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SCIENCE AND PHILOSOPHY OF CHIROPRACTIC

Our time together today?

Clinical Concepts in the management of the Craniocervical Junction (CCJ) Vertebral Subluxation (part 2 of 4)
Jeff Scholten, DC

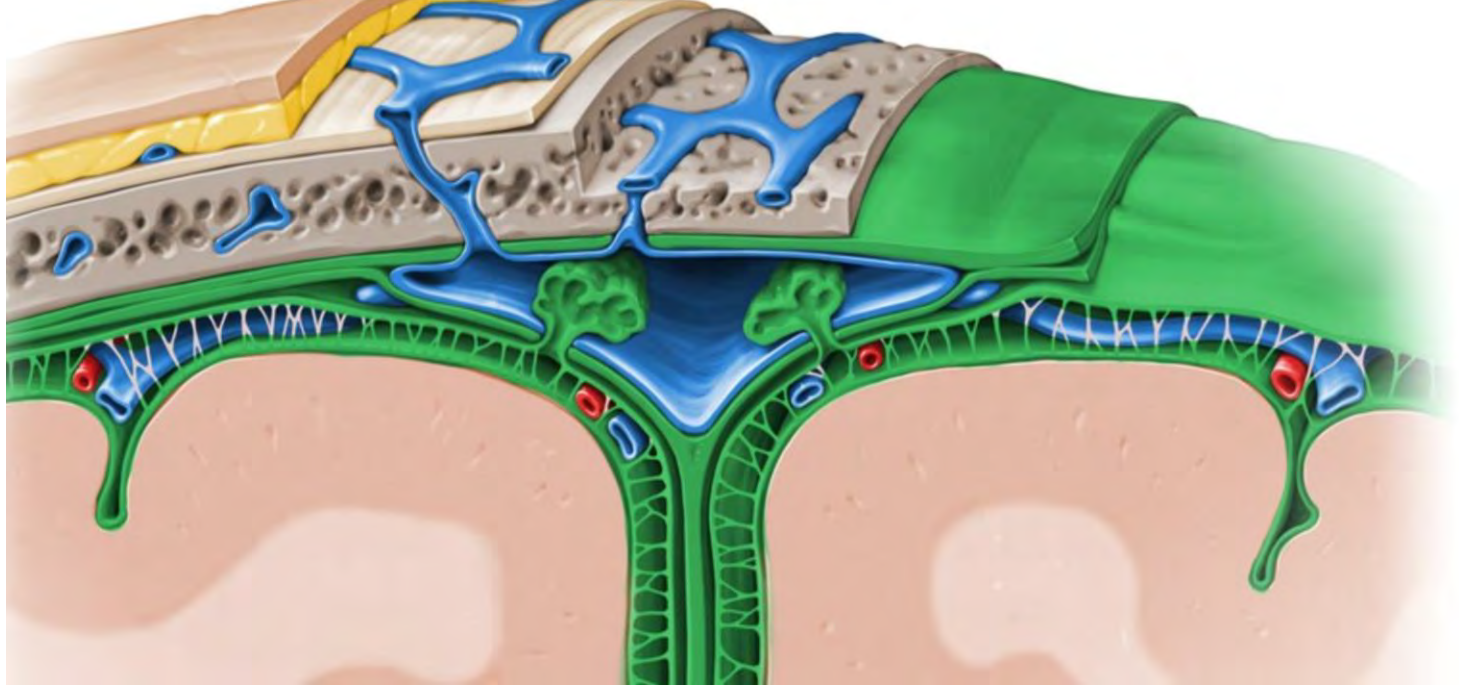
Meninges

Epidural space
- (potential space)

Dura Mater
- (2 layers in the cranium)

Subdural space
- (potential space)

Arachnoid Mater



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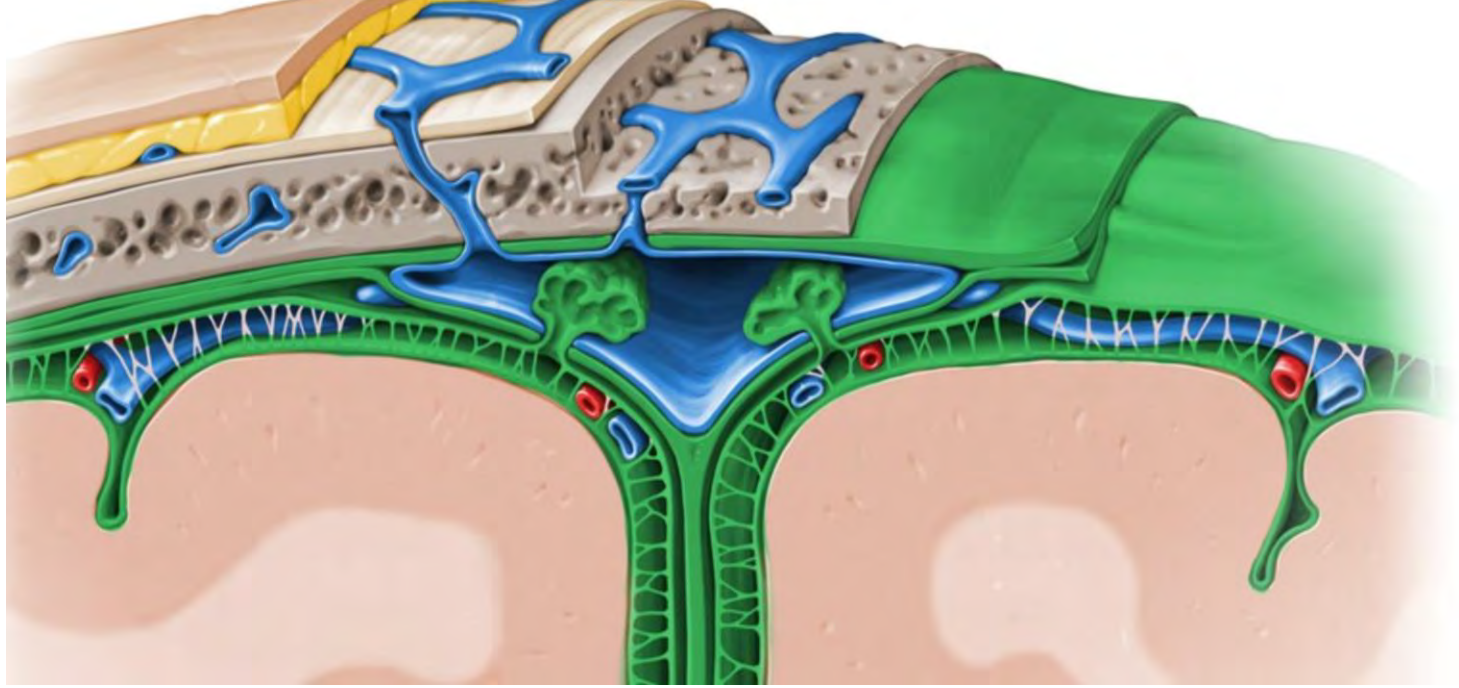
Meninges



Arachnoid Mater

Subarachnoid Space

- **Avascular** but cranial nerves, nerve roots, arteries & veins from the brain and spinal cord
- Down to S2 (lumbar cistern (dural sac of spinal cord) L1 or 2 - S2)
- Cisterns are openings in this space (areas in the cranium where CSF pools and many nerves pass and exit towards skull foramina)

Pia Mater (2 layers)

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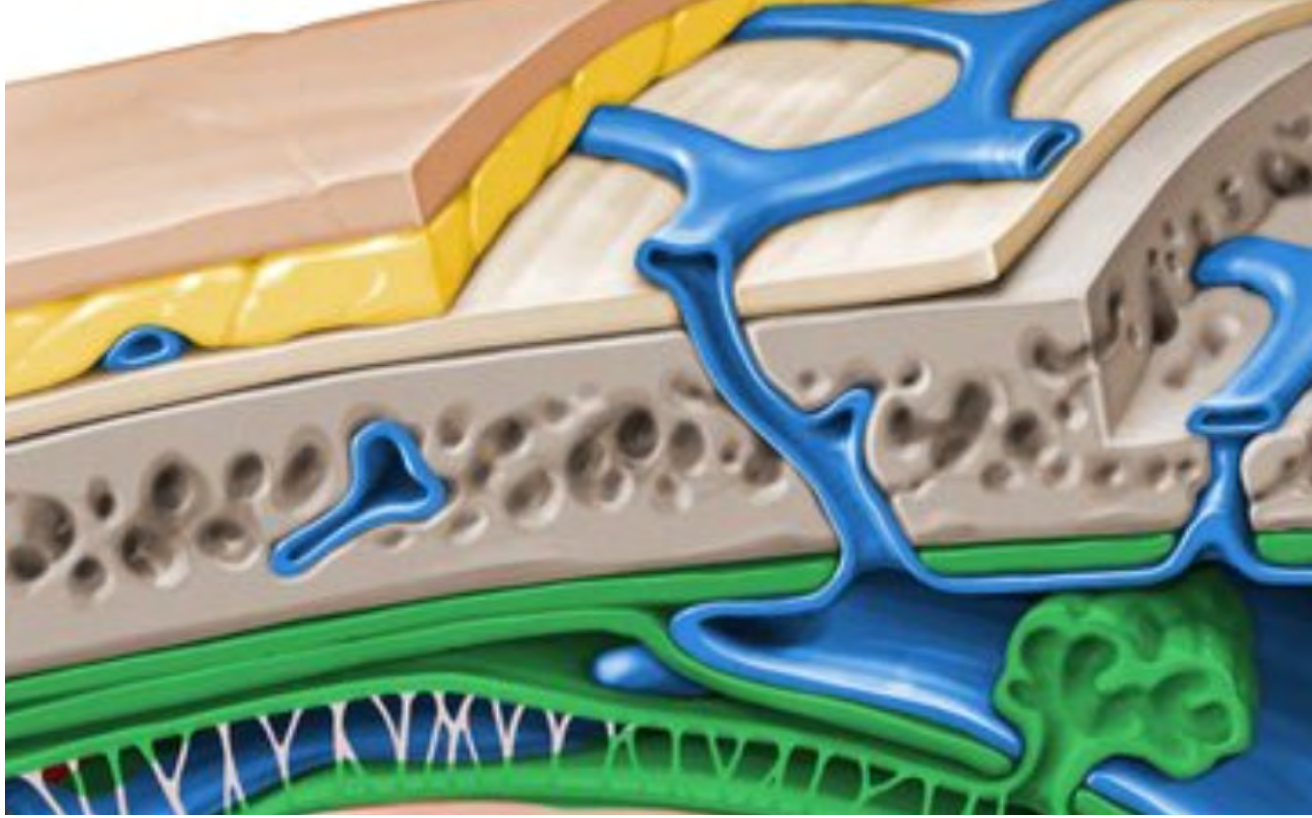
Dura Mater



Innervation (V, X, C1-3)

Two layers:

- Periosteal
  (does not extend
  beyond the foramen magnum)
- Meningeal
  - Infolds to create the DVS and the Falx Cerebri, Tentorium Cerebelli, & Falx Cerebelli

