Gross Morphology of Spinal Cord

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** I did my best and sorry for any mistake
** the sheet does not contain pictures, tables and some slides so please be careful and go back to slides
**spinal cord located in spinal canal in vertebral column , it is also a connection between PNS and brain**

slide 3 :
The Spinal Cord
• Together with brain forms the CNS
• Functions
  • spinal cord reflexes
  • integration (summation of inhibitory and excitatory) nerve impulses
  • highway for upward and downward travel of sensory and motor information

slide 4 :
• Flattened cylinder
• 16-18 Inches long & 3/4 inch diameter
  • In adult ends at L2
  • In newborn ends at L4
• Growth of cord stops at age 5
  • Cervical enlargement (C4-T1)
  • upper limbs
  • Lumbar enlargement (L2-S3)
  • lower limbs

** note that the growth of spinal cord stopped at 5 years old , while the vertebral column continue in growth so this makes the spinal cord shorter than vertebral column .

**cervical enlargement extend from C4 to T1 of spinal segments , and because the spinal cord is shorter in length than the spinal cord, it extends from the C3 to T1/T2 vertebral levels.

**note that the beginning of cervical tract of spinal canal does not have spinal cord, it rather contains a little part of brain stem "Lower part of medulla oblongata".

**lumbar enlargement extends from L2-S3 of spinal segment, and opposites T11-T12 vertebrae .

slide 5 :
Inferior End of Spinal Cord

• Conus medullaris
  • cone-shaped end of spinal cord
• Filum terminale
  • thread-like extension of pia mater
  • stabilizes spinal cord in canal
• Caudae equinae (horse’s tail)
  • dorsal & ventral roots of lowest spinal nerves
• Spinal segment
  • area of cord from which each pair of spinal nerves arises

**filum terminale** it is thread/ligament like structure, ends with the end of vertebral column and prevents jumping of spinal cord.

**you have to know that the spinal cord ends at lower border of L1 or upper border of L2, while spinal nerves continue downward to reach their target intervertebral foramen to exit from it, now this continuation of spinal nerves makes what we called the Caudae equinae.**

**slide 6:**

**Spinal Nerves**

• 31 Pairs of spinal nerves
• Named & numbered by the cord level of their origin
• 8 pairs of cervical nerves (C1 to C8)
• 12 pairs of thoracic nerves (T1 to T12)
• 5 pairs of lumbar nerves (L1 to L5)
• 5 pairs of sacral nerves (S1 to S5)
• 1 pair of coccygeal nerves
• Exit through the IVF

**slide 7:**

**Spinal Cord & Spinal Nerves**

• Spinal nerves begin as roots
• Dorsal or posterior root is incoming sensory fibers
• dorsal root ganglion (swelling) = cell bodies of sensory nerves
• Ventral or anterior root is outgoing motor fibers

**ventral root is an axon of motor neuron which it is either autonomic" from lateral horn " or somatic " from ventral horn "**

**the ventral and dorsal roots come together to make the spinal nerve " mixed nerve fiber"**

**slide 8:**

**Structures Covering the Spinal Cord**

• Vertebrae
• Epidural space filled with fat
• Dura mater
  • Dense irregular CT tube
  • Ends at the lower border of S2
• Follows the nerve roots and become continuous with epineurium
• Subdural space filled with interstitial fluid
• Arachnoid = spider web of collagen fibers
  • Ends at the lower border of S2
  • Follows the nerve roots into the IVF
• Subarachnoid space = CSF
  • Lumbar cistern (enlargement in subarachnoid space)
    • L2-S2
• Pia mater
  • Thin layer covers BV
  • Denticulate ligaments hold SC in place

**Epidural space is an exception for spinal Meninges in compared with cerebral Meninges
"in other word this space is not found in cerebral Meninges , and it is distinct for the spinal Meninges ".

**dura matter makes a ligament connection or attachment with denticulate ligament and it continues downward with spinal nerves as epineurium .

