The spinal cord - Medulla spinalis

The development of the neural tube in the area of the spinal cord

The spinal cord - Medulla spinalis

- **length 40 – 50 cm, thickness 1cm**
- **weight circa 30g**
- **it is located within the spinal canal**
- **it follows curvature of vertebral column**

Cranially: it continues as medulla oblongata,
Borderline is decussatio pyramidum or detachment of 1st spinal nerve

Caudally: conus medullaris (apex lies at the level of intervertebral disc L1-2, body of L2) – **filum terminale** (25 cm, 1 mm)
Caudal part of vertebral canal is filled with nerve roots– cauda equina (a horse tail)

The spinal cord

- **It keeps structure of original neural tube with canalis centralis in the middle**
- **At the level of spinal cord, there are simple unconditional reflexes realized**

The spinal cord

• thickness of the spinal cord is not the same in all sections **– enlargements**

intumescentia *cervicalis (C3-T2)*

intumescentia *lumbosacralis (T9-L1)*

places where the nerves for limbs arise

Structure of the spinal nerve

- radix anterior: motor
- radix posterior: sensory
  - Ganglion spinale

} Spinal nerve → ramus dorsalis mixed
} Spinal nerve → ramus ventralis mixed

- **Number of spinal segments corresponds to number of spinal nerves**

Cervical part (***pars cervicalis***): 8 segments (C1-8), C1 arises betweeen the occipital bone and atlas, ***nervi cervicales***
Thoracic part (***pars thoracica***): 12 segments (Th1-12), ***nervi thoracici***
Lumbar part (***pars lumbalis***): 5 segments (L1-5), ***nervi lumbales***
Sacral part (***pars sacralis***): 5 segments (S1-5), ***nervi sacrales***
Coccygeal part (***pars coccygea***): 1 segment (Co1), ***nervus coccygeus***

- **Longitudinal grooves**

Fissura mediana anterior
Sulcus medianus posterior
Sulcus anterolateralis
Sulcus posterolateralis
Sulcus intermedius posterior

- **sulcus anterolateralis** (**motor**)
- **sulcus posterolateralis** (**senzsory**)

The spinal cord – *anterior view*

- **Fissura mediana anterior**
- **Sulcus anterolateralis- radix anterior**

The spinal cord: posterior view

- **Sulcus medianus posterior**
- **Sulcus posterolateralis**
    - **radix posterior**
- **S. intermedius posterior**

During the third month of intrauterinne development, the spinal cord fills whole lenght of the spinal canal. Later the vertebral column grows much faster than the spinal cord and the spinal cord of newborn usually ends at **L3.**

Due the different speed of growth, the lumbar and sacral roots extend to reach appropriate intervertebral spaces and they form **cauda equina**. The superior thoracic roots pass horizontally.

Internal structure of the spinal cord

Grey matter (bodies of neurons)

- Around the central canal, it has the shape of a butterfly
- It protrudes into two horns– **at the front:** thicker and shorter ***cornu anterius***, with **motoneurons** whose axons form efferent (**motor**) neural pathways

  at the back: thiner and longer ***cornu posterius***, on whose neurons end axons of pseudounipolar neurons (of the spinal ganglia) of the afferent (**sensory**) pathways
- Between both horns, there are **interneurons** (connective neurons)

White matter (axons)

- Located on surface, it is formed by **bundles of myelinated axons**, we distinguish following pathways:

associative: **connect two different places of the same spinal segment on the same side**

comissural: **connect right and left half of the same segment**

projective: **go ascending or descending through the spinal cord and enter the brain, there are two types (according direction of course):**

- **descending: pass within anterior part of spinal cord and continue as motor pathways**
- **ascending: pass within anterior part of spinal cord anf they are continuation of sensory pathways**

The spinal cord – crossection

Grey matter *(substantia grisea)*

- canalis centralis
- **cornu anterius**
- **cornu posterius**

White matter (*substantia alba*)

- **funiculus anterior**
- **funiculus lateralis**
- **funiculus posterior**

The pathways within spinal cord– white matter

- **Ascending (afferent) sensory**
  - somatosensory and viscerosensory information converge within spinal nerves
- **Descending (efferent) motor**
  - **somatomotor**
  - **visceromotor (autonomous)**

- ***Crossing of tracts !!!***

(damage can cause

contralateral paralysis***)***

Ascending tracts

Modality: ***touch, pain, heat-cold, position (proprioception)***

Receptor: ***Exteroceptors, Interoceptors, Proprioceptors***

- First neuron: ***ganglion nervi spinalis***
- Second neuron: ***spinal cord / brain stem***
- Third neuron: ***thalamus (nuclei ventrobasales)***
- Ending: ***cerebral cortex, cerebellar cortex, brain stem***

Descending tracts

Tractus corticospinalis = pyramidal tract

main motor tract – *voluntary movement*

1st neuron – cerebral cortex(pyramidal cell)

2nd neuron – alfa-motoneurons → spinal nerve

Extrapyramidal tracts

Involuntary movement

Nuclei

Ncl. Proprius
Ncl. Thoracicus
Ncl. Intermediomedialis
Ncl. Intermediolateralis
Ncll. motorii

