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The Nervous System (Divisions)

Peripheral Nervous System
- Cranial Nerves
- Spinal Nerves

Central Nervous System
- Spinal Cord
- Brain
- Fore brain
  - Cerebrum
  - Diencephalon
  - Pons
  - Medulla Oblongata
- Mid brain
- Hind brain
  - Epithalamus
  - Thalamus
  - Hypothalamus
  - Subthalamus
  - Cerebellum
*Cerebral cortex = 2500 square cm = 4.5(A4) size paper (gyri)
*If smooth suf. = 1/3 of above area
*Cerebral cortex contains 14-16 billion neurons
*Adult Wt. = 1600g (male), 1450g (female)
*Size is proportional to body size (not intelligence)
*Blood supply is constant at all times (750 ml/min)
*Receives 15% of body’s blood and 20% of Oxygen & Glucose

**Interruption of blood supply:**
*10 Sec. = loss of consciousness
*1-2 Min. = Significant impairment of neuronal function
*4 min. = Irreversible brain damage
LEARNING OBJECTIVES 
الأهداف التعليمية

By the end of the course you should be able to describe:

1- The general topography of spinal canal & spinal cord.
2- It’s coverings (meningies)
3- The blood supply of the spinal canal, meningies and the spinal cord.
4- The internal & external features of the spinal cord.
5- The main ascending & descending tracts.
6- The given examples of spinal cord lesions.
Appendix (ملحق)
Lexicon (معجم) of biomedical word elements

* Cauda equina, (cauda = Tail + equin = horse)
* Dura mater, ( dura = tough + mater = mother)
* Arachnoid mater, (arachn = spider, spider web + oid = resembling)
* Pia mater, (pia = tender, soft)
* Funiculi, (funicul = little rope, cord) e.g. Columns
* Fasciculi, (fascicul little band) e.g. Tracts
* Gracile, (gracil = thin, slender)
* Cuneate, (cune = wedge)
* Proprioceptione, (proprio = one’s own + cept = receive, sense)
* Lemniscus, (lemniscus = ribbon)
The Spinal Canal

*Only opening are the intervertebral foramina.
*Contains the spinal cord & its meninges.
*Lined with extradural fat which contains the internal vertebral venous plexus.
*This plexus receives the basi-vertebral veins which drains the bone marrow of the vertebral bodies and sends its efferent's through the intervertebral foramina, into the segmental veins.
*The plexus exists as a by-pass of the diaphragm.
Spinal meningies

1. Dura mater.
   Epidural space
   Subdural space

2. Arachnoid mater.
   Subarachnoid space

3. Pia mater.
Function of spinal cord

1- Receives fibers of dorsal root (afferent) from somatic and visceral receptor

2 - Give rise to ascending pathways transmitting impulses to higher levels of neuroaxis

3 - Give rise to fibers of ventral root (efferent) that innervated somatic & visceral effectors

4- Coveys descending pathways from higher levels of nervous system.

5- Participate in various somatic & autonomic reflexes
The Spinal Cord

• Grayish white structure
• Begin superiorly at foramen magnum in the skull
• Terminate inferiorly, in the adult age 20Y, at the level between L1 & L2 vertebrae.
• Surrounded by three meninges
• Average length in normal adult is 45 cm
• Circumference is about 2.5 cm
• Ant. It has ant. Median fissure (deep).
• Post. it has post. median septum (shallow).
• In fetus spinal cord extend to S2.
• At birth to L3.
• Reach its permanent level (bet. L1 & L2) at age 20 years.
The Spinal Nerves Roots

*31 pairs.
*Attached to spinal cord by a series of rootlets.
*Each evaginate the Dura mater separately before uniting to form a mixed spinal nerve in the intervertebral foramina.
*DRG on post root (in intervertebral foramina).
*From C1-L1 roots pass ant. & post. To ligamentum denticulatum.
*Below L1 roots pass vertically downwards, through the subarachnoid space to form the cauda equina with its centrally placed film terminale.
Spinal Cord-Internal structure

- Central **grey** mater surrounding central canal.
- Enclosed by a cylindrical mass of **white** mater.
- Divided into 2 halves by ant. Median fissure & post. Median septum.
- H-shaped grey mater & shows ant. & post grey horns.
*Lateral grey horns:

A. T1-L2 (pregang. Sympathetic).
B. S2,3,4 (pregang. Parasympathetic).

*Thoracic Nucleus (C8-L3)

- Receives **Aff.** proprioceptive fibers (impulses) from muscle spindles (degree of contraction).
- **Eff.** Fibers form the post. Spino-cerebellar tract of the same side.
*Interneurons* (connector cells) of spinal reflex arcs.

*Substantia Gelatinosa*
- concerned with the transmission of **pain** impulses.

*Central Canal*
- Lined with ependema (columor epithelium with stereocilia).

*Grey Commissure*
- Cross bar of the H
**White Mater**

- Divided into 3 main columns by ant. & post. Horns & their attached rootlets.

