forearm to wrist	Lateral dorsal forearm and back of thumb & index finger	Lateral palm Index, middle & lateral half ring finger	Medial palm and fifth & medial half ring finger
Sensory loss	Small area over deltoid	Lateral forearm	Dorsum of thumb & index (if any)	As above from skin crease at wrist	As above but often none detectable
Area of pain	Across shoulder tip	Lateral forearm	Dorsum of thumb & index	Thumb index & middle finger. Often spreads up forearm to elbow (reason unknown)	Ulnar supplied fingers & palm distal to wrist. Occasionally pain along course of nerve up to elbow (can be confusing)
Reflex arc	None	Biceps jerk	Triceps jerk & supinator jerk	Finger jerks (flexor digitorum sublimis)	None
Motor deficit	Deltoid (teres minor cannot be evaluated) usually very obvious	Biceps Brachialis (coracobrachialis weakness not detectable)	Triceps Wrist extensors Finger extensors Brachioradialis & supinator of forearm	Wrist flexors Long finger flexors to thumb index & middle finger Abductor pollicis brevis	All small hand muscles excluding abductor pollicis brevis. Flexor carpi ulnaris. Long flexors of ring & little finger
Causative lesions	Fractured neck of humerus Dislocated shoulder Deep i.m. injections	Very rarely damaged	Crutch palsy Saturday night palsy Fractured humerus In supinator muscle itself	Carpal tunnel syndrome Direct trauma to wrist Suicide attempt Falling on glass Palmar space infection	***Elbow*** Local trauma Bed rest (resting on elbow) Fractured olecranon ***Wrist*** Local trauma Ganglion at wrist joint

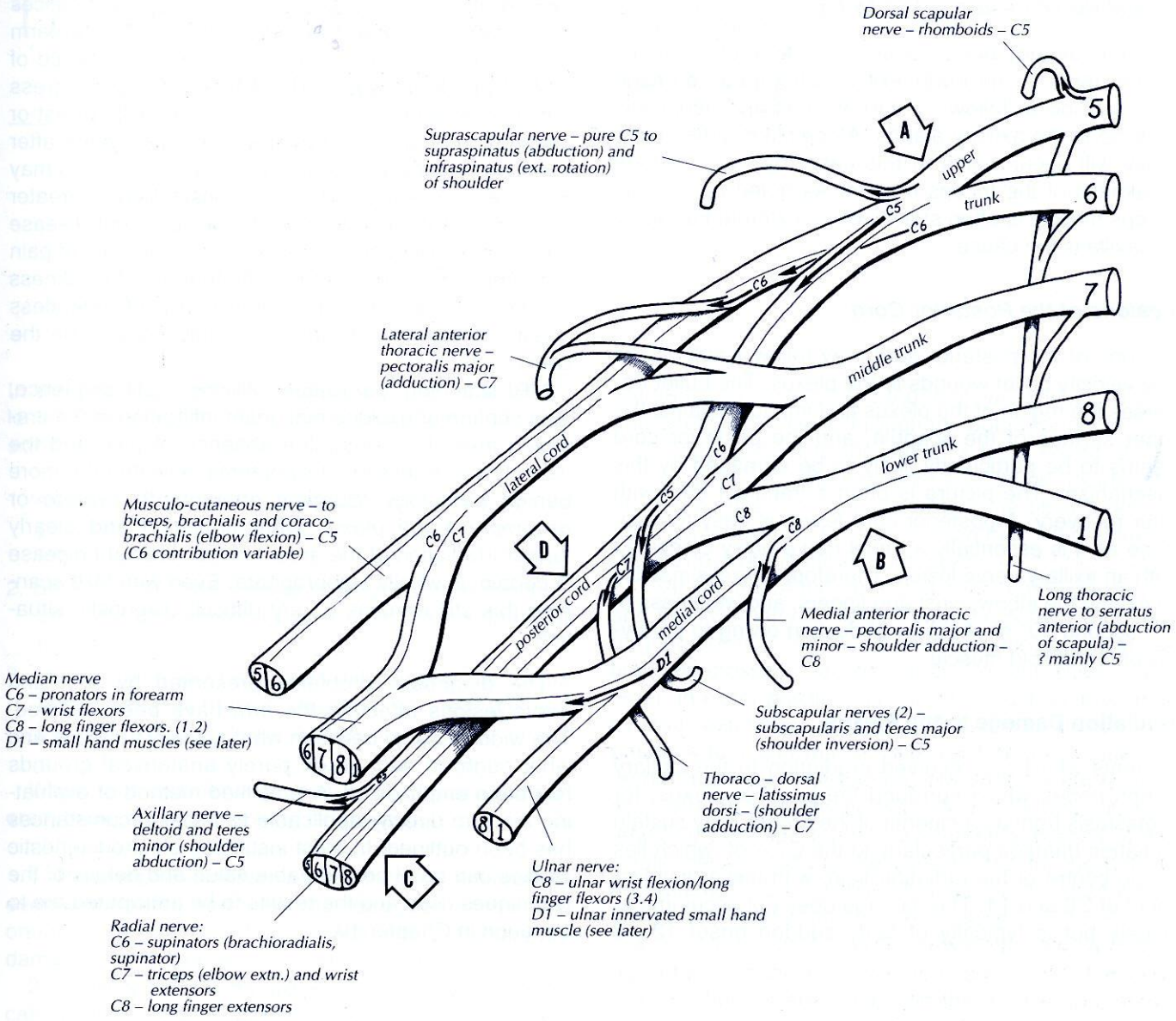
Table 17.2 Comparative data – nerve lesions in the leg

