The Nervous System

Cranial and spinal Nerves

Peripheral Nervous System (PNS)

- All neural structures outside the brain and spinal cord
  - Sensory receptors
  - Peripheral nerves and associated ganglia
  - Motor neuron endings
  - Constitutes a pathway between CNS and outlying structures
  - 12 pairs of cranial nerves
  - 31 pairs of spinal nerves

Cranial Nerves

- 12 pairs of nerves
  - Associated with the brain
- Do not decussate
  - May continue in tracts that do
  - Typically see ipsilateral functional deficits with brain injury
- Function may be sensory, motor, or both
  - Most are at least partially mixed
- Each nerve is identified by...
  - Number (I through XII)
  - Name
Cranial Nerves

- MANY mnemonics to help you remember name, order, and function
  - Google at your own risk
- A few possibilities...

Table 13.2

<table>
<thead>
<tr>
<th>Cranial Nerves</th>
<th>Sensory Function</th>
<th>Motor Function</th>
<th>PS* fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>Yes (smell)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>II Optic</td>
<td>No (vision)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>Yes (general sensation)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>Yes (general sensation)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

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<tr>
<td>VII Facial</td>
<td>Yes (taste)</td>
<td>Yes (general sensation)</td>
<td>Yes</td>
</tr>
<tr>
<td>VIII Vestibulo cochlear</td>
<td>Yes (hearing and balance)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>IX Glossopharyngeal</td>
<td>Yes (taste)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>X Vagus</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>XI Accessory</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>XII Hypoglossal</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

*PS = parasympathetic

Figure 13.5 (b)

Loss of function causes ptosis, external strabismus ("down and out")

Trochlear Nerve Palsy
Spinal Nerves

- 31 pairs of mixed nerves named according to their point of issue from the spinal cord
  - 8 cervical (C1–C8)
  - 12 thoracic (T1–T12)
  - 5 Lumbar (L1–L5)
  - 5 Sacral (S1–S5)
  - 1 Coccygeal (C0)
Spinal Nerve Organization

- Spinal nerve connects to the spinal cord via two roots
  - Ventral roots
    - Contain motor (efferent) fibers from the ventral horn motor neurons
    - Fibers innervate skeletal muscles
  - Dorsal roots
    - Contain sensory (afferent) fibers from sensory neurons in the dorsal root ganglia
    - Conduct impulses from peripheral receptors
- Dorsal and ventral roots unite to form spinal nerves
  - Emerge from vertebral column via the intervertebral foramina

- Rami
  - Each spinal nerve branches into mixed rami
    - Dorsal ramus
    - Ventral ramus
      - Rami communicantes branch off of ventral ramus
      - Involved in ANS signaling pathways
    - Meningeal branch
      - Reenters the vertebral canal and innervates the meninges and blood vessels within
Spinal Nerve Organization

- Dorsal ramus
  - Innervates
    - Deep back muscles
    - Posterior surface of trunk (skin and muscle)
- Ventral ramus
  - Innervates
    - Superficial back muscles
    - Limbs
    - Lateral and anterior surfaces of trunk (skin and muscle on side, chest, ribs, abdominal wall)

Distribution of Spinal Nerves

- Dermatome
  - Area of skin innervated by the cutaneous branches of a single spinal nerve
  - All spinal nerves except C1 participate in dermatomes
  - Most dermatomes overlap

Plexuses

- All ventral rami form interlacing nerve networks
  - 4 plexuses
    - Cervical, brachial, lumbar, and sacral
    - Fibers from the rami branch and become redistributed
    - Each nerve exiting the plexus has fibers from several spinal nerves
    - Advantage?
- Exception: ventral rami of T2-T12
  - Do not form a plexus
  - Form intercostal nerves
Plexuses

- **Cervical plexus**
  - Formed by ventral rami of C1-C4
  - Innervates skin & muscles of the neck, ear, back of head, and shoulders

Plexuses

- **Phrenic nerve**
  - Major motor and sensory nerve of the diaphragm
  - Critical for breathing
  - Receives fibers from C2-C5
  - Therefore receives innervation from both the cervical plexus and the brachial plexus

Plexuses

- **Brachial plexus**
  - Formed by ventral rami of C5-T1
  - Gives rise to the nerves that innervate the upper limb
    - Median
    - Ulnar
    - Axillary
    - Radial
    - Musculocutaneous
Injuries

- Radial nerve damage causes the fingers, wrist, or hand to be in the chronically flexed position
  - “Crutch paralysis” – caused when crutches are improperly adjusted
  - “Saturday night paralysis” – caused by falling asleep with the arm hanging over the armrest of a chair
  - “Honeymoon paralysis” – caused by someone else sleeping on and compressing the arm

- Radial nerve is constantly pushed against the humerus, and cannot innervate extensor muscles
  - Improves quickly with therapy

- Ulnar nerve is the largest nerve in the body that is not protected by muscle or bone
  - Injury is common
    - “Funny bone”
    - Weakness in flexion of the hand at wrist, inability to cross fingers
    - “Claw hand” at rest

- Carpal tunnel
  - Caused when the median nerve is compressed as it travels through the wrist
  - Pain, numbness, tingling in the hand, forearm, and shoulder
  - Caused by anything that applies pressure to the median nerve
    - Esp. cumulative trauma caused by repetitive motion
    - If untreated may cause wasting on muscles at the base of the thumb

Plexuses

- Lumbar plexus
  - Arises from L₁–L₅ (some T₁₂)
  - Innervates thigh, abdominal wall, external genitalia, leg & foot
    - Femoral nerve
      - Innervates quadriceps, skin of anterior thigh & medial surface of leg
        - Functions in extending the knee; sensory function in skin on front and inner sides of thigh, shin, and arch of foot
    - Obturator nerve
      - Passes through obturator foramen
      - Innervates adductor muscles; sensory function in skin on medial aspect of thigh
Plexuses

• Sacral plexus
  – Arises from L4-S5
  – Serves the buttock, lower limb, pelvic structures & perineum
  – Gives rise to sciatic nerve
    • Longest and thickest nerve of the body
    • Innervates
      – Muscles of the leg and foot
      – Skin on the leg and foot

Figure 13.11 (a) Superior gluteal
Inferior gluteal
Common fibular
Deep fibular
Superficial fibular
Plantar branches

(b) Distribution of the major nerves from the sacral plexus to the lower limb