**lumbar cistern it locates between the end of spinal cord and the end of arachnoid matter (S2) , also it is the place for lumbar puncture " note that before the end of spinal cord this space is limited ".

slide 9 :

Cervical Vertebral Canal: Content
• Meninges
• Dura matter
  • Continuous with cranial dura matter (meningeal layer)
• Arachnoid matter
• Pia matter
• Lower part of medulla oblongata
• Cervical segments of the spinal cord :
  • Contain the upper motor neurons for the upper and lower limbs
  • Other descending fibers to the spinal cord (e.g. reticulospinal fibers)
• Contain the ascending (sensory) fibers from the neck below
• Cervical enlargement
  • Innervation for the upper limb
  • Lower motor neurons
• Cervical spinal nerves
  • C1-C8
  • C1-C7 exit above the corresponding vertebra
    • C1 exit between the atlas and the occipital bone
• C8 exit between the C7 and T1 vertebrae
• C1-C4 form the cervical plexus
• C5-T1 form the brachial plexus

** the areas where the spinal cord is enlarged is an increasing number of body cells of ventral horn of gray matter to supply either upper or lower limbs " to innervates more muscle fibers "
** remember that spinal nerve C1 exits above the atlas so the remnant cervical spinal nerves exits above the corresponding vertebrae , such as the sixth cervical nerve exits from the fifth intervertebral foramen , this is only for cervical spinal nerves , the other nerves exit from the corresponding vertebrae , such as: T5 nerve exit from the 5th thoracic intervertebral foramen.
** brachial plexus exits from the cervical enlargement while the lumbosacral plexus exits from the lumbar enlargement.
** if the cervical segments of spinal cord damaged , most of the body "upper and lower limbs" will be damaged ; because it is not distributes yet ! also it will effect function of some cranial nerves.

slide 10 :
Caudal Epidural Anesthesia
• Caudal epidural anesthesia during delivery
• Into sacral hiatus
• Sacral and coccygeal cornua are important landmarks
• Anesthetize S2-Co1 spinal nerves

slide 11 :
Inferior End of vertebral canal: Content
• Conus medullaris
  • In adult ends at L2
  • In newborn ends at L4
• Cauda equina (horse’s tail)
  • dorsal & ventral roots of lowest spinal nerves (L1-Co1)
• Spinal meninges
• Dura matter
  • Ends at S2-S3
• Arachnoid matter
  • Ends at S2-S3
• Subarachnoid space = CS
  • Lumbar cistern (enlargement in subarachnoid space)
  • L2 - S2
• Pia matter
  • Filum terminale
• thread-like extension of pia mater
• stabilizes spinal cord in canal

slide 12:

Joints of Vertebral Bodies
• Cartilaginous joint- Symphysis
• Vertebral bodies covered with thin plates of hyaline cartilage
• IVD
• Ligaments
  • Anterior longitudinal ligaments
  • Wider & stronger
  • Attached to the vertebral bodies and the IVD
• Posterior longitudinal ligaments
• Weak and narrow
• Nerve supply: meningeal branches of the spinal nerves

slide 13:

Joints of Vertebral Arches
• Also called zygapophysial joint
• Plane synovial joint between the superior & inferior articular processes
• Articular facets
• Capsular ligament
• Ligaments
• Supraspinous ligament
  • Between tips of spins
• Intraspinous ligament
• Between spines
• Intertransverse ligaments
  • Between transverse processes
• Ligamentum flavum
  • Between laminae
• Nerve supply: articular branches from posterior rami of the spinal nerves

slide 14:

Lumbar Puncture
• Lumbar puncture is used to withdraw CSF for diagnostic purposes
• LP performed from lumbar cistern to avoid the damage to the spinal cord
• LP approached mostly in L3-L4 or L4-L5
• Epidural anesthesia
• Target the epidural space
• Same approach as LP
• Could be approached from the sacral hiatus
** best position and easiest way to reach the subarachnoid space is to make the puncture posterolaterally " going away from spinous process"

** in lumbar puncture you will penetrate the following layers : skin – muscles – ligamentum flavum " which it is tough so you will feel that you are penetrate it " – epidural space – dura matter " also it is tough " – and finally the subarachnoid space .