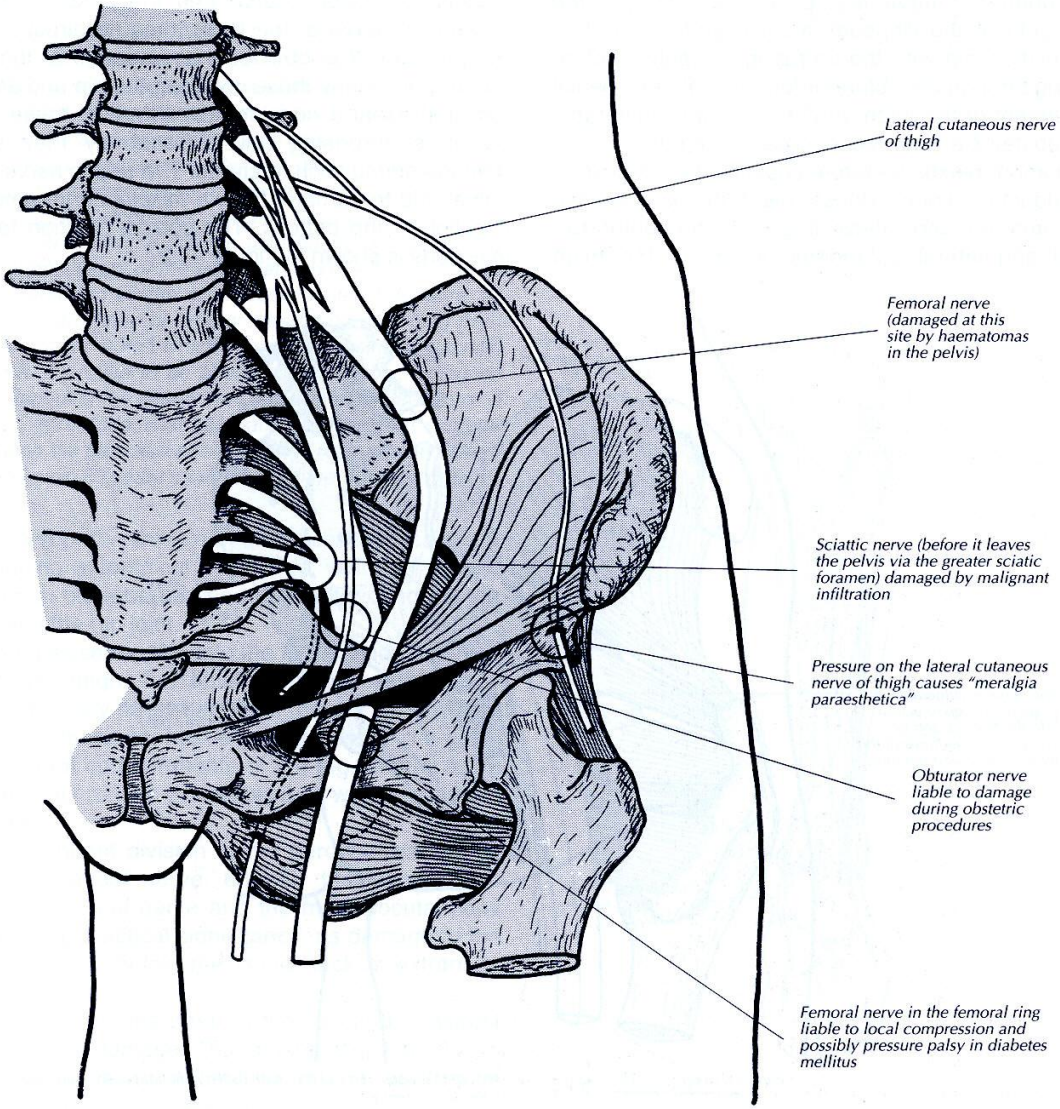
Nerves	Obturator	Femoral	Sciatic nerve	
			Peroneal division	Tibial division
Sensory supply	Medial surface of thigh to posterior axial line	Anteromedial surface of thigh and leg down to medial malleolus	Anterior leg, dorsum of ankle and foot	Posterior leg, sole and lateral border of foot
Sensory loss	Often none	Usually anatomical as above	Often only detectable dorsum of foot	Sole and lateral border of foot
Area of pain	Medial thigh	Anterior thigh and medial leg to ankle	Often painless dull ache Anterolateral leg & foot	Often painless Very uncommon
Reflex arc	Adductor jerk	Knee jerk	Lateral hamstring jerk	Ankle jerk Medial hamstring jerk
Motor deficit	Adduction of thigh	Extension of knee	Dorsiflexion, inversion (tibialis anterior) & eversion of the foot Lateral hamstrings	Plantar flexion and inversion of foot (tibialis posterior) Medial hamstrings
Causative lesions	Pelvic neoplasm Pregnancy Pelvic surgery	Diabetes Femoral hernia Retroperitoneal haematoma (anticoagulants) Femoral artery aneurysm Posterior abdominal neoplasm Psoas abscess	Pressure palsy at fibula neck Hip fracture/dislocation Penetrating trauma to buttock Misplaced injection in buttock	Very rarely injured even in buttock Peroneal division more sensitive to damage (reason unknown)

CN VII

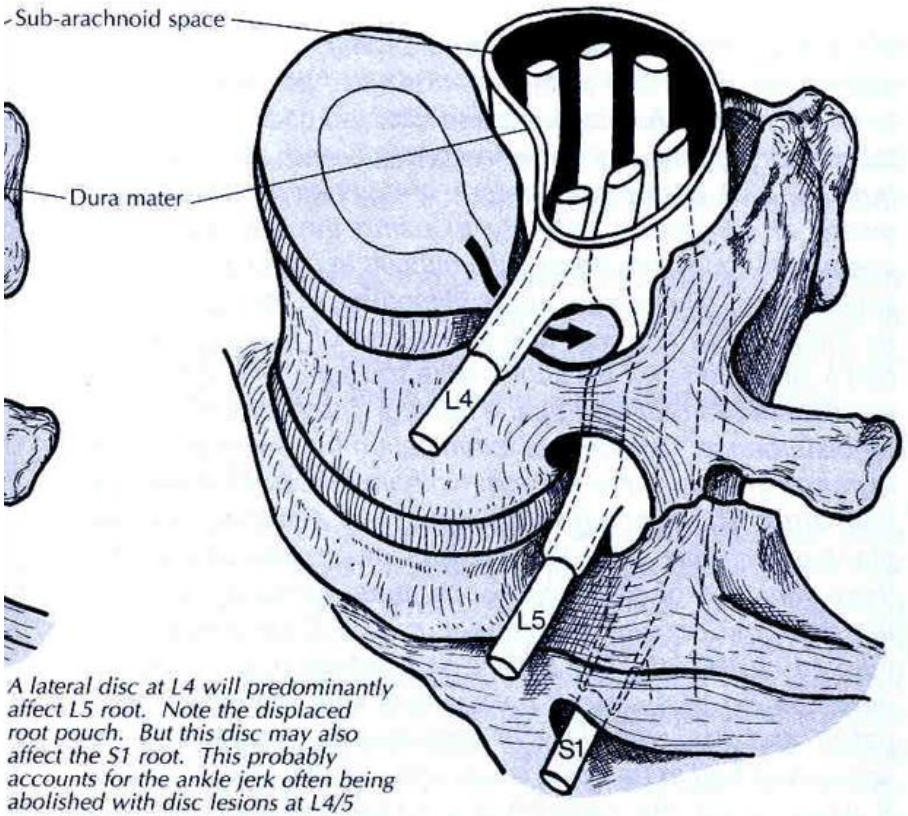


Samuels M, *Office Practice of Neurology*, 1996.

