

CNS

Anatomy



Sheet



Slide

Number

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Anatomy Lab#1 Spinal Cord

Corrector's note: If you studied the theoretical lectures very well, then there's no need to dig deep into this lab, just read it quickly, Most of the information have been already mentioned in class. The only two things that were not mentioned are the blood supply and the cross sections of different spinal segment. Good luck. Check the slides for the figures.

Blood supply of brain

1. Internal Carotid artery (branch of common carotid): internal carotid artery begins at the level of upper thyroid cartilage and it enters the cranium through carotid foramen and foramen lacerum. (There are 2 carotid foramen; one on each side)
2. Vertebral artery (branch of first part of subclavian artery)

- The carotid foramen which is located in the petrous part of the temporal bone in the inferior surface of the cranial bone form the entrance of carotid artery to cranial cavity.
- The foramen magnum (in occipital bone in the inferior surface of the cranial bone) form the entrance of vertebral artery to cranial cavity.

The circle of Willis

The blood supply (BS) of spinal cord (SC)

NOTE: we will focus on vertebral artery and not on the whole circle

- Right vertebral artery and left vertebral artery will unite superiorly to form the basilar artery which runs in the anterior aspect of pons in a groove called basilar groove.

They also will give two more branches relative to the SC(inferiorly) :

1. Posterior inferior cerebellum artery.
2. Anterior spinal artery.

BS of SC comes from **two kinds** of artery:

1. Longitudinal arteries: They run along the entire length of SC.
2. Horizontal (segmental) arteries: they enter the SC via intervertebral foramen.

**** The branches of longitudinal arteries arise from the vertebral arteries:** which are:

- A. single anterior spinal artery (direct branch of vertebral artery): both right and left vertebral arteries unite inferiorly to form it, it then runs in a groove anterior medial fissure)

B. Two posterior spinal arteries (indirect branch of vertebral artery as they arise from the posterior inferior cerebellar arteries): they run in posterolateral grooves

**** The horizontal arteries (segmental arteries) :**

- Those arteries arise from different arteries depending on the level of spinal segment. So, they arise from vertebral arteries in the cervical region, the deep cervical arteries in the neck and the cervical region, from posterior intercostal arteries (branch of aorta) in the thoracic region and from lumbar arteries (paired arteries of abdominal aorta) in the abdominal region.

→ They enter the spinal cord through the intervertebral foramen from both sides.

AFTER the entrance of segmental arteries into the SC canal every segmental artery gives

1. posterior reticular within the posterior root
2. anterior reticular within the anterior root
3. segmental medullary artery (to form anastomosis with anterior spinal artery)

-For example, in the thoracic region; Aorta gives posterior intercostal artery which gives segmental artery that enters the SC(via intervertebral foramen)then – the segmental artery- gives anterior and posterior reticular and segmental medullary arteries .

Artery of Adamkiewicz

- It's a segmental artery usually on the left side of the spinal cord, to reinforce the arterial supply to the lower portion of the spinal cord.
- It arises from Left posterior intercostal artery at the level of the 9th to 12th intercostal artery, which branches from the aorta, and supplies the lower two thirds of the spinal cord
- Anastomose with anterior spinal artery.
- There is a lot of variation regarding its location among individuals.

******What I understood is that the **lower, left** segmental arteries don't anastomose with the anterior spinal artery, so Artery of Adamkiewicz forms the anastomoses instead to –as previously said- reinforce the blood supply of the lower two thirds of spinal cord.

General Blood Supply

- Terminal branches of the spinal medullary arteries join to form **arterial vasocorona**, and along with the **posterior spinal arteries** (remember there are two posts, right and left): They supply the

1. Posterior white column which contains the PCML tract, fasciculus gracilis and fasciculus cuneatus.
 2. Peripheral part of lateral and anterior funiculi.
- **Anterior spinal artery** (a single artery): it supplies
 1. Most of the grey matter
 2. Adjacent parts of white matter (anterior and lateral parts)

Note: occlusion in anterior spinal artery causes anterior spinal artery syndrome.

Venous drainage (Variable)

- The space outside the dura is called extradural space (fat filled space)
- There is pair of veins on each side of SC, one vein on the midline anteriorly (anterior spinal vein) and one vein on the midline posteriorly (posterior spinal vein).