** in epidural anesthesia you will not penetrate the dura matter " you don’t need to penetrate it "

slide 15

Spinal Nerves: Level of Exit
- From T1 to L5, spinal nerves exit from the IVF below their encountered vertebrae
- S1-S4 rami exit from their encountered sacral foramen
- S5 & Co1 exit from sacral hiatus

slide 16
- go back to slide and read the table " it is important "

** note that there is no intervertebral foramen in the sacral instead of that it has a ventral and dorsal foramen .

** spinal nerves branch into ventral and dorsal ramus after exiting from the foramen , while in sacral spinal nerves this branching occur within the spinal canal before they exit , so they exit as dorsal ramus from the dorsal sacral foramen to outside pelvic , and ventral ramus from ventral sacral foramen to inside pelvic .

slide 17

Gray Matter of the Spinal Cord
- Gray matter is shaped like the letter H or a butterfly
- contains neuron cell bodies, unmyelinated axons & dendrites
- dorsal gray horns (sensory neurons)
- ventral gray horns (motor somatic neurons)
- lateral horns (motor autonomic neurons) only present in thoracic spinal cord
- gray commissure crosses the midline
- Central canal continuous with 4th ventricle of brain

slide 18

Nerve Cell Columns in the Gray Matter
- Motor
  - Medial motor nucleus (cell column)
    - Axial muscles
    - Entire SC
  - Lateral motor nucleus
    - Limb muscles
• Enlargements
  • Intermediolateral cell column
    • Autonomic
    • T1-L2, S2-4

** dorsal rami of spinal nerve contains most axons of medial motor nucleus

** remember that the innervations of axial muscle is posterior rami of SC.

** note that axial muscles roughly responsible on an unconscious coordination peripheral movement " involuntary movement "

** lateral motor nucleus responsible on the voluntary movement of upper and lower limbs " conscious movement "

** control of medial nucleus mostly unconscious

** as we said previously that the ventral horn is responsible on spinal cord enlargement, now we can be more accurate and say that the lateral motor neurons are responsible for this enlargement

** Intermediolateral cell column → cell bodies of the autonomic nervous system specifically preganglionic neurons

** Intermediolateral cell column is more general term than lateral horn; because " lateral horn " is an extension of gray matter, and it is not present in all over the spinal cord, mainly it is found in thoracic area or in area where there is a preganglionic sympathetic neurons, and because we have preganglionic parasympathetic neurons in the sacral there is no lateral horn in it, but it still has cell bodies of autonomic neurons " Intermediolateral cell column"

slide 19:
Nerve Cell Columns in the Gray Matter
• Sensory
  • Substantia gelatinosa
    • Entire SC
    • Pain, temperature & touch
  • Nucleus proprius
    • Entire SC
    • Proprioception (sense of position & movement), two-point discrimination & vibration
• Nucleus dorsalis (Clarke’s column)
  • C8-L2
  • Proprioceptive endings
** Proprioception in Nucleus proprius is conscious while in Nucleus dorsalis is unconscious.

slide 20 :

go back to slide

** neurons that innervate extensor muscle locate more superficial than those who innervate the flexor muscles.
** if there is an injury in this area the extensor neurons affected firstly

**if there is an injury in the most lateral part of cervical enlargement, hand muscles will be affected.

slide 21 :
White Matter of the Spinal Cord
• White matter covers gray matter
• Anterior median fissure deeper than Posterior median sulcus
• Anterior, Lateral and Posterior White Columns contain axons that form ascending & descending tracts

** whit matter decrease as we go downward

** gray matter increase depends on the presence of enlargement.

slide 22:
go back to slide
slide 23 :
Tracts of the Spinal Cord
• Function of tracts
• highway for sensory & motor information
• sensory tracts ascend
• motor tracts descend
• Naming of tracts
• indicates position & direction of signal
• example = anterior spinothalamic tract
• impulses travel from spinal cord towards brain (thalamus)
• found in anterior part of spinal cord

slide 24 :
go back to slide

slide 25 :
Functions of Spinal Tracts Sensory
• Spinothalamic tract
• pain, temperature, deep pressure & crude touch
• Posterior columns
• propioception, discriminative touch, two-point discrimination, pressure and vibration

Motor
• Direct pathways (corticospinal & corticobulbar)
• precise, voluntary movements
• Indirect pathways (rubrospinal, vestibulospinal)
• programming automatic movements, posture & muscle tone, equilibrium & coordination of visual reflexes

slide 26:

White Matter of the Spinal Cord
• Ventral white commissure
• Lissaur’s tract (dorsolateral fasciculus)
• Intersegmental fibers (fasciculus proprius)

** Lissaur’s tract makes connection between ventral segments of spinal cord

** Intersegmental fibers also makes connection between ventral segments of spinal cord.

slide 27,28,29
sorry but the doctor didn’t explain it so please go back to slides

good luck