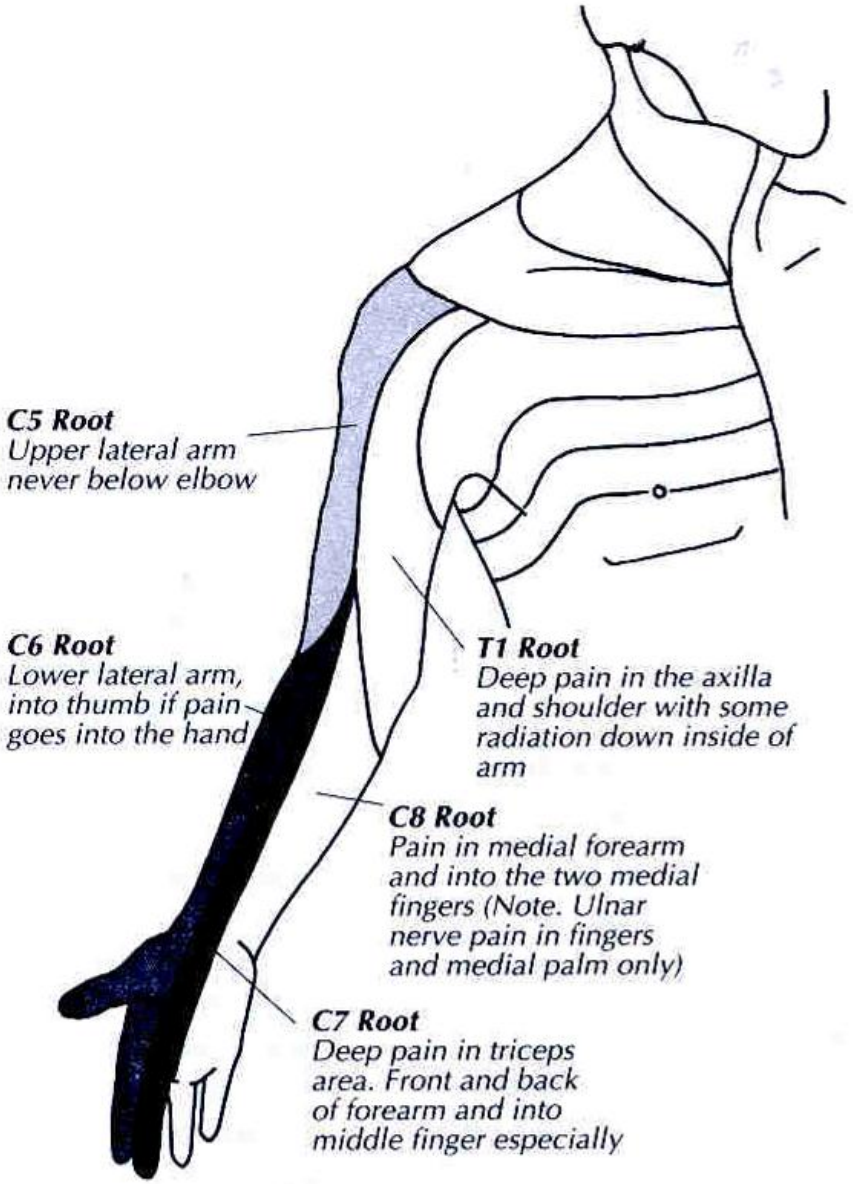

Dorsal scapular nerve – rhomboids – C5
Suprascapular nerve – pure C5 to supraspinatus (abduction) and infraspinatus (ext. rotation) of shoulder
A
upper trunk
middle trunk
lower trunk
5
6
7
8
1
C5
C6
C7
C8
D1
Lateral anterior thoracic nerve – pectoralis major (adduction) – C7
lateral cord
posterior cord
medial cord
Musculo-cutaneous nerve – to biceps, brachialis and coraco-brachialis (elbow flexion) – C5 (C6 contribution variable)
D
B
Medial anterior thoracic nerve – pectoralis major and minor – shoulder adduction – C8
Long thoracic nerve to serratus anterior (abduction of scapula) – ? mainly C5
Median nerve
C6 – pronators in forearm
C7 – wrist flexors
C8 – long finger flexors. (1.2)
D1 – small hand muscles (see later)
Subscapular nerves (2) – subscapularis and teres major (shoulder inversion) – C5
Thoraco – dorsal nerve – latissimus dorsi – (shoulder adduction) – C7
Axillary nerve – deltoid and teres minor (shoulder abduction) – C5
C
Ulnar nerve:
C8 – ulnar wrist flexion/long finger flexors (3.4)
D1 – ulnar innervated small hand muscle (see later)
Radial nerve:
C6 – supinators (brachioradialis, supinator)
C7 – triceps (elbow extn.) and wrist extensors
C8 – long finger extensors


Lateral cutaneous nerve of thigh
Femoral nerve (damaged at this site by haematomas in the pelvis)
Sciattic 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

Lateral Disc Prolapse



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

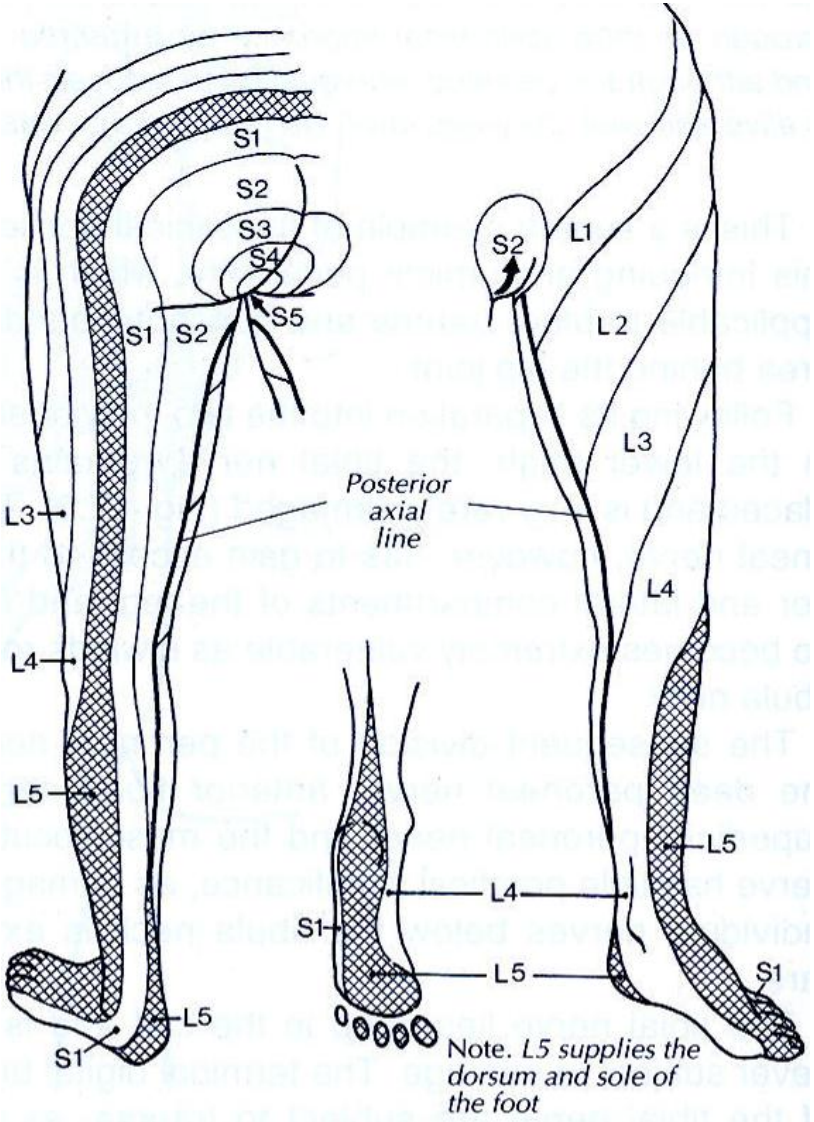
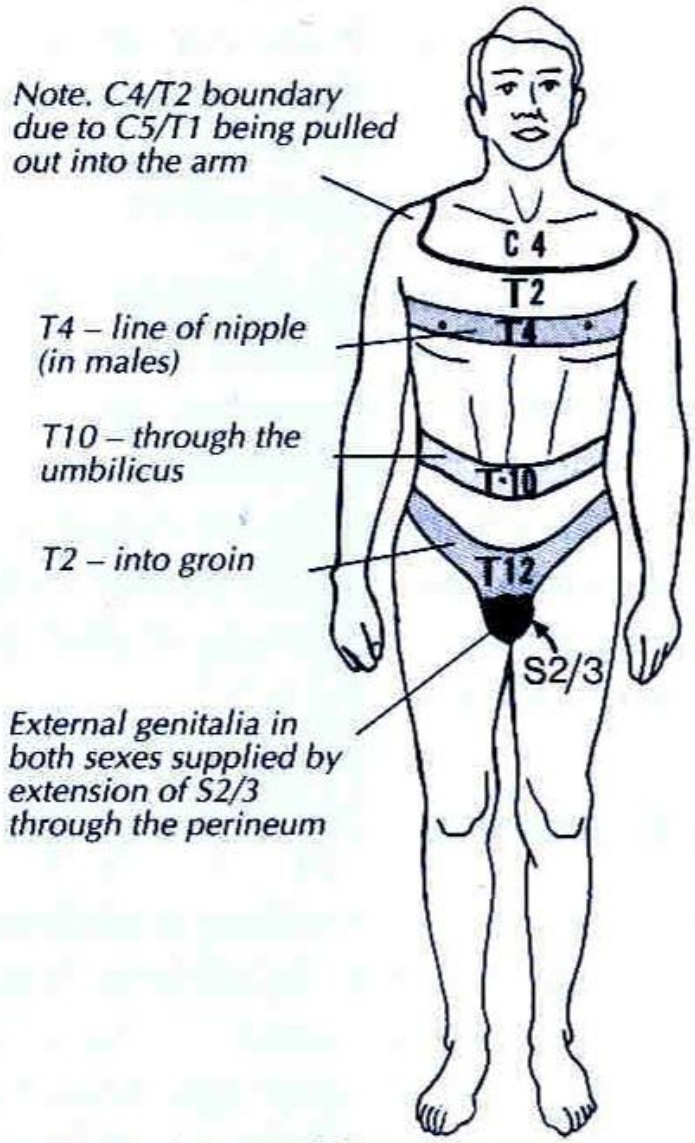