These veins drain into either one of these three sites:

1. extradural plexus of veins (in extradural space).
2. Azygos vein in thorax.
3. The upper part of spinal cord may drain into the intracranial veins.

GROSS ANATOMY OF SPINALCORD:

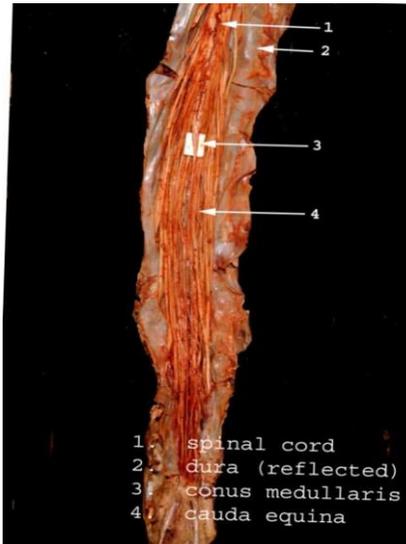
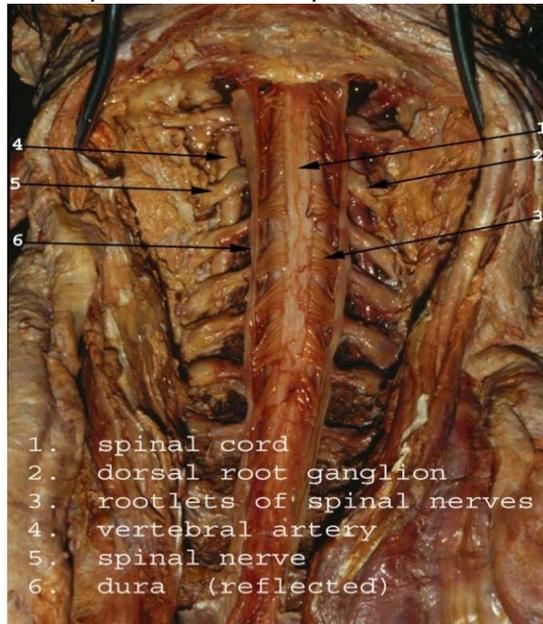
- SC extends from foramen magnum to L1|L2.
- It's divided into segments: cervical thoracic lumbar sacral and coccygeal which are not uniform in diameter.
- We have 31 pairs of mixed nerves.

→Notes about the following figures

** The lamina is the posterior part of vertebral arch and in this figure it was removed (laminectomy)

The spinal muscles were reflected (moved aside) and the dura and arachnoid mater were removed, too. So, now we have an exposed spinal cord and you can see the dorsal root, the bulging represents dorsal root ganglia and you can also see the posterior spinal artery.

**The pia mater is firmly attached to the SC.



Cross section of the SC slide 12

** Denticulate ligament is a fold that runs from the pia mater to the inner surface of arachnoid mater.

General features (seen in all segments) :

1. Cavity(central canal): continuous with the 4th ventricle superiorly and it contains CSF.
2. Anterior median fissure (anteriorly).
3. Posterior median sulcus (posteriorly).
4. Posterior lateral sulcus (from where the posterior root emerges)
5. Anterior lateral sulcus (from where the anterior root emerges)
- 4.Gray matter (inside) contains cell bodies (divided into 10 laminae)
 - Behind the tip of lamina 1 lies the **posterolateral tract (Tract of lissauer's)** which is a local tract formed by fibers of 1st order neurons in spinothalamic tract (anterolateral system) that ascend one or two segments before synapsing with 2nd order neurons forming this local tract.
5. White matter (outside): divided into funiculi\columns.
 - Posterior funiculus\column (posterior white column)
 - Lateral white column
 - Anterior white column

Rexed Lamina: the gray matter is divided into 10 laminae. Slide 13+14

- **Lamina 1** relay information related to pain and temperature
- **Lamina 2:** relay information related to pain and temperature
(Pain modulation)