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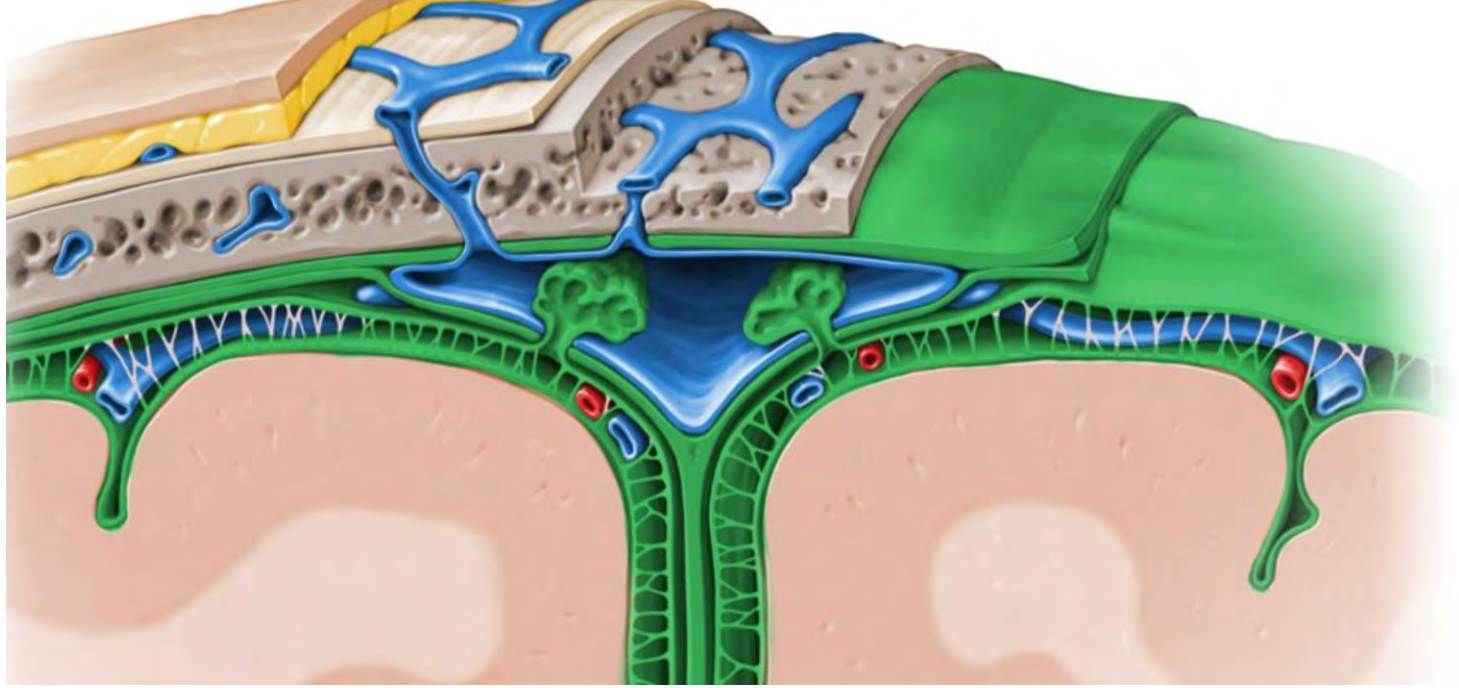
Superior Sagittal Sinus



Receives fluid from:

Arachnoid Villi -
herniate through the
arachnoid & one layer of dura
from the subarachnoid space

- As humans age villi clump and are referred to as **granulations**
- Arachnoid granulations are one way valves allowing CSF to enter the blood stream

Lateral Lacunae

- Associated blood lakes (3 on each side) that receive CSF from arachnoid granulations

Superior Cerebral Veins (8-12)

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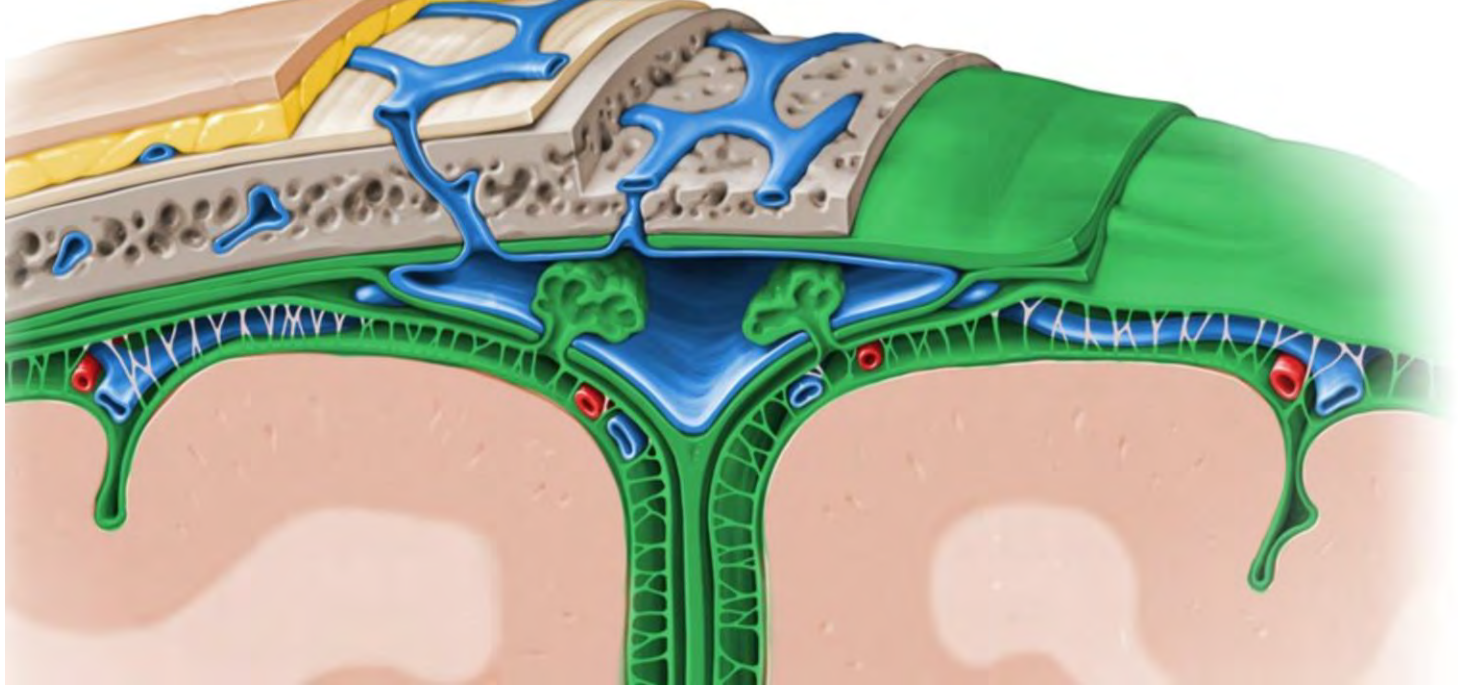
Arachnoid Mater



Impermeable to fluid

Adhered to Meningeal layer

of Dura Mater

Connected to Pia Mater by Arachnoid Trabeculae

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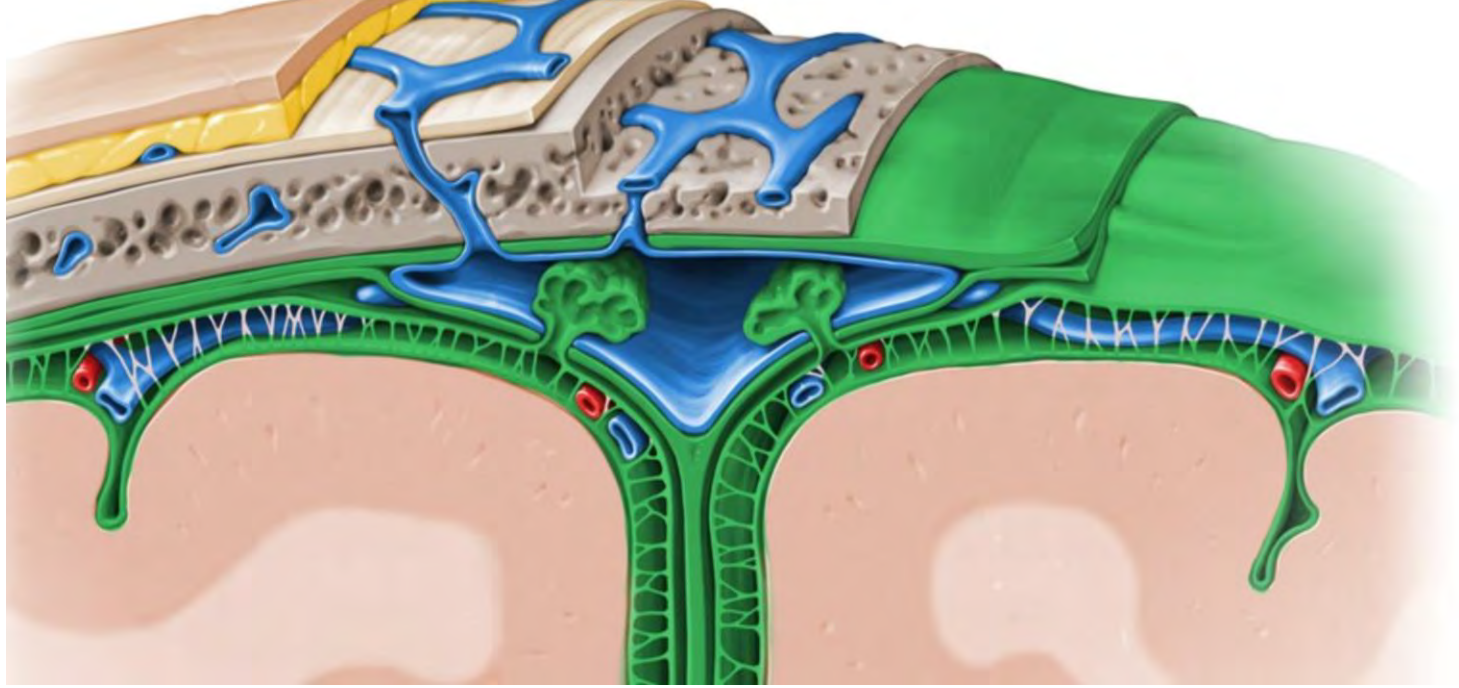
Pia Mater



Tender mother
Impermeable to fluids
In spine connected to
Dura Mater by Denticulate Ligament
Connected to Arachnoid Mater by **Arachnoid Trabeculae**
Connected to the brain via **glial astrocytes**
Forms **Glial Limitans** (Pia-Glial Barrier)
Invaginates into the brain by entering with the cerebral arteries which it surrounds.

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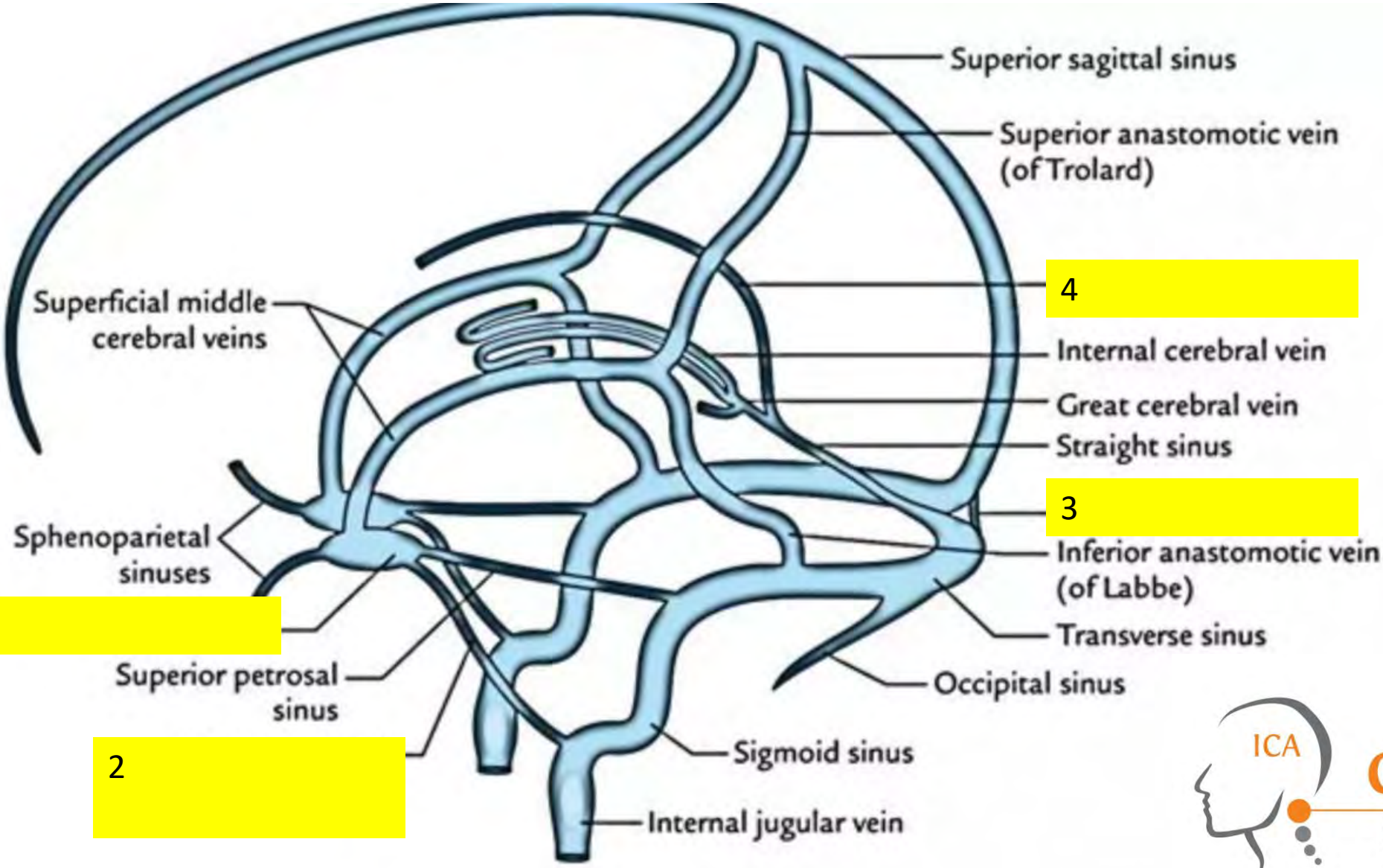
https://myneurosurg.com/cranial-anatomy/dural-venous-sinuses/