S1
S2
S3
S4
S5
S1
S2
L3
L4
L5
S1
Posterior axial line
S2
L1
L2
L3
L4
L5
S1
L4
L5
S1
Note. L5 supplies the dorsum and sole of the foot

Table 16.1 Comparative data – root lesions in the arm

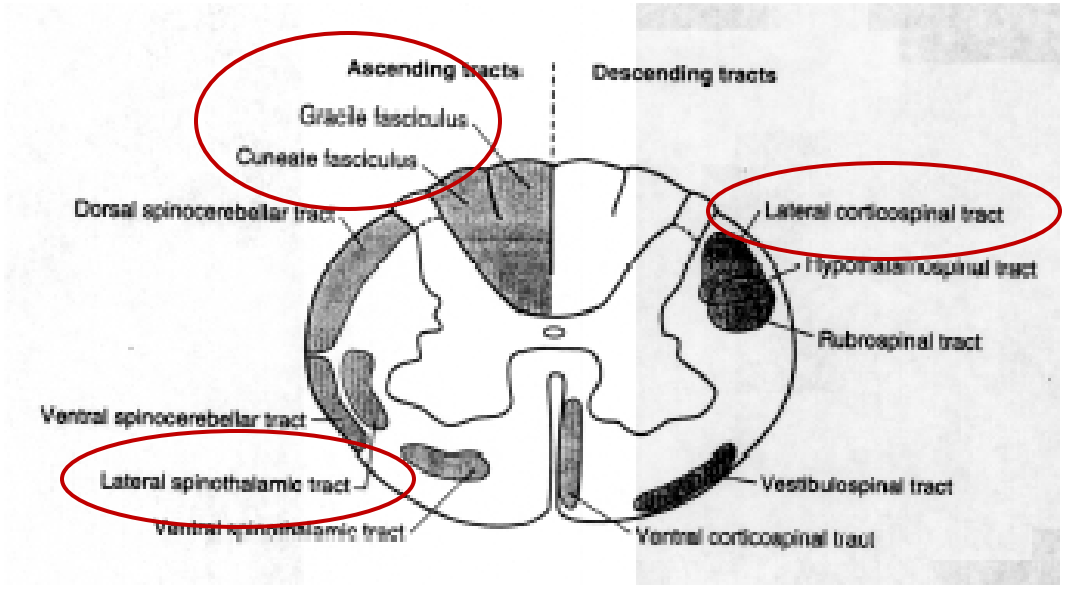
Roots	C5	C6	C7	C8	T1
Sensory supply	Lateral border upper arm to elbow	Lateral forearm including thumb & index	Over triceps, mid-forearm & middle finger	Medial forearm to include little finger	Axilla down to the olecranon
Sensory loss (Main location)	As above over deltoid	As above over thumb & radial border of hand	Middle fingers Front & back of hand	Little finger Heel of hand to **above** wrist	In axilla (usually minimal)
Area of pain	As above and medial scapula border	As above, esp. thumb & index finger	As above and medial scapular border	As above (up to elbow)	Deep aching in shoulder & axilla to olecranon
Reflex arc	Biceps jerk	Supinator jerk	Triceps jerk	Finger jerk	None
Motor deficit (muscles most involved and easily tested)	Deltoid Supraspinatus Infraspinatus Rhomboids	Pronators and supinators of forearm Biceps Brachioradialis Brachialis	Triceps Wrist extensors Wrist flexors Latissimus dorsi Pectoralis major	Finger flexors Finger extensors Flexor carpi ulnaris (Thenar muscles in rare patients)	**All** small hand muscles (thenar muscles via C8 in rare patients)
Causative lesions	Brachial neuritis Cervical spondylosis Upper plexus avulsion	Cervical spondylosis Acute disc lesions	Acute disc lesions Cervical spondylosis	Rare in disc lesions or spondylosis (See T1 usually affected by same pathology)	Cervical rib Altered anatomy of first rib Pancoast tumour Metastatic carcinoma in deep cervical nodes Outlet syndromes

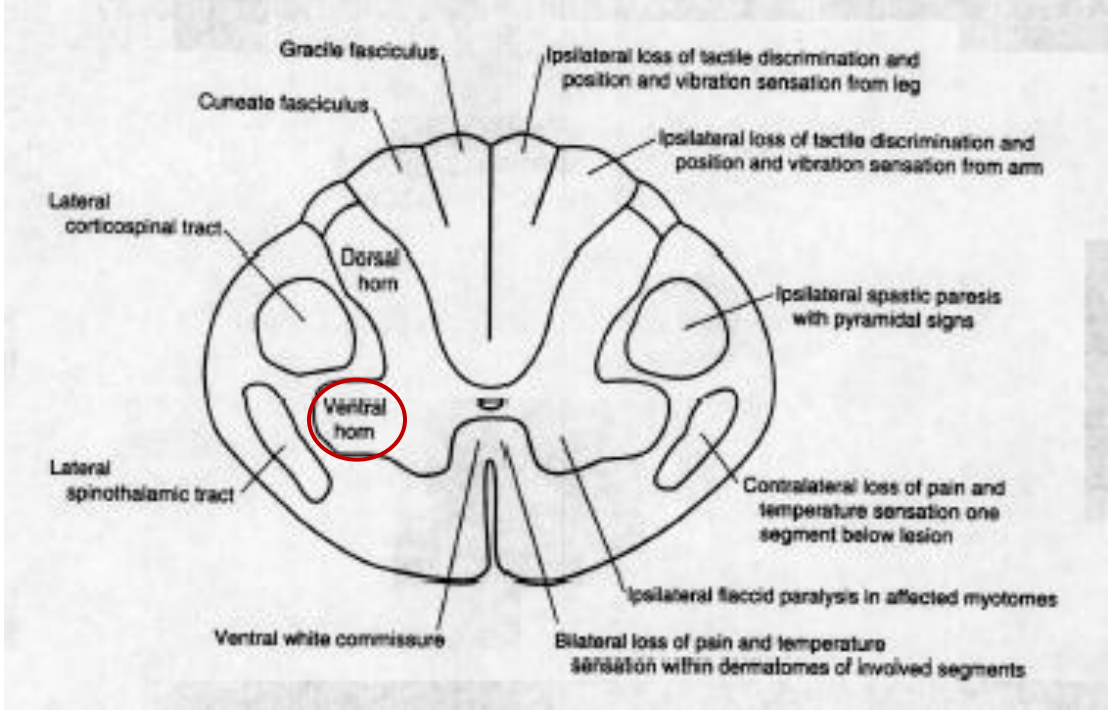
Table 17.1 Comparative data – root lesions in the leg