**** Lamina 2 and part of lamina 1 form substantia gelatinosa; at which 1st order neurons (C fibers that transmit slow pain) of the spinothalamic tract synapse with 2nd order neurons. Meanwhile, A-beta fibers that transmit fast pain synapse with 2nd order neurons in lamina 1 and lamina 5.**

- **Lamina 3 and 4:** Nucleus proprius; these laminae have many interneurons. At which the pyramidal fibers descending from the primary sensory area synapse.
- **Lamina 5:** relay information related to pain and temperature
- **Lamina 6:** presents only at the cervical and lumbar enlargements and receives proprioception
- **Lamina 7:** further divided into:
 - Intermedio-lateral nucleus: sends preganglionic fibers of sympathetic pathway (T1-L2) – Autonomic pathway.
 - Intermedio-medial nucleus: receives visceral pain (afferents) carried by C type fibers.
 - Dorsal nucleus of Clark's: presents at (C8 – L2 or T1-L4), relay center for unconscious proprioception. It sends fibers to the cerebellum via anterior and posterior spinocerebellar tracts.

-NOTE: Autonomic supply and transmission of visceral pain transmission

- → **Preganglionic fibers (that emerge from the interiomedio-lateral part of lamina 7 in the lateral horn of SC → synapse → postganglionic fibers of the ANS to supply viscera of abdomen and thorax. And visceral pain is carried back to the CNS via C fibers which synapse at the interiomed-medial part of lamina 7.**

**** Laminae from 1 to 7 are mainly sensory located in the dorsal horn.**

- **Lamina 8:** motor interneurons, Commissural nucleus.
**** Upper motor neurons –in most cases- synapse with the interneurons in lamina 8.**
- **Lamina 9:** contains lower motor neurons.
 - It is further subdivided into many nuclei, it's too important to memorize and understand them in order to be able to understand the spinal cord lesions.

In General:

The most lateral part lateral → mainly supplies distal muscles.

And the medial part → supplies axial muscles.

- **Ventromedial nucleus:** seen in all segments controls the extensors of vertebral column (the axial muscles)
- **Dorsomedial nucleus:** (seen only in this segment T1-L2) to supply intercostals and abdominal muscles.
- **Ventrolateral nucleus:** (seen in these segments C5-C8 (supplies the arm) L2-S2 (supplies the thigh))
- **Dorsolateral nucleus:** C5-C8 (supplies the forearm), L3-S3 (supplies the leg)