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C1-C2 X-Ray assessment of misalignment parameters in patients with Chronic Cerebra-spinal Venous Insufficiency and Multiple Sclerosis versus patients with other pathologies.

Mandolesi S (1), Marceca G (9), d'Alessandro A (4), Ciccone MM (8), Zito A (8), Manconi E (2), Niglio T (3), Ricci D (5), Mandolesi D (6), d'Alessandro A (7), Fedele F (1)

"… people with CCSVI and MS, severe anterior intrusion and right laterality misalignment that are two to three times more frequent as compared to controls."

Limbic System

The “Edge” (Limbus in Latin)

- Separates the Hypothalamus from the Cerebrum
- Emotional experience and expression

Limbic System

“Five “F’s”:

1. Feeding (satiety & hunger)
2. Forgetting (memory)
3. Fighting (emotional response)
4. Family (sexual reproduction and maternal instincts)
5. Fornicating (sexual arousal)”

https://www.kenhub.com/en/library/anatomy/limbic-system

Limbic System

“Cortical components (limbic lobe)

1. Orbital frontal cortex - perceive smell, involved in formation of memories
2. Hippocampus - associated with long-term memory
3. Insular cortex - associated with desires, cravings, addiction
4. Cingulate gyrus - perception of neuropathic pain and nociception
5. Parahippocampal gyrus - provides path for communication between cortical association areas and hippocampus”

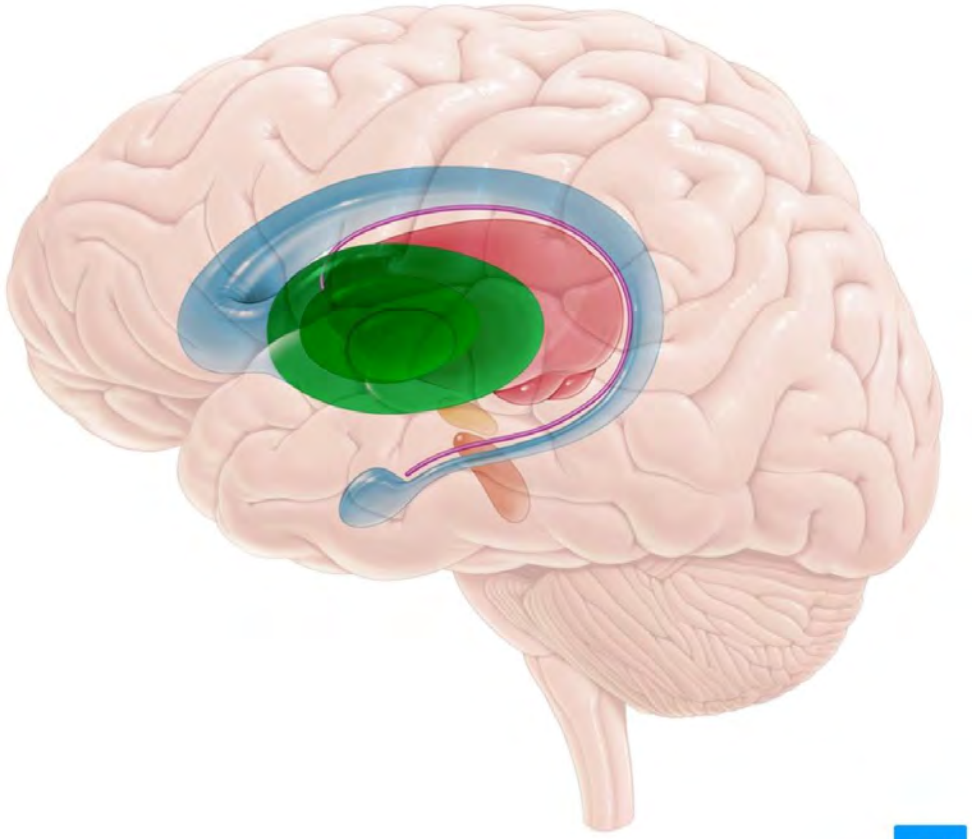
“Subcortical components

- Amygdala - fear, anxiety responses
- Olfactory bulb - receives olfactory input about smells detected in nasal cavity
- Hypothalamus - final output of the limbic system
- Anterior and dorsomedial nuclei of the thalamus (pain relay)
- Septal nuclei”

https://www.kenhub.com/en/library/anatomy/limbic-system

Basal Ganglia

Functions in integrating movement, cognition, emotion



Neurological Involvement

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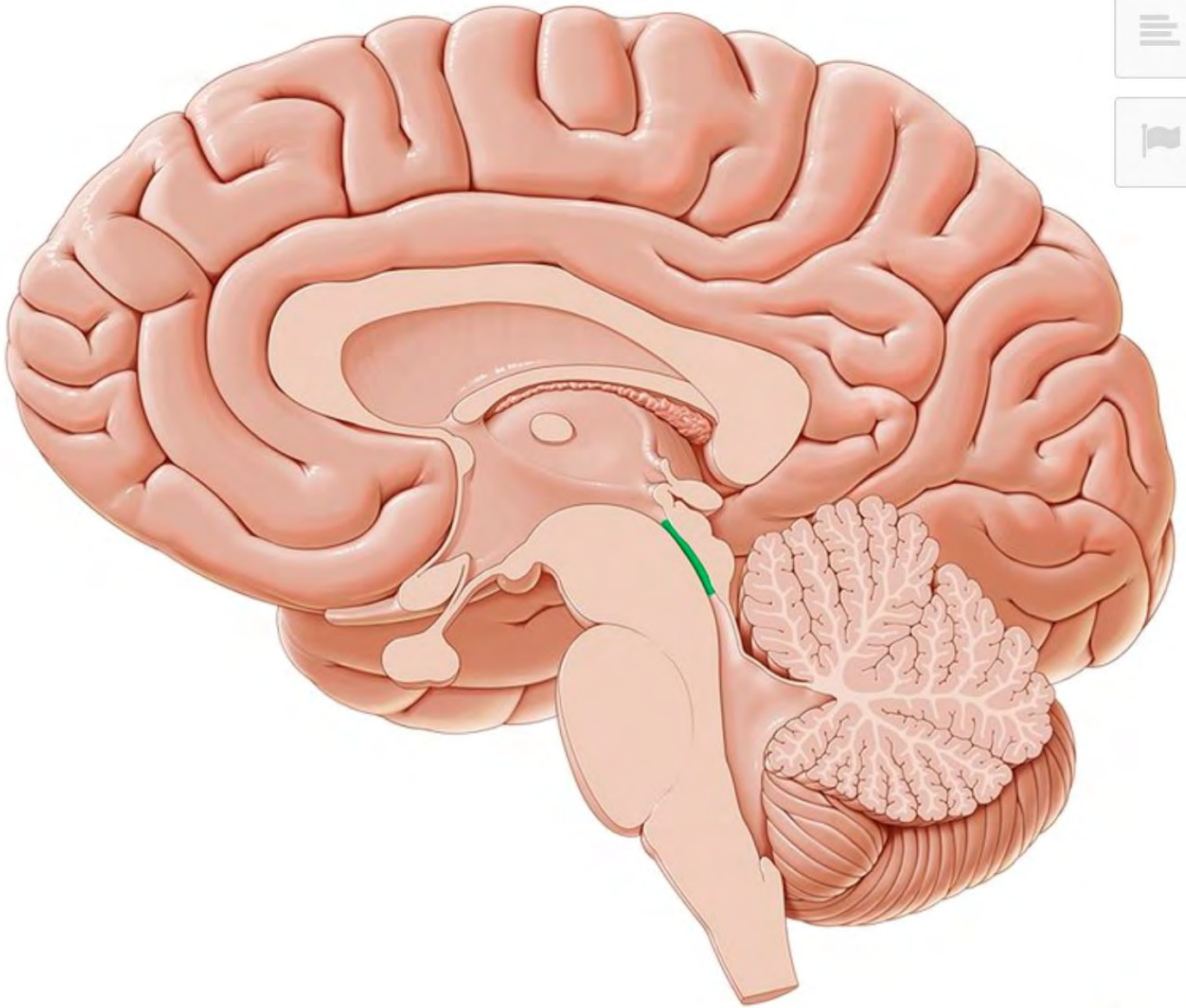
Midbrain – **Periaquaductal Gray** – pain signal transmission to the cortex, descending pain modulation

Pons – **Locus Coeruleus** – stress, panic, pain (rhomboid fossa, reticular activating system)

Medulla – **Rostral Ventromedial Medulla** -responsible for inhibition and facilitation of nociceptive signals

Cerebral Aquaduct



Neurological Involvement

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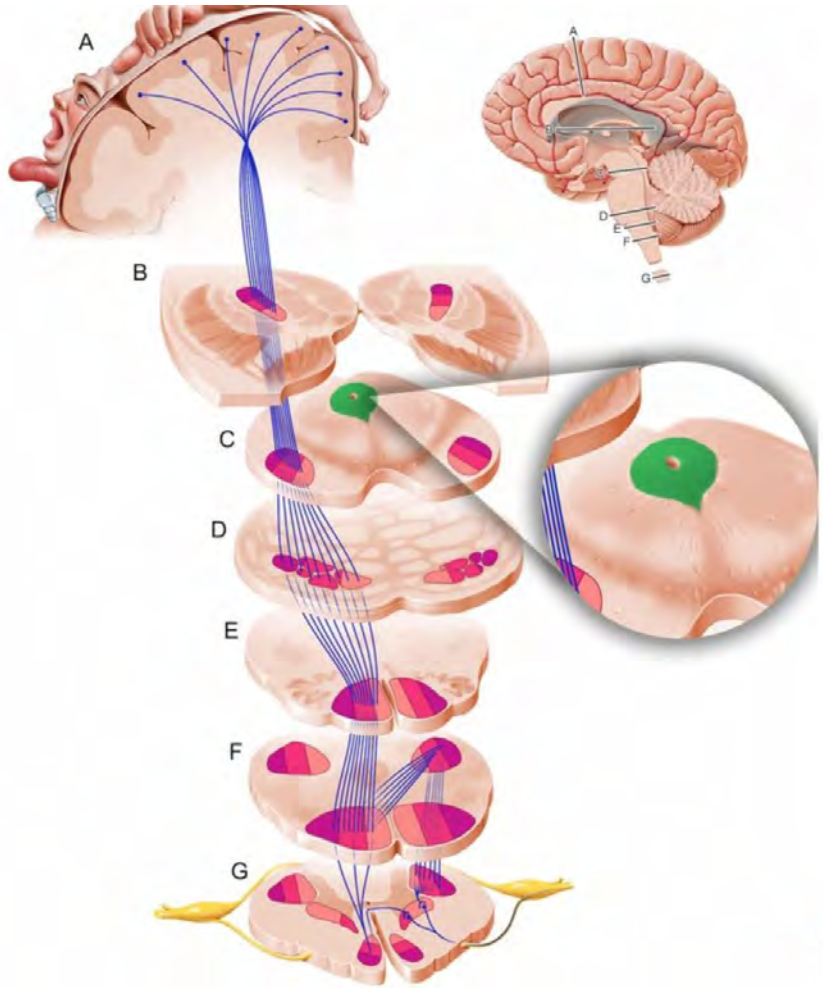
Midbrain