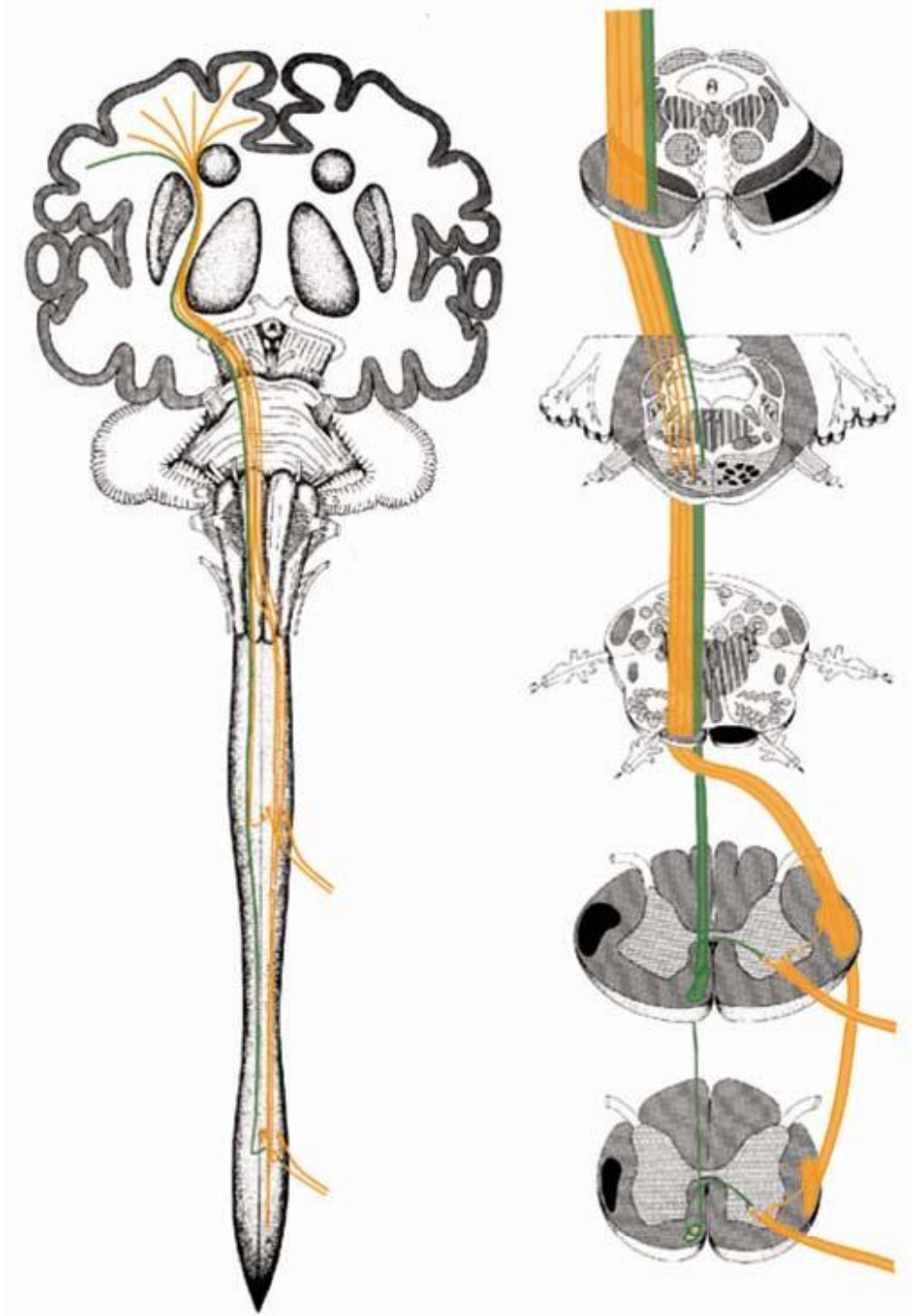
Roots	L2	L3	L4	L5	S1
Sensory supply	Across upper thigh to posterior axial line	Across lower thigh to posterior axial line	Across knee to medial malleolus	Lateral leg to dorsum and sole of foot and great toe	Behind lateral malleolus to lateral foot and little toe
Sensory loss	Often none Lateral area if any	Often none Lateral area if any	Medial leg below knee to medial malleolus	Dorsum of foot to great toe	Behind lateral malleolus and lateral border of foot
Area of pain	Across thigh diagonally	Across thigh diagonally	Down to medial malleolus. Often severe at knee round patella	Back of thigh lateral calf, dorsum of foot and great toe	Back of thigh back of calf lateral foot to little toe
Reflex arc	None	Adductor reflex	Knee jerk	None	Ankle jerk and hamstring jerks
Motor deficit (most readily demonstrated)	Hip flexion Thigh adduction	Knee extension Thigh adduction	Inversion of the foot	Dorsiflexion of toes and foot (latter L4 also)	Plantar flexion & eversion of foot
Causative lesions (in order of frequency)	L2 / L3 / L4 Neurofibroma Meningioma Neoplastic disease Disc lesions very rare (except L4 < 5% all)			L5 / S1 Disc lesions Metastatic malignancy Neurofibromas Meningiomas Congenital lesions affecting cauda equina	



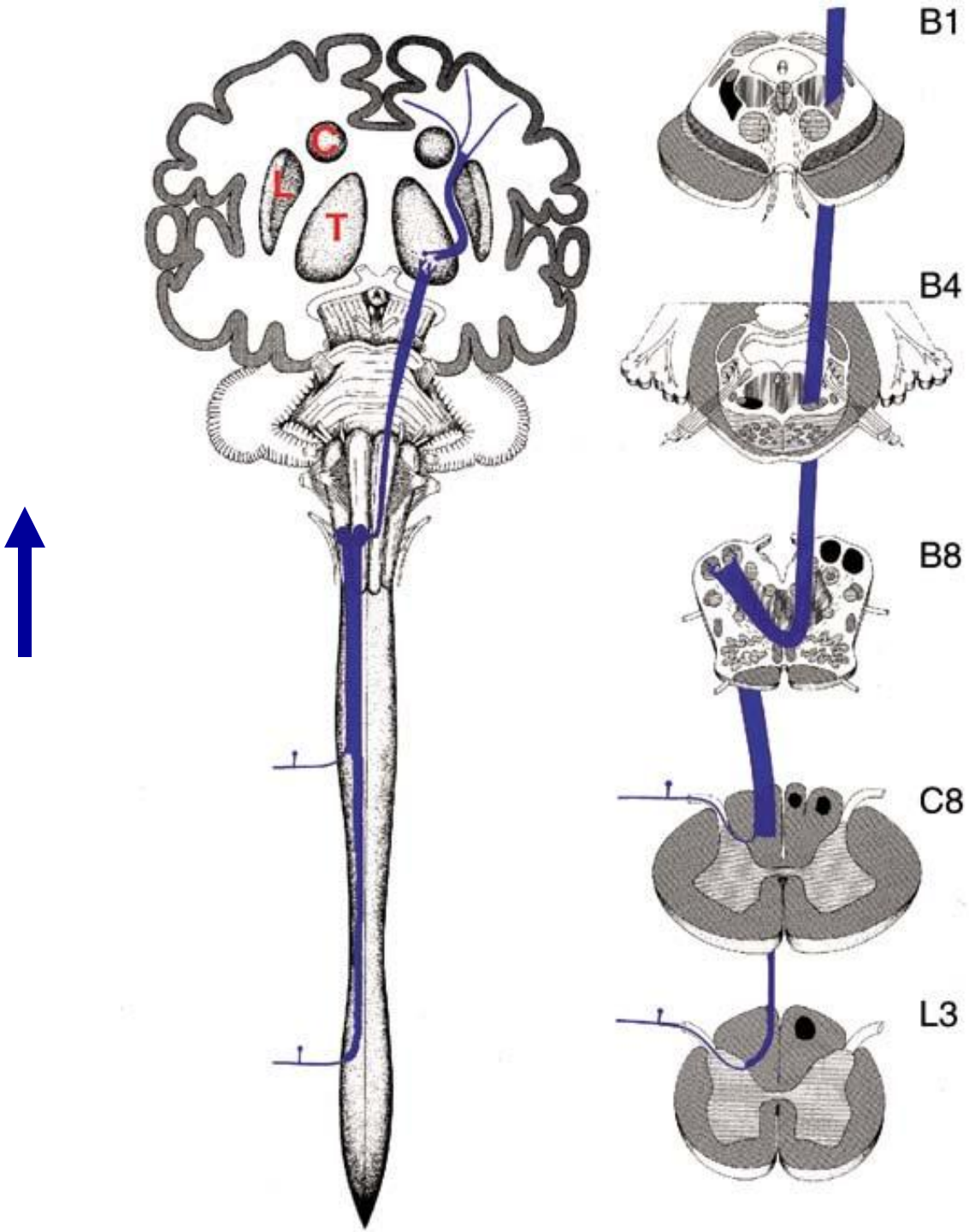
13.9 Normal dermatomes.