**Posterior (Dorsal) White Columns**

A. Fasciculus Gracilis  
B. Fasciculus Cuneatus  

**Lateral White Columns**

**I. Descending Tracts**

1- Lat. Cerebro-Spinal Tract (Cortico-spinal)  
2- Vestibulo-Spinal Tract  
3- Tecto-Spinal Tract  
4- Reticulo-Spinal Tract  
5- Rubro-Spinal Tract  

**II. Ascending Tracts**

1- Lat. Spino-Thalamic Tract  
2- Dorsal (post.) Spino-Cerebellar Tract  
3- Ventral (ant.) Spino-Cerebellar Tract  
4- Spino-Vestibular tract  
5- Spino-Tectal Tract  
6- Spino-Olivary Tract  

**Anterior White Columns**

1- Ant. Cerebro-Spinal Tract (Cortico-spinal)  
2- Ant. Spino-thalamic Tract  
3- Vestibulo-Spinal Tract
Blood supply of spinal cord

*Ant. Spinal Artery* (one)
(Branch from each vertebral art.)

*Post Spinal Arteries* (two)
(branches from vertebral or post. Inf. Cerebellar arts.)

*Radicular Arteries* (boosters)
(Ant. & Post.) from segmental spinal artery.
Type of sensation conveyed by:

A. post. white column (DOSAL COLUMNS)
1. Kinesthetic
   الإحساس بالحركة
Muscle and joint sense
Spatial appreciation
Vibration sense
1. Discriminative touch
   اللمش التَمْيِيزِي
e.g.: two points discrimination
1. Deep touch (pressure)

B. Spino-thalamic tracts
1. Lat. Spino-thalamic Tract
   Pain & Temperature
2. Ant. Spino-thalamic Tract
   Light touch & Presser

C. Lissauer Tract
   Pain fibers

D. Spino-cerebellar Tracts
   Carry Proprioceptive impulses
1. Ant. Spino-cerebellar Tract
   From whole limb movement
1. post. Spino-cerebellar Tract
   From individual muscle movement
Pyramidal System

(Pyramidal Fibers) → Cortico-Nuclear Fibers (to cranial motor nuclei) → Cortico-Spinal Fibers (to ant. Horn cells)

Precentral gyrus (motor area 4) → Corona Radiata

Pons → Crus Cerebri → Interna Capsule

Medulla Oblongata (Pyramids) (90%) decussate to other side (Lat. Cortico-Spinal Tract) (10%) remain on same side (Ant. Cortico-Spinal Tract)

Synapse on ant. Horn cells
Extra-Pyramidal System

Modulates & Integrates motor impulses that originate from cerebral cortex.

Cerebral Cortex (Frontal & Temporal)

Pontine nuclei

Cerebellum

Basal nuclei

a. Red nucleus
b. Vestibular nucleus
c. Olivary nucleus

Ant. Horn neurons
Spinal Cord Lesions

- Complete cord transection
- Ant. cord syndrom
- Central cord syndrom
- Brown-sequard syndrome
- Syringomyelia
- Poliomyelitis
Complete Cord Transection Syndrome

1- Bilat. **Lower motor neurone (LMN)** paralysis (ant. Motor neurons damage)
   (Bilat. flaccid paralysis & muscle atrophy in segments of lesion).

2- Bilat. **Upper motor neuron (UMN)** paralysis (pyramidal & extra-pyramidal damage).
   (Bilat. spastic paralysis below level of lesion).

3- Bilat. Loss of all sensations below level of lesion.
   (Spino-thalamic tracts 2-3 segments. Below lesion).

4- Loss of voluntary control of urinary bladder & rectum. (Descending autonomic damage)
   (Result of 1- # dislocation of verteb. Col. 2- Bullet or stab wound. 3-Expanding tumor.)
Ant. Cord Syndrome
1. Bilat. **LMN** paralysis (flaccid) & atrophy in segs. of lesion.
2. Bilat. **UMN** paralysis (spastic) below level of lesion.
(Caused by cord contusion during 1-vertebral # or dislocation. 2-Inj. Ant. Spinal art. or its boosters. 3-Herniated disc).
Central cord syndrome
1. Bilat. LMN paralysis (flaccid)& atrophy in segs. of lesion.
2. Bilat. UMN paralysis (spastic) below level of lesion with sacral sparing.
(Caused by hyperextension of cervical spine which causes cord to be pressed by vertebral bodies & ligamentum flavum).
Brown-Sequard syndrome
1. Ipsilat. LMN paralysis (flaccid) & atrophy in segs. of lesion.
2. Ipsilat. UMN paralysis (spastic) below level of lesion.
4. Ipsilat. Loss of kinesthetic, vibration.....etc.sensations below level of lesion.
(Caused by: 1- # dislocation of vertebral column. 2- bullet or stab wound. 3- Expanding tumor).
**Syringomyelia**

*Bilat. Loss of pain & temp sensations (dissociated sensory loss) in dermatomes related to affected cord segments (interruption of Spino-thalamic tracts as they cross midline of cord).

(Due to developmental abnormality of the central canal. Mostly in brainstem & cervical region. Destruction or degeneration of grey & white matter adjacent to central canal which leads to cavitations & accumulation of fluid in central region of cord).
**Poliomyelitis**
*lower motor neuron lesion (LMN) (flaccid paralysis) with decreased deep tendon reflexes and muscle wasting). (*Caused by poliomyelitis virus infecting ant. Horn neurons.)