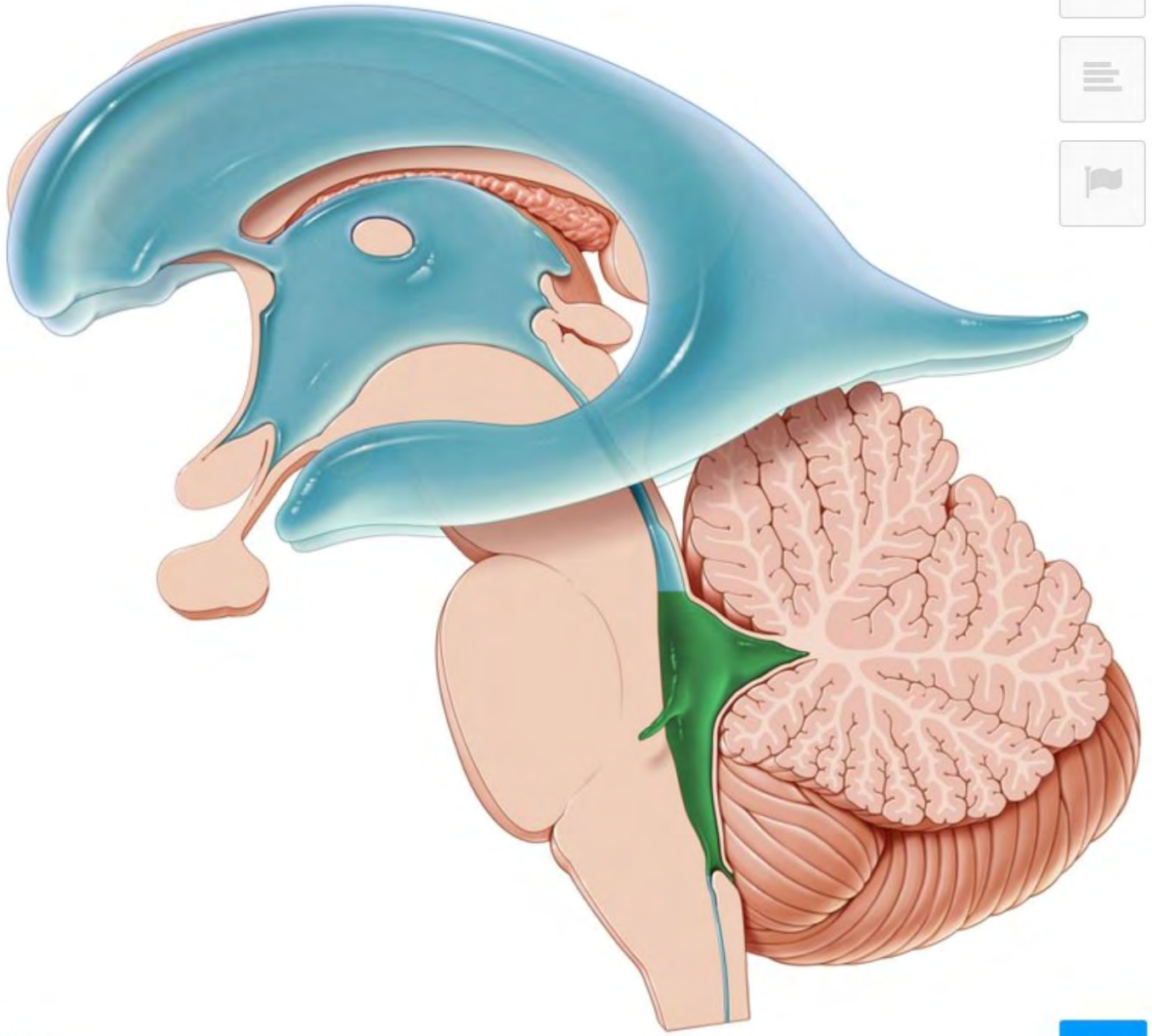
Periaquaductal Gray

Pain signal transmission to the cortex

Crucial in descending pain modulation



Fourth Ventricle



Neurological Involvement

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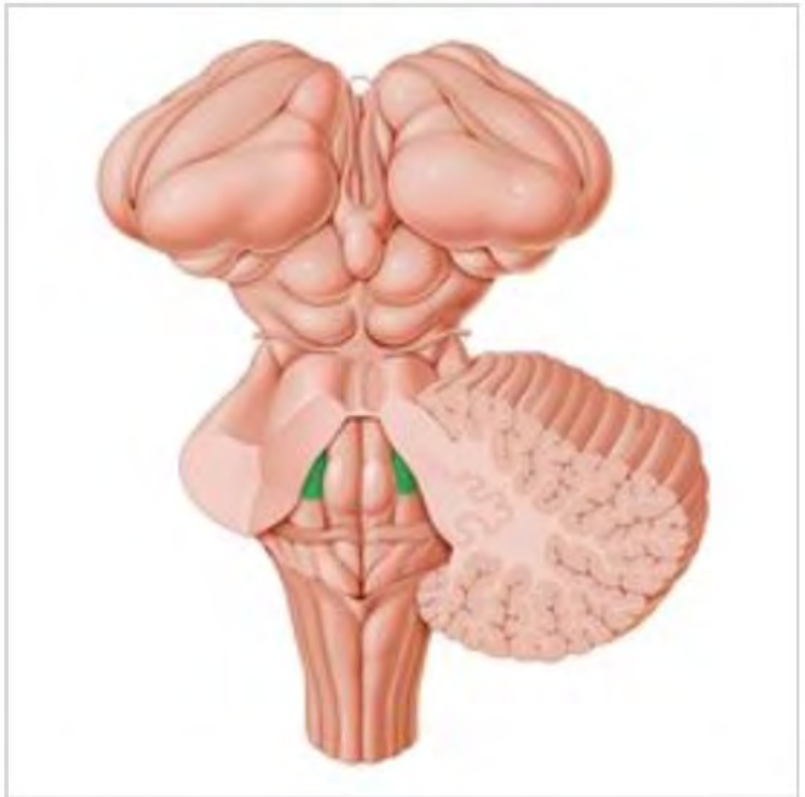
Locus Coeruleus – stress, panic, pain

(rhomboid fossa, reticular activating system)

Located in the **Pons**

Major relay center for pain



Locus coeruleus

Neurological Involvement

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Spinal Cord – relay centers from DRG – **Spinothalamic tract**

The brain sites known to be part of the pain transmission system in the thalamus and cortex were fully activated only when both stimulus intensity and high pain cues were given together