Ascending tracts
Descending tracts
Gracile fasciculus
Cuneate fasciculus
Dorsal spinocerebellar tract
Lateral corticospinal tract
Rubrospinal tract
Ventral spinocerebellar tract
Lateral spinothalamic tract
Vestibulospinal tract
Ventral corticospinal tract

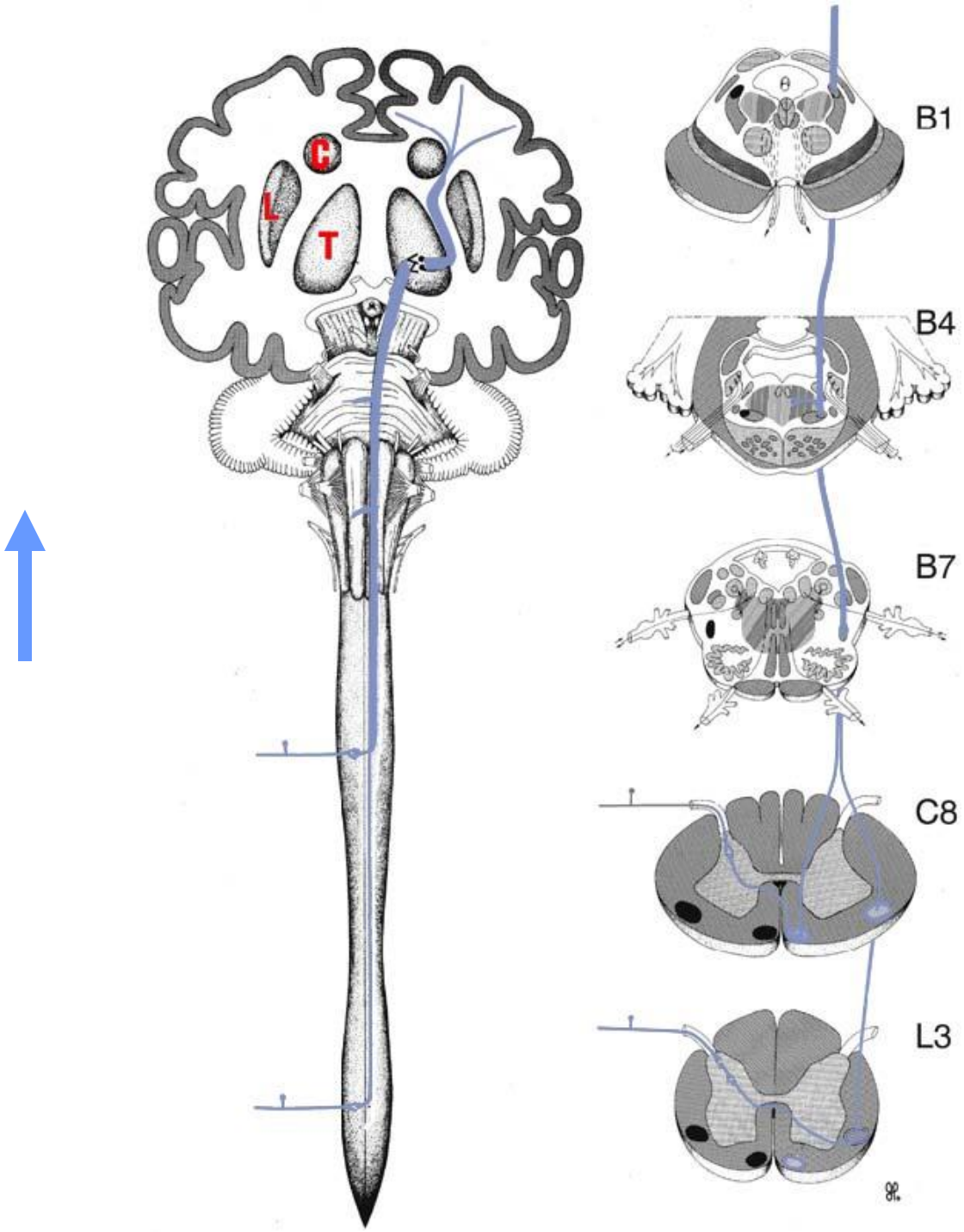

Gracile fasciculus
Ipsilateral loss of tactile discrimination and position and vibration sensation from leg
Cuneate fasciculus
Ipsilateral loss of tactile discrimination and position and vibration sensation from arm
Lateral corticospinal tract
Dorsal horn
Ipsilateral spastic paresis with pyramidal signs
Ventral horn
Lateral spinothalamic tract
Contralateral loss of pain and temperature sensation one segment below lesion
Ipsilateral flaccid paralysis in affected myotomes
Ventral white commissure
Bilateral loss of pain and temperature sensation within dermatomes of involved segments



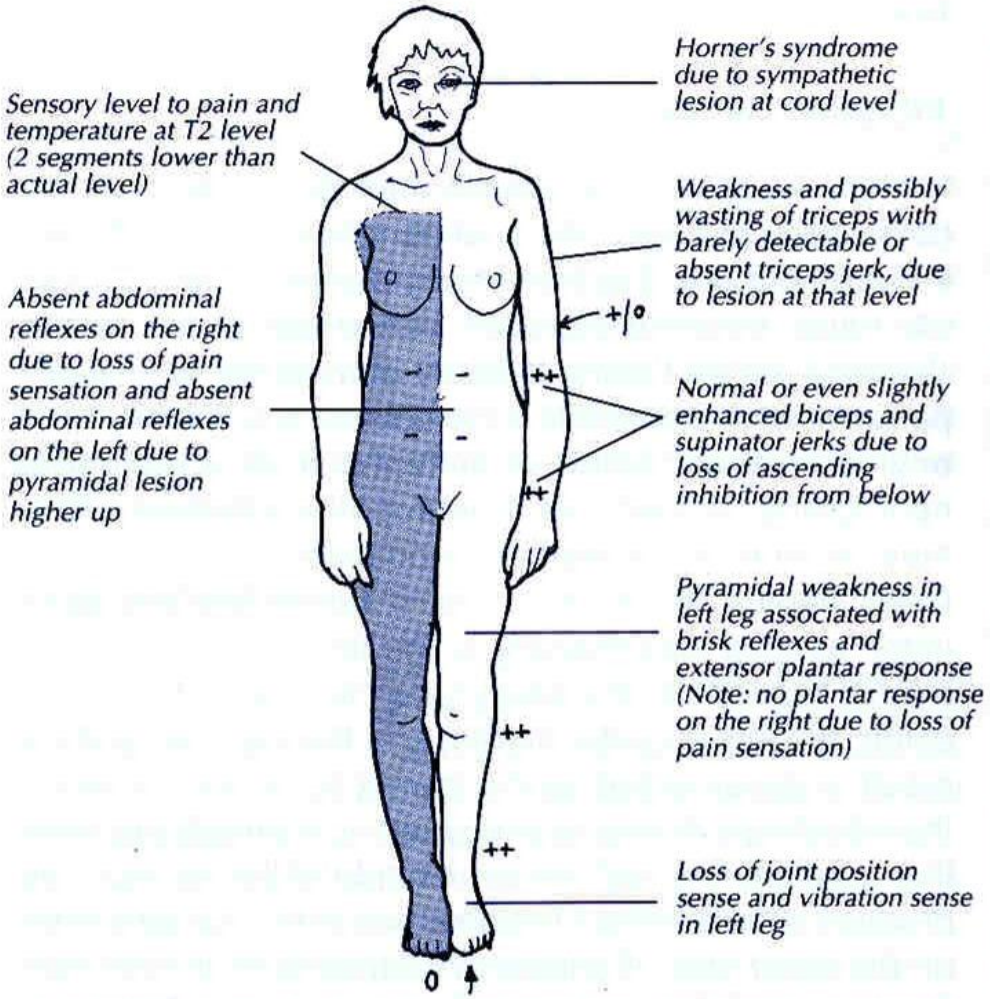
WJ Hendelman. Atlas of Functional Anatomy. CRC 2000.