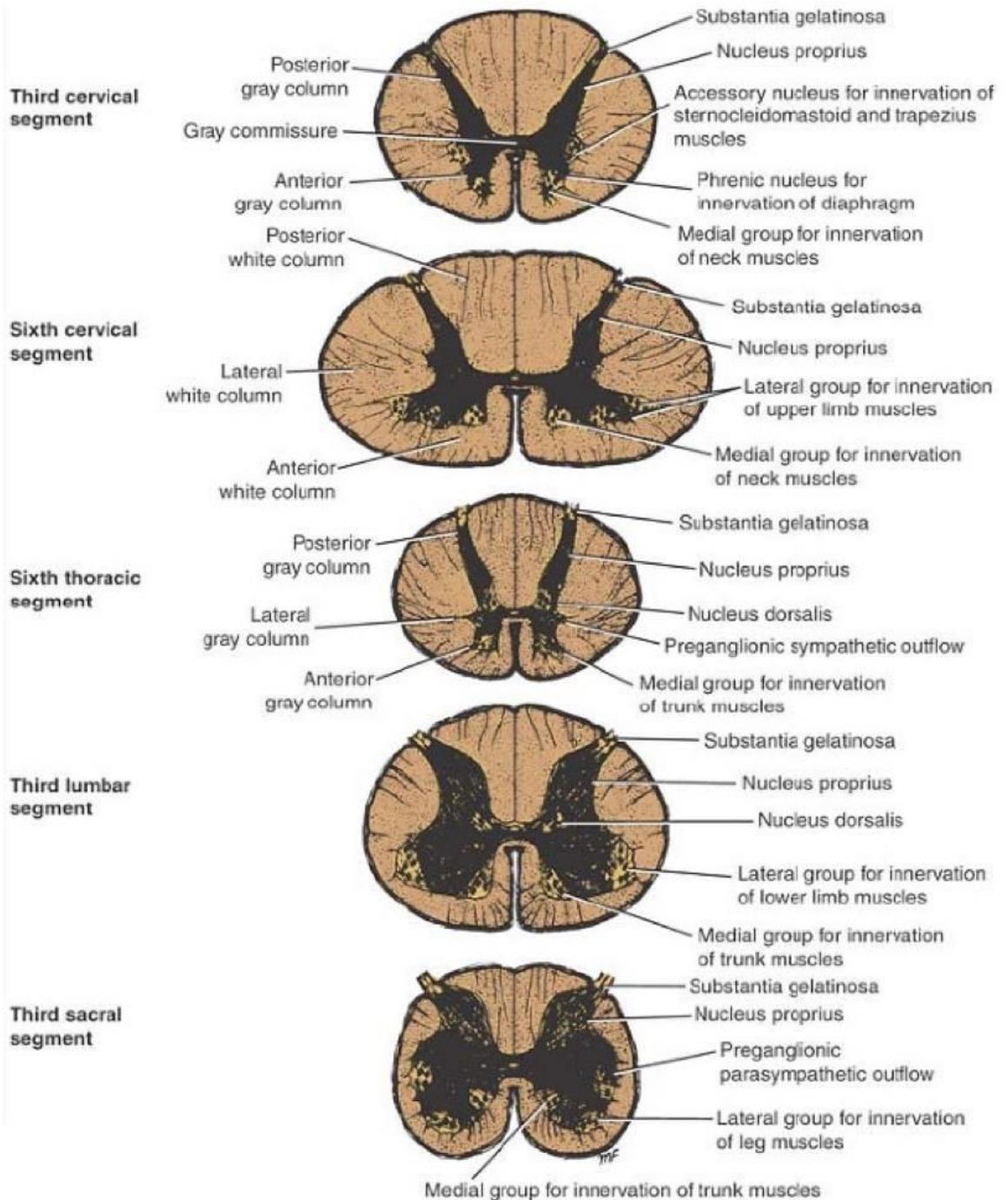
- **Reterodorsolateral nucleus:** C8-T1 (Hand), S1-S2 (foot)
 - **Central nucleus:** Phrenic nerve (C3-C5) – motor supply to diaphragm.
- **Lamina X:** Surrounds the central canal – the grey commissure. The function of which is unknown, but it's postulated that it's involved in sensation interpretation.

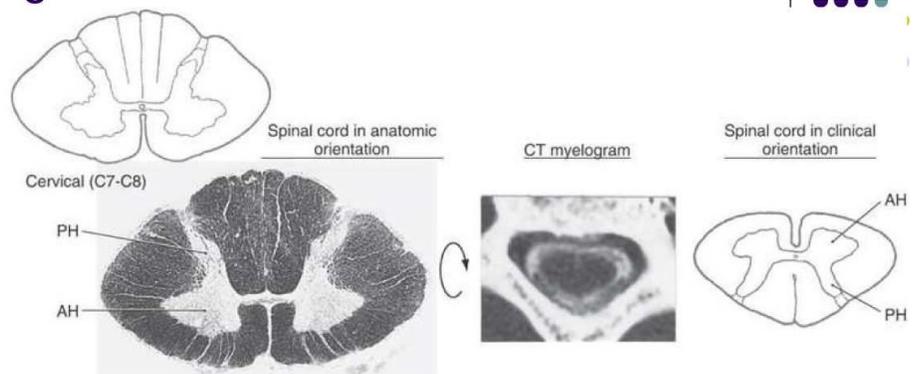
Comparison between SC at different levels:

take a general look:

Cervical segments: In general

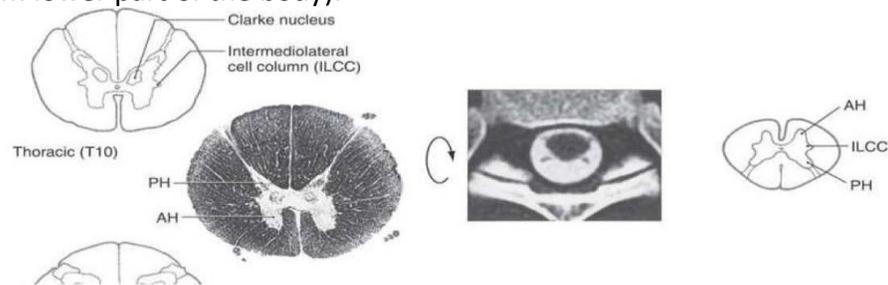
- The upper segments are rounded and the lower ones are oval.
- Well-developed white mater columns\funculi particularly, the posterior column since the fibers from all over the body pass through the cervical segments to reach the final destination in cerebral or cerebellar cortex.
- Well-developed anterior horn especially in the lower cervical segments. And we can explain this by recalling the innervation of upper limb –since the anterior horn hosts the cell body of lower motor neurons and since the brachial plexus which supplies the upper limb emerges from the lower part of cervical segments (C5-T1).





Thoracic Segments

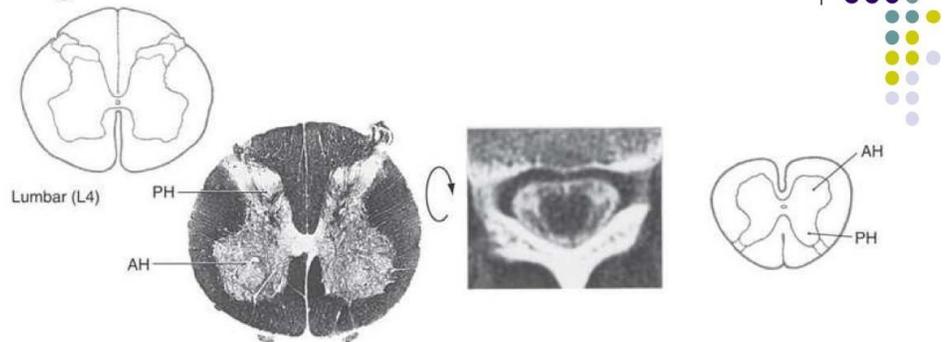
- Rounded profile (like upper cervical)
- Small, slender, narrow and peglike anterior grey horn.
- Lateral horns are unique to thoracic segments
- Relatively well-developed white mater, but not in all thoracic segments; above the level of T6 both fasciculus grasilus and coneatus are present, and below the level of T6 (e.g: at level of T10) we can only find gracile fasciculus (which receives fibers from lower part of the body).



Lumbar segments:

- Relatively the white mater is small and the grey mater is large
- Rounded to oval

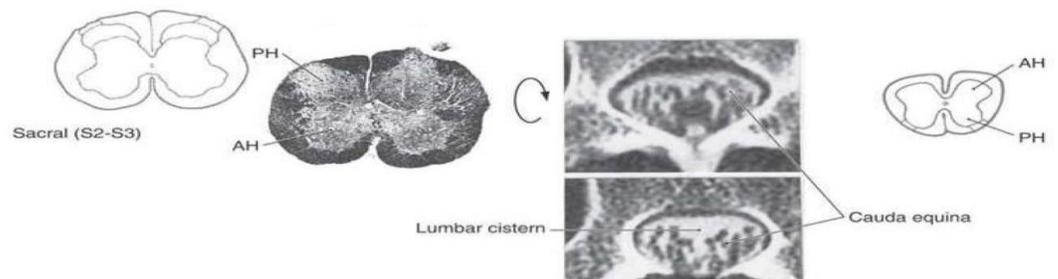
- Very well developed anterior horn (lumber plexus that innervate the lower limb)