what happens and what we expect

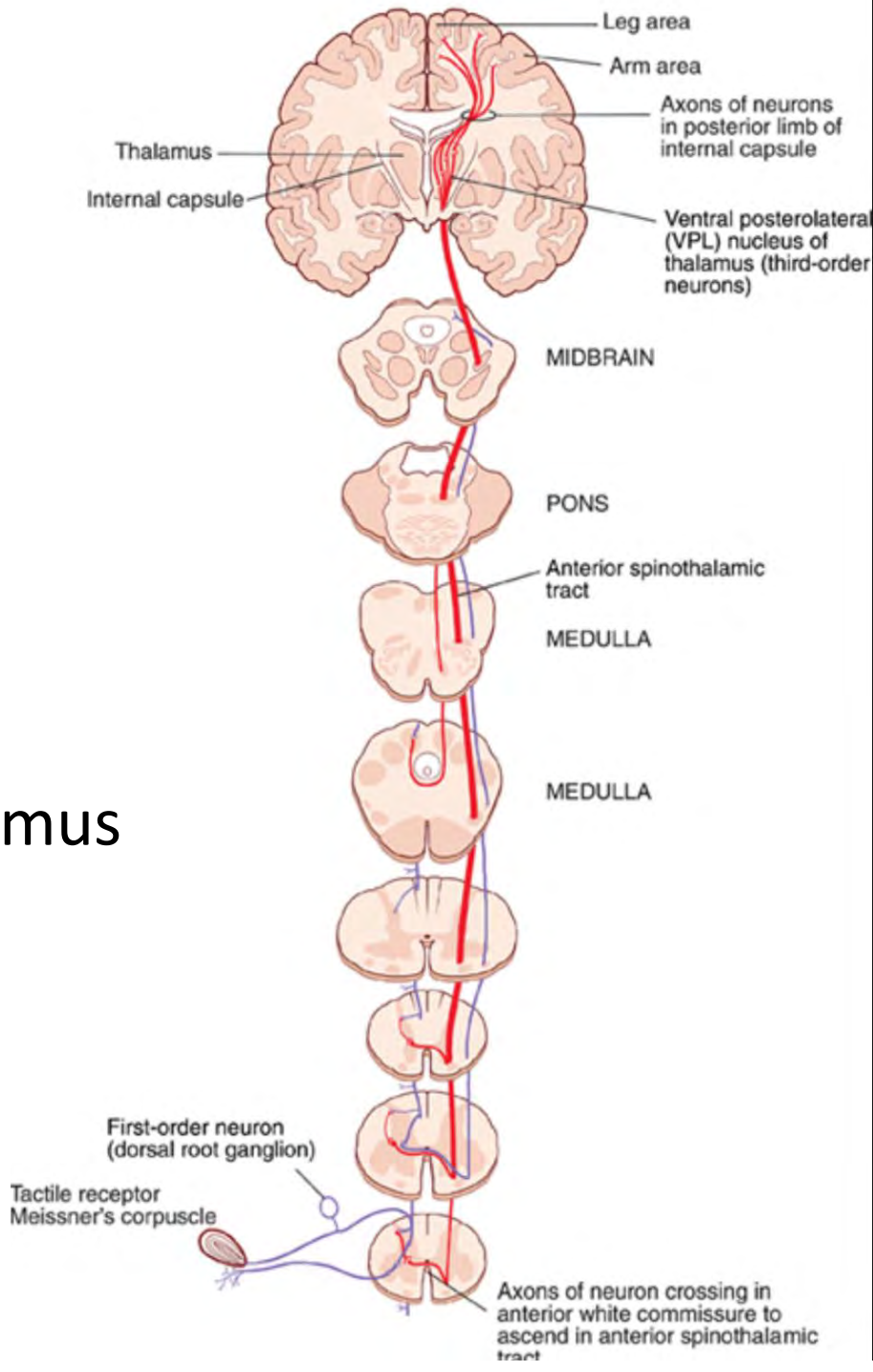
Spinothalamic

i. Pain Temperature
ii. Light touch

Enters cord – synapses

Crosses at or close to cord level where it enters

Travels through cord and brainstem to the Thalamus



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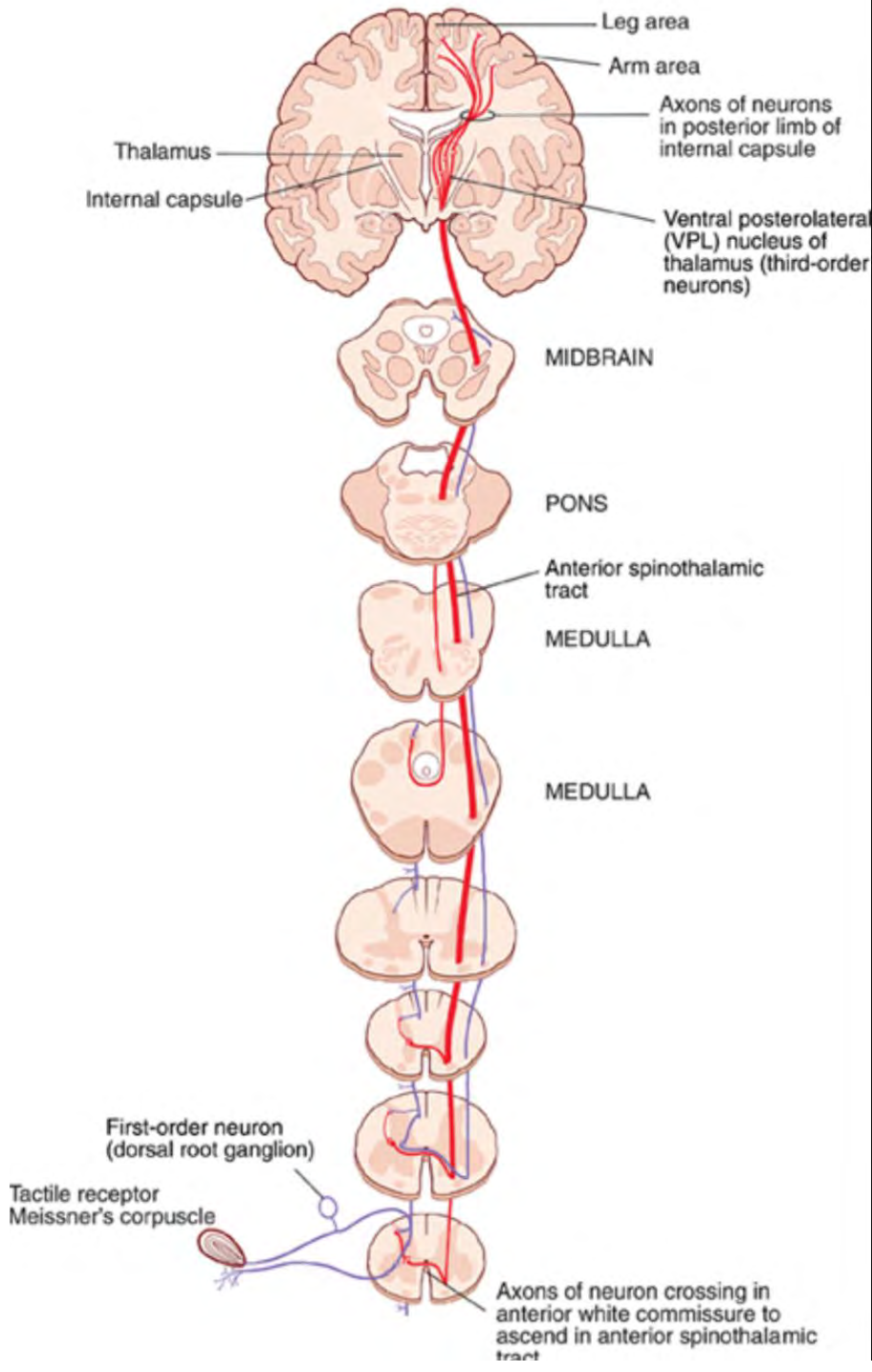
https://www.physio-pedia.com/images/6/66/Spinothalmaic_tract.jpg

Spinothalamic

Most crucial for nociception

Mainly from Lamina I & V



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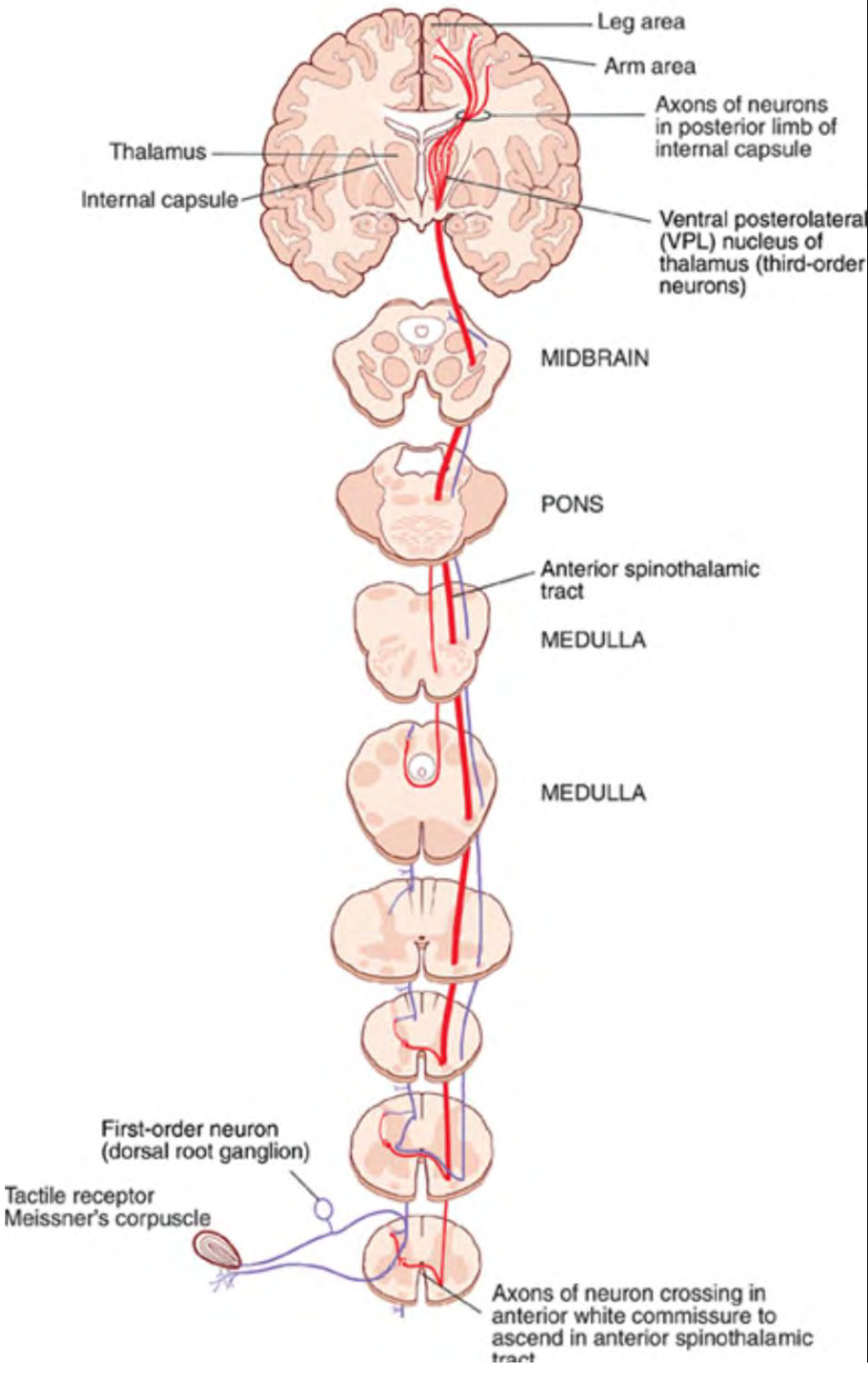
https://www.physio-pedia.com/images/6/66/Spinothalmaic_tract.jpg

Spinothalamic

Most crucial for nociception

Mainly from Lamina I & V

Sensitization of cells in Lamina V are thought to underlie Allodynia



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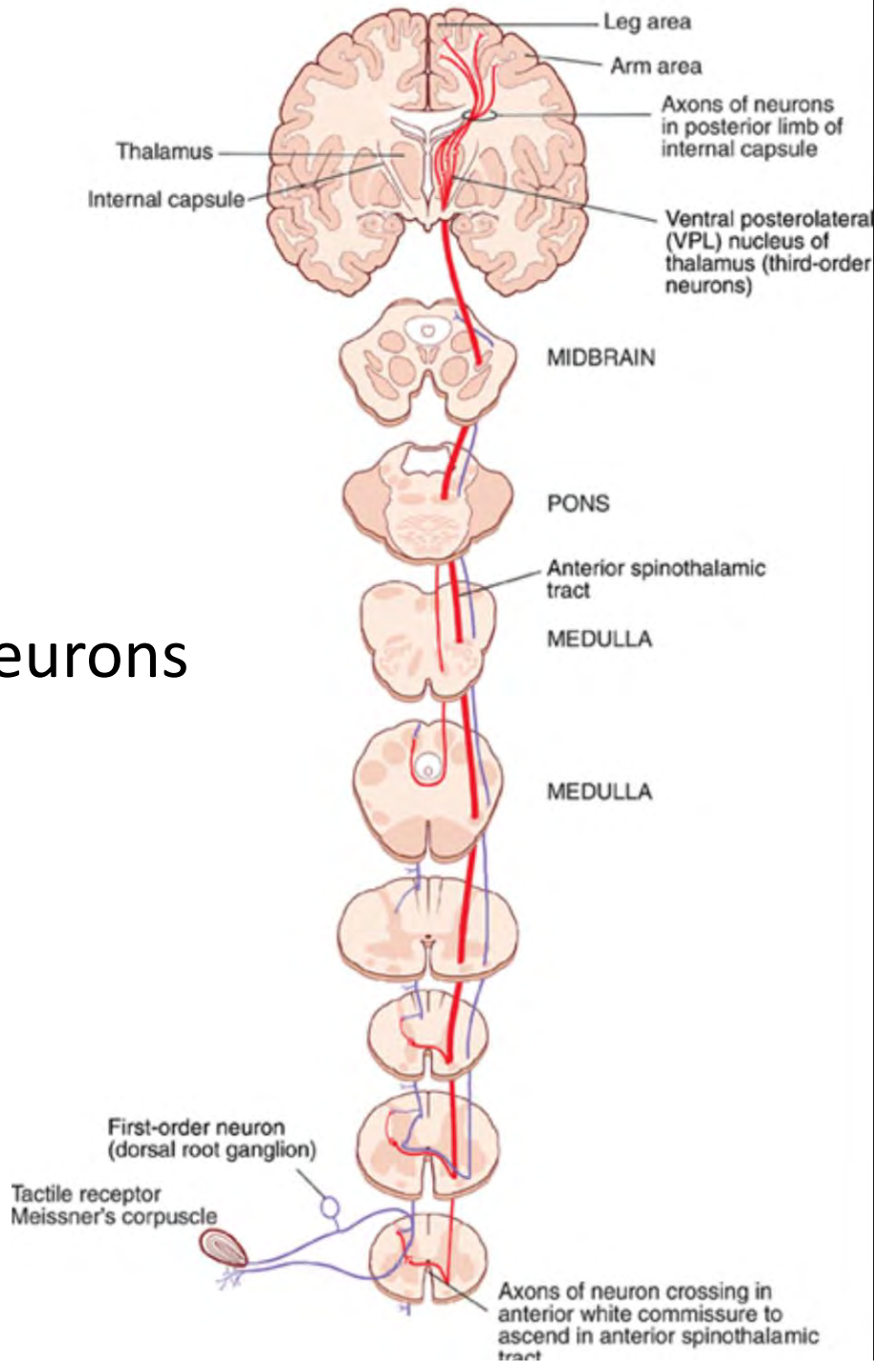
https://www.physio-pedia.com/images/6/66/Spinothalmaic_tract.jpg