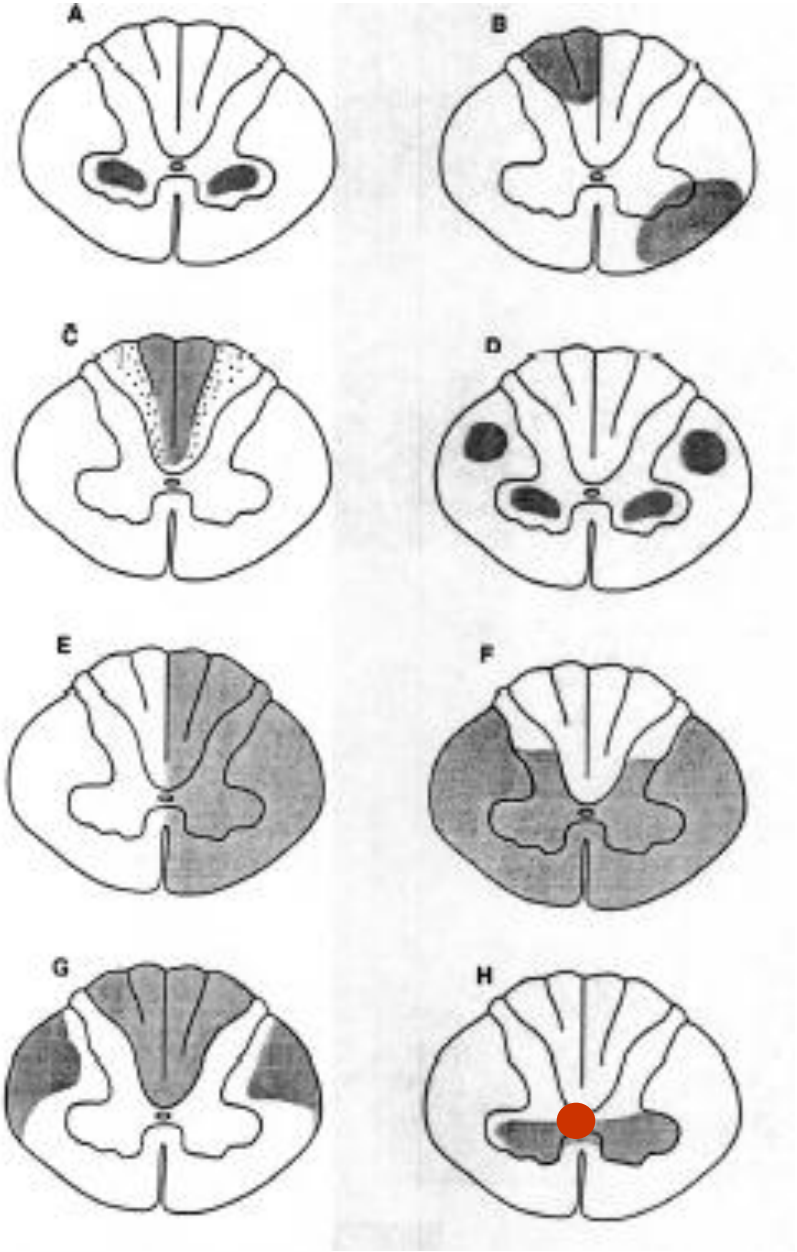
WJ Hendelman. Atlas of Functional Anatomy. CRC 2000.



WJ Hendelman. Atlas of Functional Anatomy. CRC 2000.