Sacral Segments

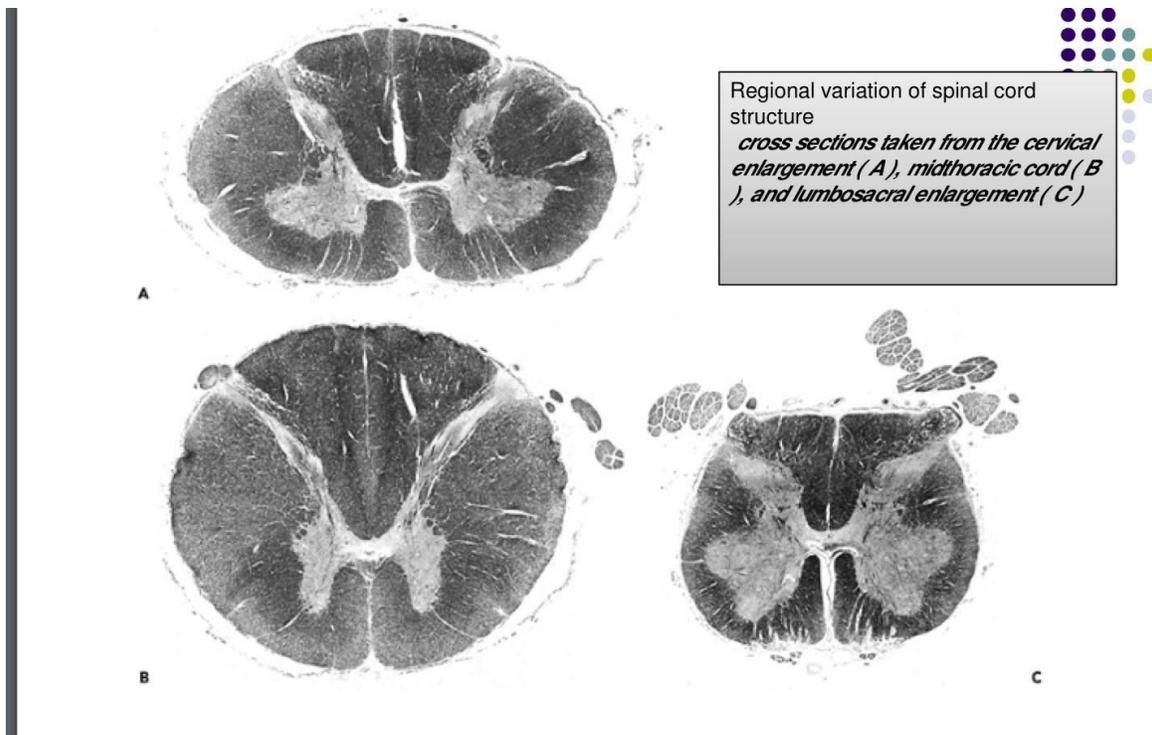
- Mainly grey mater and very minimal white mater (tiny small rim قشرة) (the sensory fibers in the posterior white medial laminscus pathway are only from the foot and leg
- Rounded.
- In S2 and S3 segments you can find lateral horn (of parasympathetic) called sacral visceromotor nucleus (this nucleus contains the cell bodies of preganglionic fibers of parasympathetic pathway)

Sacral segment



NOTE: In general , the distal you go in the SC segments , you will obviously notice that the density of white mater significantly decreases (but not completely).

TEST YOURSELF



The arrangement of fibers in the white mater slide 22

→PCML in posterior white column :

- They ascend ipsilaterally
- The sensory fibers of lowermost part (foot and leg) of the body will enter via dorsal root to the most medial part (fasciculus gracilis) so sacral fibers (represent the lowermost part of lower limb) will be more medially located in the posterior white column and the cervical fibers (represent the upper part of the body) will be more lateral in the posterior white mater.

So, from medial to lateral; we find the arranged fibers as follows ; sacral fibers, the lumbar, the thoracic and finally the cervical fibers.

→Spinothalamic tract:

- Ascend contralateral, so the fibers cross to the opposite side on the anterior white commissure after synapsing in the dorsal horn. So, **sacral** fibers will cross the midline(in the anterior white commissure- just anterior to the central canal) and pass to the most **lateral** part of the opposite lateral white mater and the cervical fibers will cross the midline and go to the most medial part of the opposite lateral white mater

CLINICAL NOTES

Extra medullary tumors (like meningioma) : the sacral fibers affected first.

Intramedullary tumors: the cervical fibers affected first.

****sacral sparing:** occurs in intramedullary tumors

it means that when a tumor originate from within the SC it will affect the cervical, thoracic and lumbar fibers, but the sacral fibers are rarely affected (it will be preserved)

In the last ten minutes the doctor opened a website and started showing a 3D picture of the SC if you are interested you can go and watch them

BEST WISHES