Spinothalamic

Wind-up

Temporal summation of pain stimulus

Progressively increased activity of dorsal horn neurons



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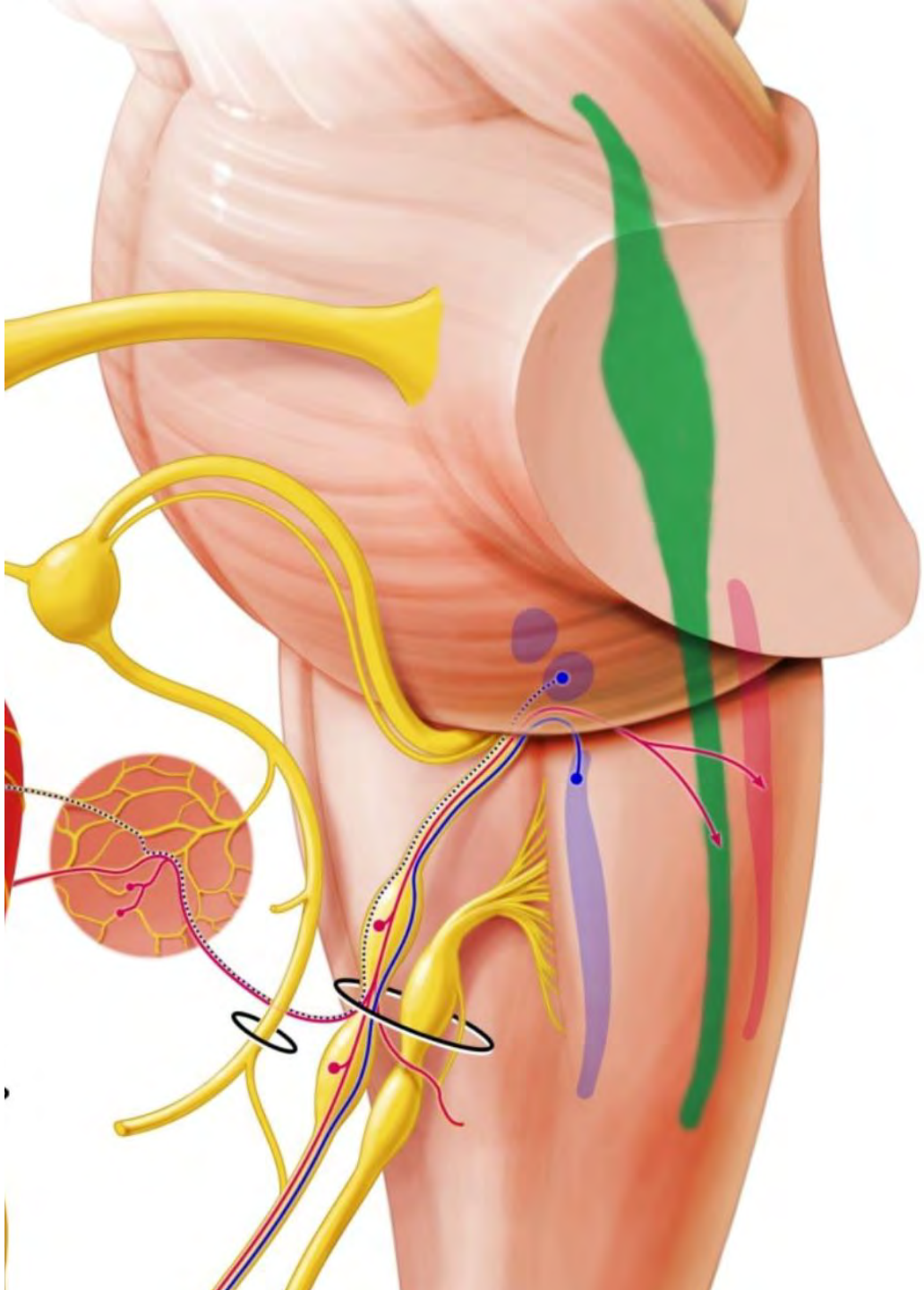
https://www.physio-pedia.com/images/6/66/Spinothalmaic_tract.jpg

Spinal Trigeminal Tract

Mesencephalic – proprioception

Pons/Medulla – Light Touch

Cervical – Pain/Temperature



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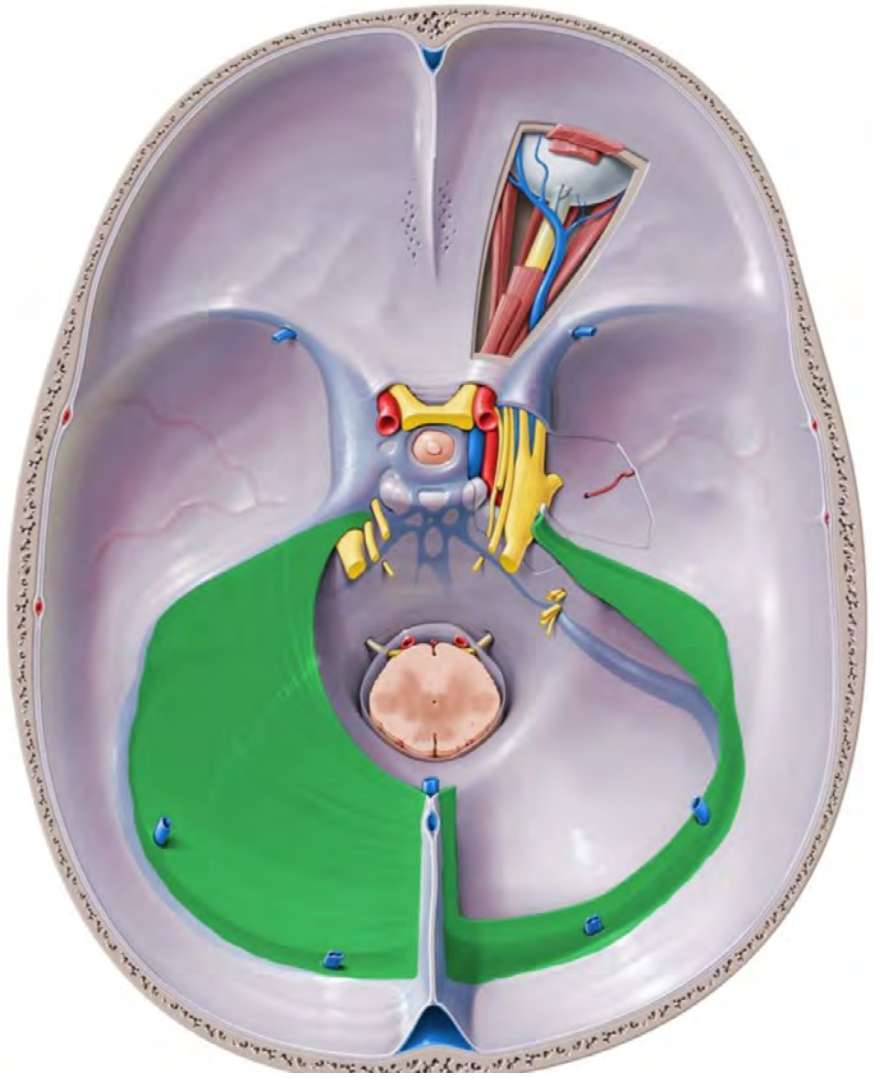
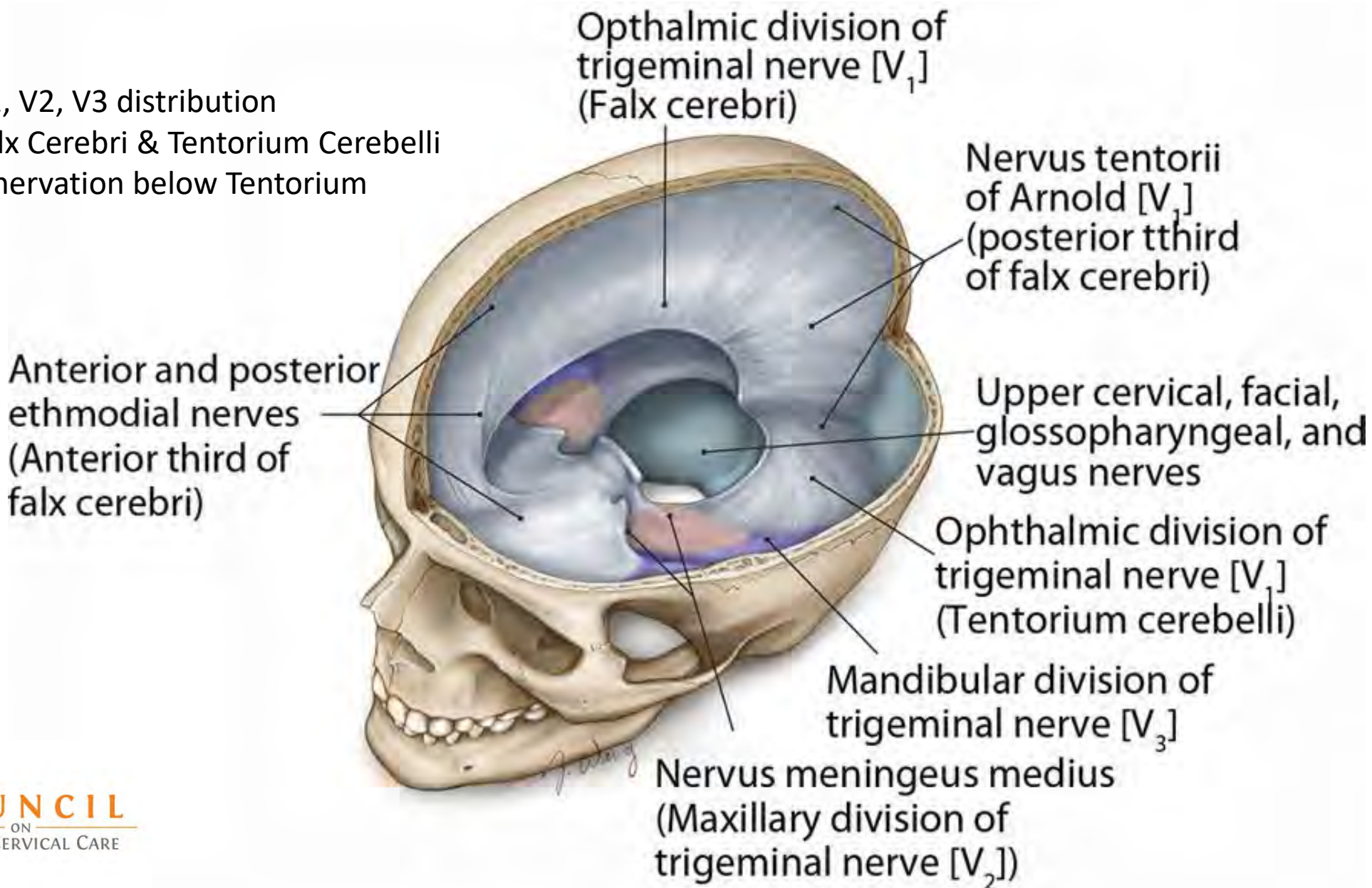
QUIZ: Intracranial Dural Innervation?

Inferior to Tentorium Cerebelli?