13.10 Clinical signs of Brown–Sequard lesion (at C7–8 level on left side).



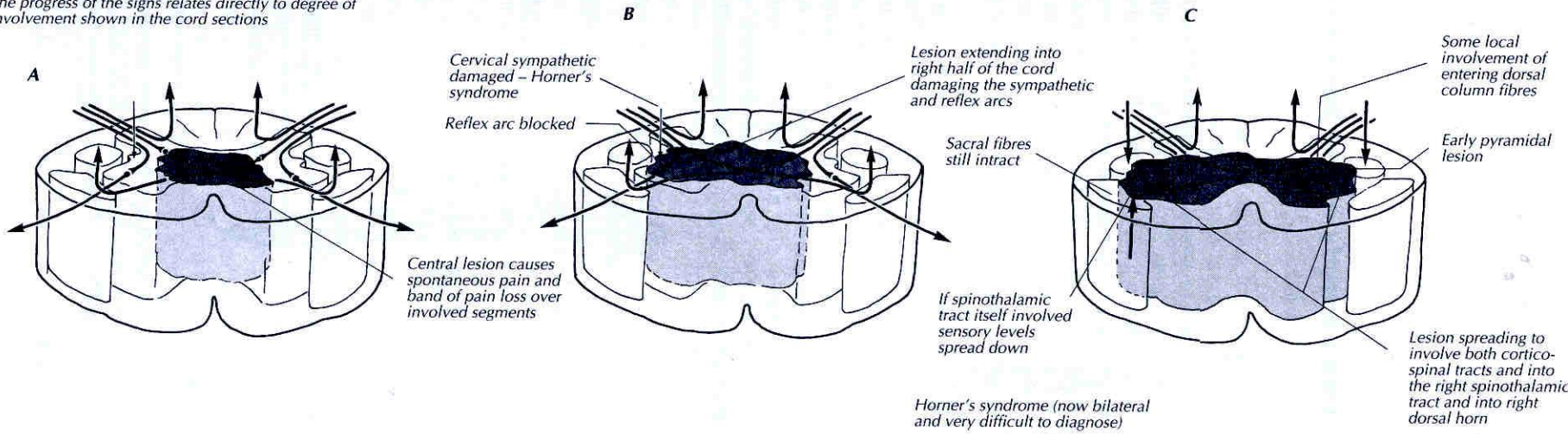
SPINAL CORD SYNDROMES

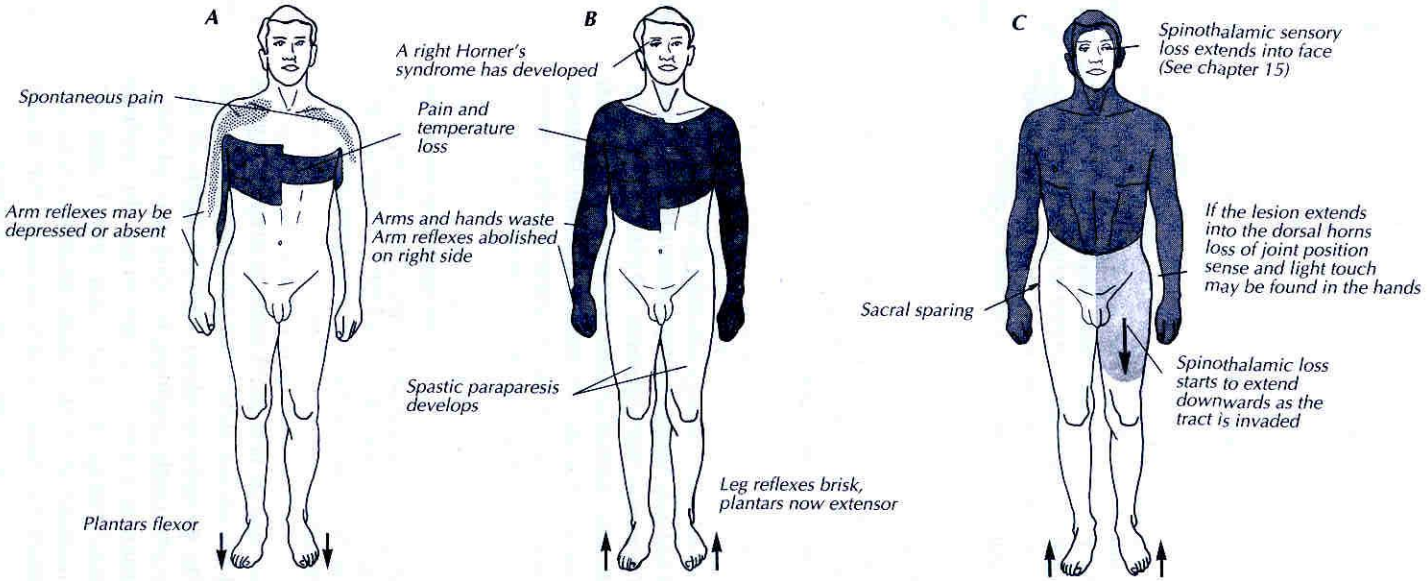
A.
B.
C.
D.
E.
F.
G.
H.

James D. Fix, High-Yield Neuroanatomy, 2nd edition

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

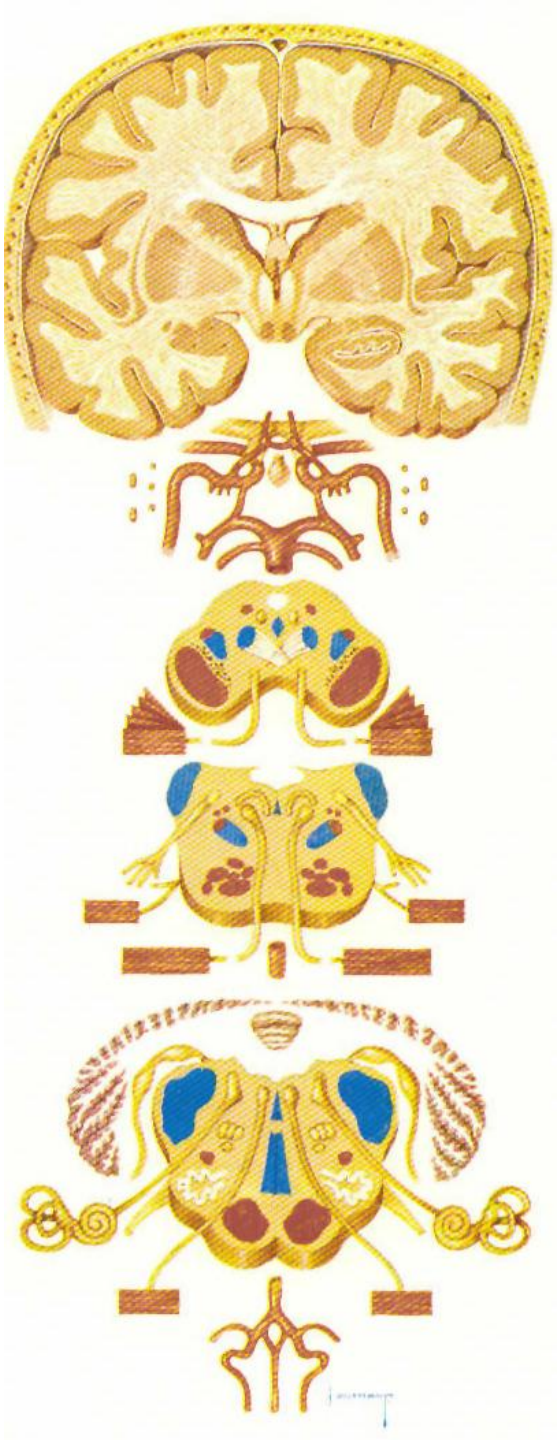




Deep nagging pain in shoulder
Sensory loss may be found by accident by patients
No signs except a thin band of pain loss

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.
Bladder often spared

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



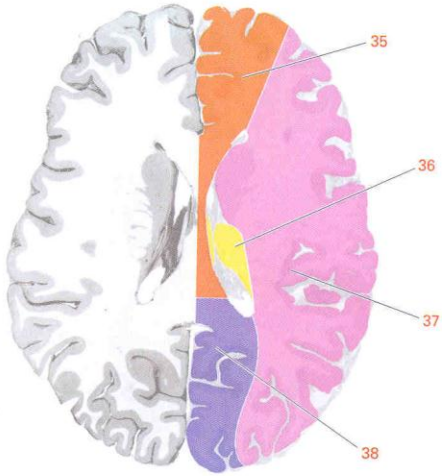
Midbrain: CN (I, II) III, IV

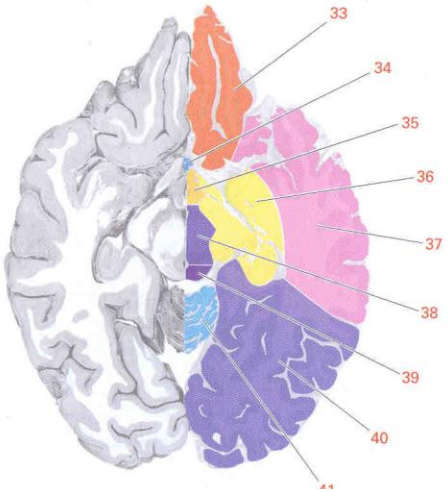
Pons: CN V, VI, VII, VIII

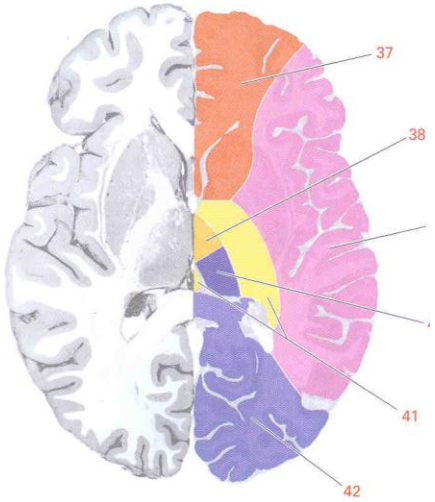
Medulla: CN IX, X, XI, XII

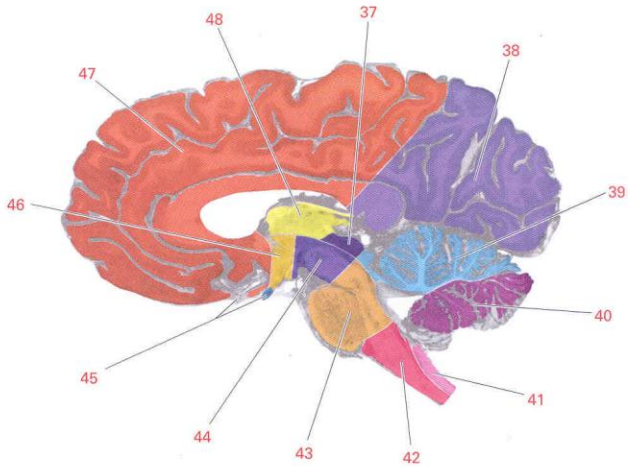
RD Collins. Illustrated manual of Neurologic Diagnosis. 1962.

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