The arterial supply

Longitudinal arteries:

a. spinalis ant. (unpaired, anteriorly) **a. vertebralis**

aa. spinales post. (most often 4, posteriorly)

transverse arteries: segmental branches

Veins of spinal cord

- **Longitudinal veins**
- **Transverse veins** **…into vv. intercostales posteriores**

THE SPINAL MENINGES

Meninges of the brain and spinal cord

- **CNS (spinal cord and brain) is covered with several layers of meninges**
- **Most superficial is a bony covering, that is formed by bones of skull and by vertebra**
- **Below the bony covering, there are *meninges*. They are fibrous coverings, which form following structures:**

- **dura mater**

  Cranial and spinal dura mater

- **arachnoid mater**

  Cranial and spinal arachnoid mater

- **pia mater**

  Cranial and spinal pia mater

SPINAL DURA MATER

- Covering fibrous membrane of the spinal cord
- Within the spinal canal, there is a space between dura and the periosteum (so-called epidural space), which is filled with fibrous tissue and venous plexuses
- It doesn´t enter the grooves and fissures on surface of the spinal cord

Saccus durae matris spinalis

- It extends from foramen magnum till body of S2 -(filum terminale externum)
- The spinal cord and cauda equina
- It is separated from walls of spinal canal using fibrous tissue
- It continues onto surface of the spinal nerves within foramen intervertebrale

Spaces around dura mater

- **spatium epidurale**:

Brain - virtual space

Spinal cord – here it is present

- **spatium subdurale**: **virtual space**

SPINAL ARACHNOID MATER

- Finer fibrous membrane
- It covers the spinal cord below dura mater
- It doesn´t enter the grooves and fissures on the surface of the spinal cord
- Between dura and arachnoid, there is so-called subdural space, between arachnoid and pia mater so-called subarachnoid space, that is filled with cerebrospinal fluid, which forms water pillow absorbing impacts against the brain

SPINAL PIA MATER

- Very fine fibrous membrane, that is contains numerous blood vessels
- It lies directly on the surface of the spinal cord and it permeates into all grooves and fissures

Endorhachis – periosteum of spinal canal
Spinal dura mater - outermost sheet of spinal meninges, it forms **saccus durae matris spinalis**
Spinal arachnoid – avascular membrane, it tightly touches the inner surface of dura mater
Spinal Pia mater – intermost sheet of spinal meninges, it contains vessels

Spatium epidurale – space between endorhachis and saccus durae matris spinalis, it is filled with fat tissue and contains venous plexuses

Spatium subdurale – just slitted space between dura mater spinalis et arachnoidea spinalis, which is enlarged just under some pathological condition (subdural hematoma)

Spatium subarachnoideum – space between arachnoidea spinalis et pia mater spinalis, it contains the cerebrospinal fluid

Layers within the spinal canal

- **Periosteum = Endorhachis**
- **Spatium epidurale**
- **Dura mater spinalis**
- **Spatium subdurale**
- **Arachnoidea mater spinales**
- **Spatium subarachnoideum**
- **Pia mater spinalis**
- **Medulla spinalis**

Clinical use

- epidural anesthesia
- Spinal tap (spinal anesthesia), drug delivery

Epidural anesthesia – spatium epidurale

Spinal tap – spatium subarachnoideale

- L3–L4, L4-L5

CEREBRAL MENINGES

CRANIAL DURA MATER

Outmost covering, solid collagen tissue

It covers the cranial cavity (it touches tightly the periosteum)

There is so called epidural space within the spinal canal, between dura and the periosteum, which is filled with fibrous tissue and venous plexuses

It doesn´t enter the grooves and fissures on surface of the brain, it enters only the largest fissures of the brain, where it emits its folds

Cranial dura mater

Cranial dura mater enters only the largest fissures of the brain, where it emits its folds:

falx cerebri
tentorium cerebelli
falx cerebelli

- **Within all falxes and their attachments on the bones, there are passing sinuses**

falx cerebri:

- **Sickle-shaped fold**
- **It arises from the whole cranial vault in the median plane from frontal to occipital bone and permeates into fissura longitudinalis cerebri**
- **Along outer margin passes an important venous sinus *(sinus sagittalis superior)***
- **Near inner margin of falx cerebri, there passes another venous sinus *(sinus sagittalis inferior)***

falx cerebelli:

- **Smaller sickle-shaped fold, that is located in the median plane**
- **Is situated between cerebellar hemispheres**
- **Attached on crista occipitalis interna**
- **Within its attachment passes smaller venous sinus *(sinus occipitalis)***

tentorium cerebelli: fold of dura mater

- **It is located in transversal plane, enters fissura transversa cerebri (fissure that separates cereberall hemispheres from cerebral hemispheres)**
- **It is attached on the margins of sulcus sinus transversi on occipital bone and within its attachment passes large venous sinus *(sinus transversus)* (it continues both sides onto temporal bone as *sinus sigmoideus***

Arachnoid mater

-avascular membrane

-between dura mater and arachnoid-spatium subdurale

-between arachnoid and pia mater-spatium subarachnoideale (cerebrospinal fluid)

-it doesn´t enter grooves and fissures

Pia mater

-fibrous membrane, it contains rich vessels

-it protrudes into all grooves and fissures

-it reaches into brain ventricles

Spina bifida

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