William J. Kemp, III, R. Shane Tubbs, Aaron A. Cohen-Gadol. The Innervation of the Cranial Dura Mater: Neurosurgical Case Correlates and a Review of the Literature *World Neurosurg. (2012) 78, 5:505-510.*

Note: V1, V2, V3 distribution
Note: Falx Cerebri & Tentorium Cerebelli
Note: innervation below Tentorium



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Classification/Diagnosis

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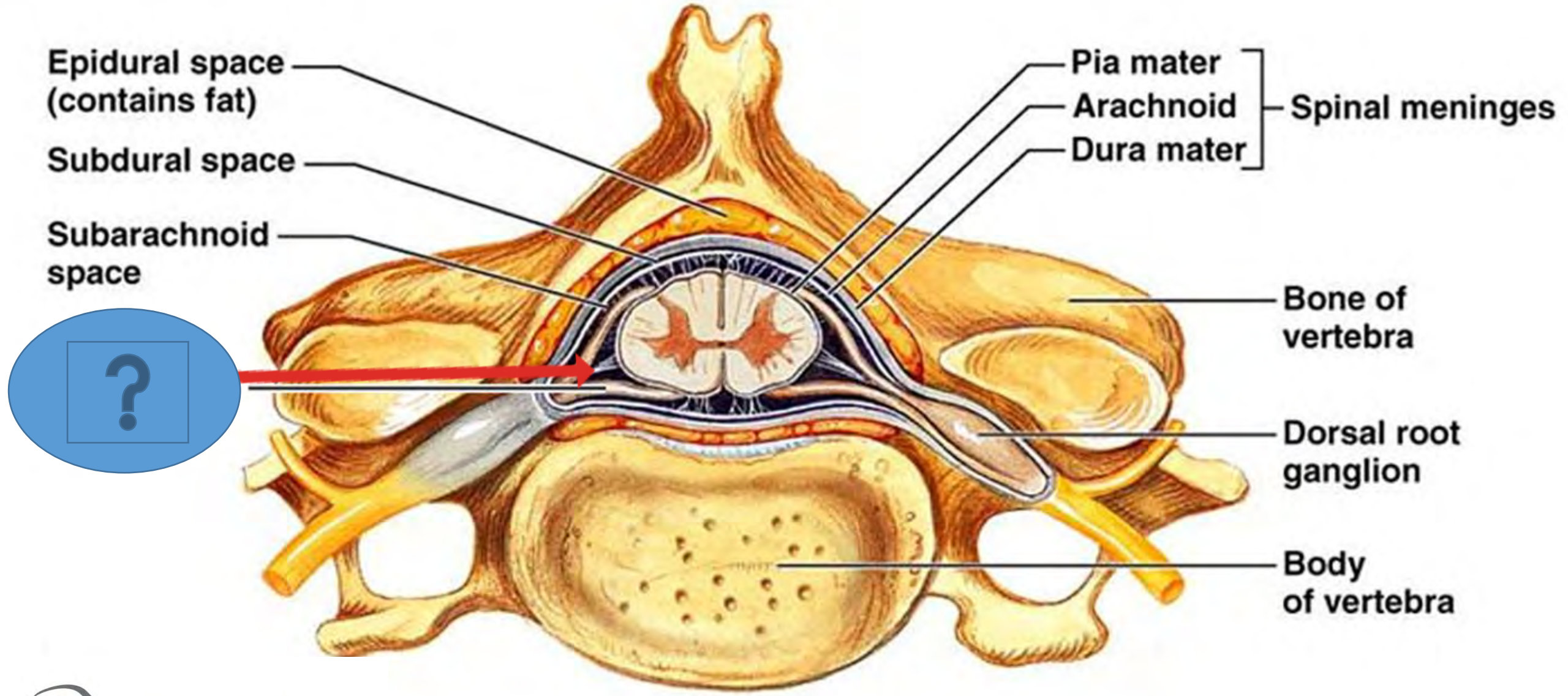
Ascending/Descending

Ocular, Occlusal, Pedorthic

Spinal Subarachnoid Space

Divided into Anterior and Posterior by Dentate Ligaments



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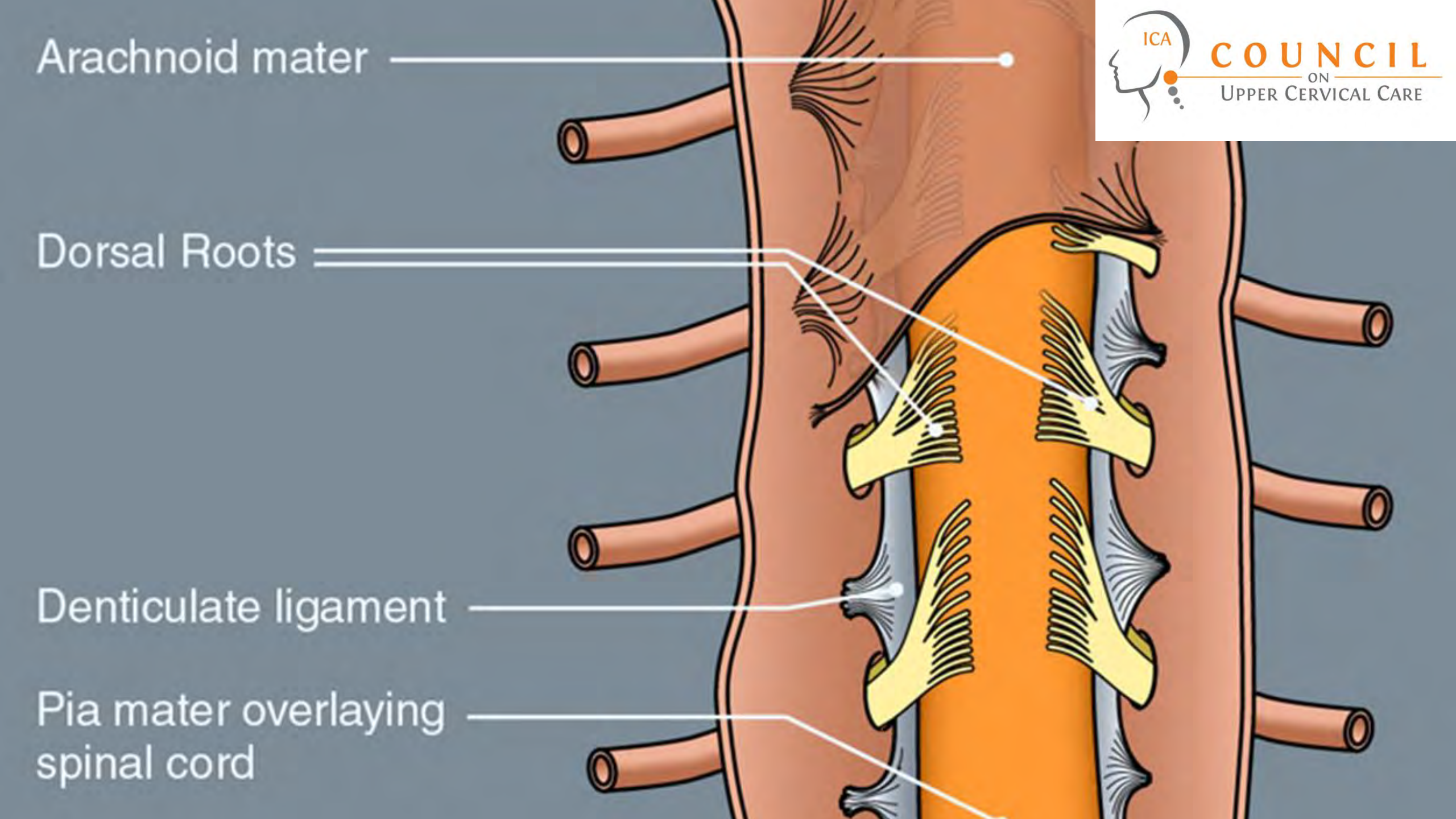
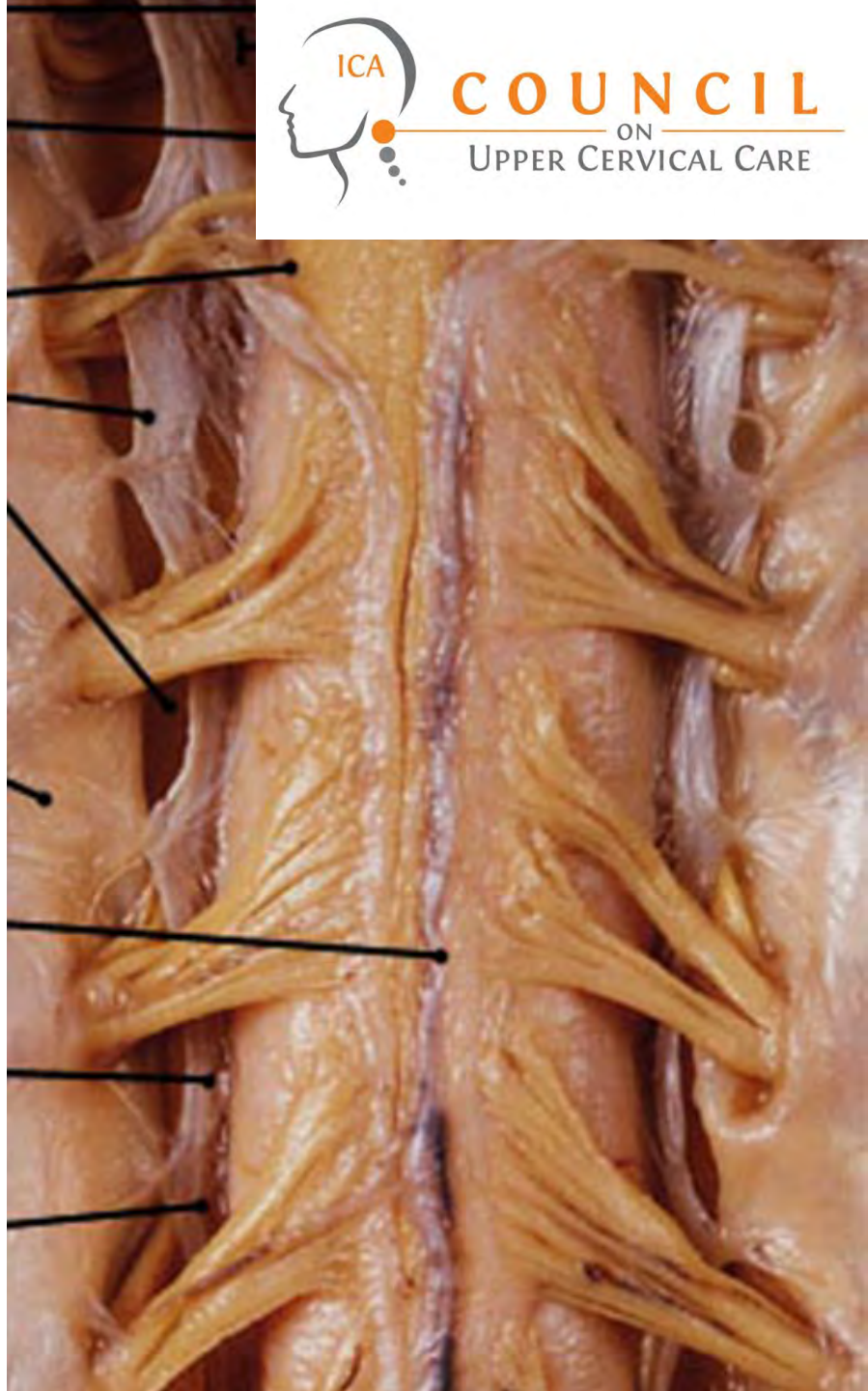


Each denticulate ligament is composed of a single narrow fibrous strip that extends from the craniovertebral junction to T12.

Source: DCCJP presentation 2014
RA Leverone, DC, DACBR



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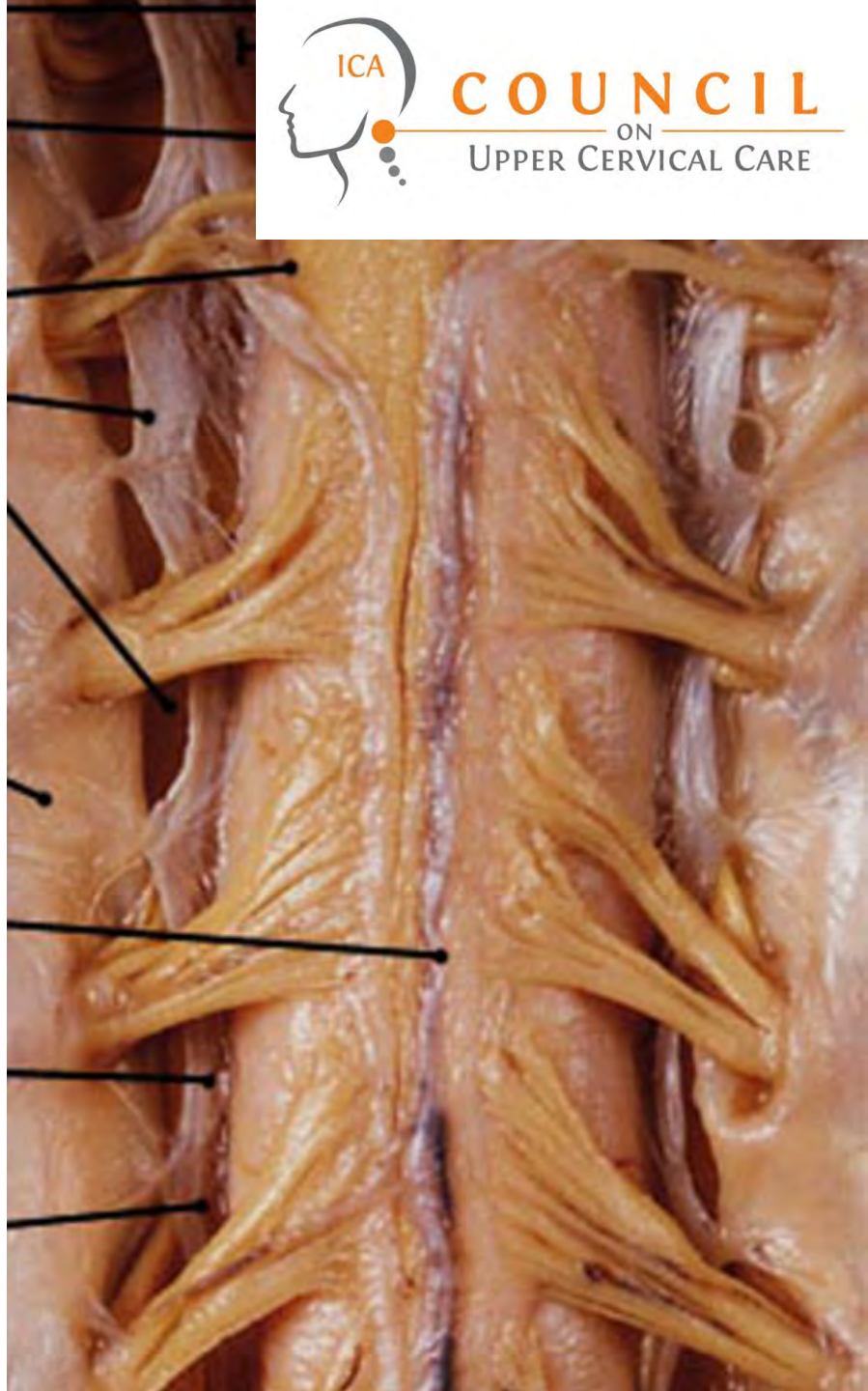
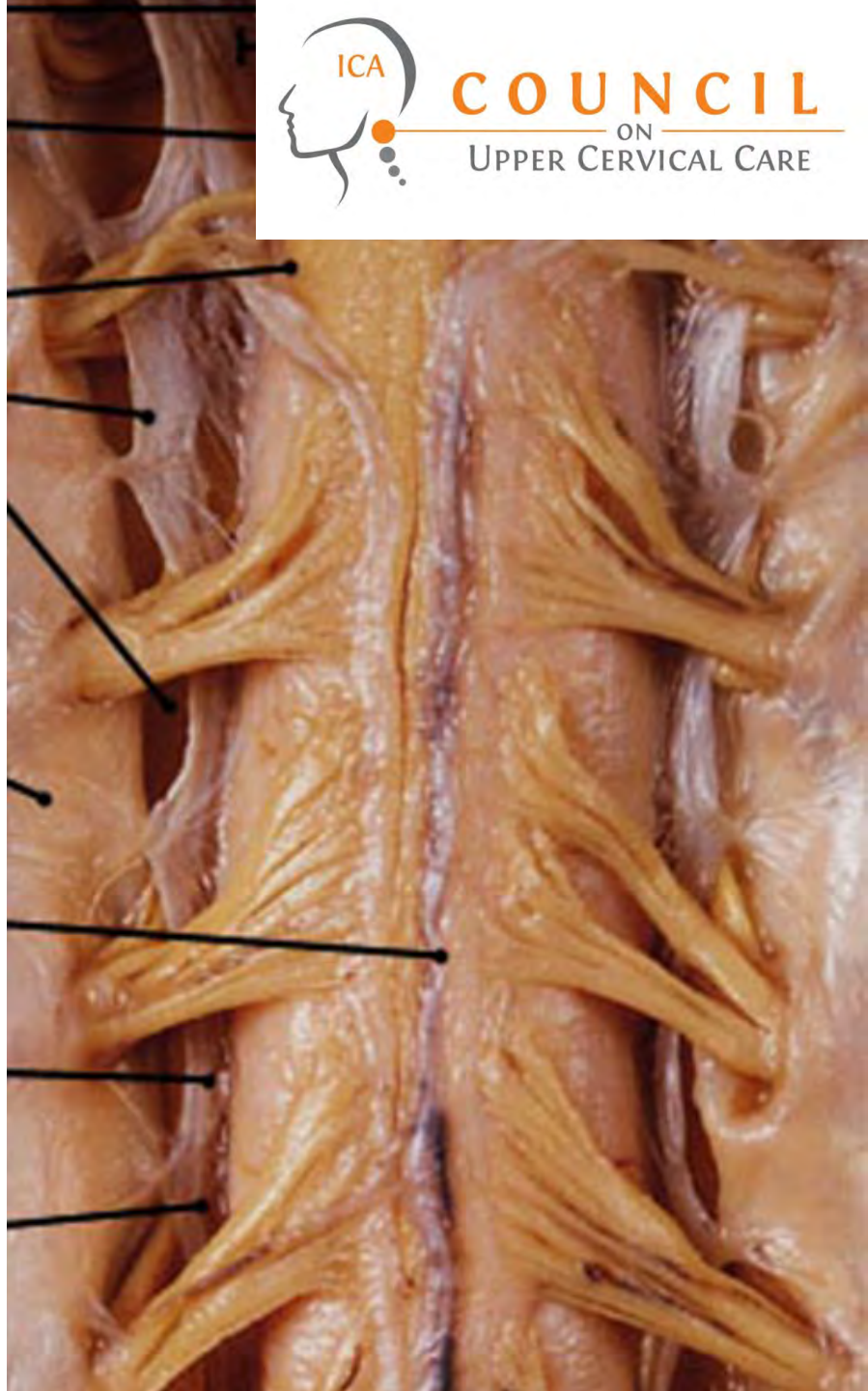
Each ligament features 18-20 triangular extensions that attach to the dura at their apices. The triangular extensions are smaller and more numerous at the cervical levels, and are larger and less numerous at the thoracic levels.

Source: DCCJP presentation 2014
RA Leverone, DC, DACBR



The apices of the extensions attach to the dura via fibrous bands at cervical levels (each band 3-5 mm long) and lower thoracic levels (21-26 mm long), whereas they attach directly to the dura at upper thoracic levels.

Source: DCCJP presentation 2014
RA Leverone, DC, DACBR



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Consideration

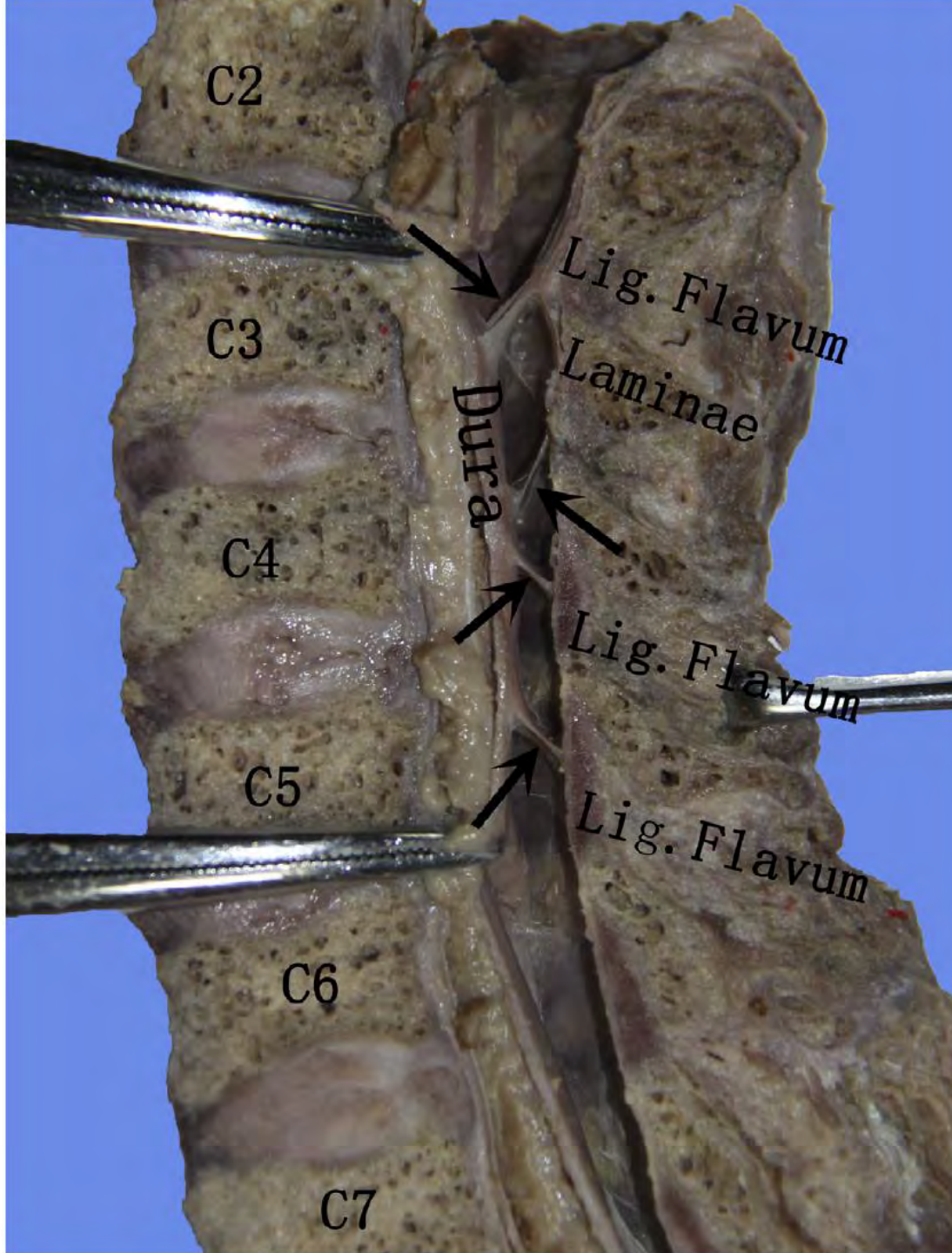
Anterior and posterior displacement of the spinal cord at the CCJ due to crowding.

Vertebral Canal divided into Anterior and Posterior compartments by the Dentate Ligaments

Dentate ligaments are very strong at that the CCJ, what is happening to the cord and dura is they are under increased tension A-P due to Anterior or Posterior displacement of C0, C1 or C2?

The **Dorsal Meningovertebral Ligaments** exist at levels **C2-C6,** attaching **dura** to the **Ligamentum Flavum** or the **Lamina.**

Author: Shi B
Title: The morphology and clinical significance of the dorsal meningovertebra ligaments in the cervical epidural space.
Source: *The spine journal* [1529-9430] yr:2014 vol:14 iss:11 pg:2733-9



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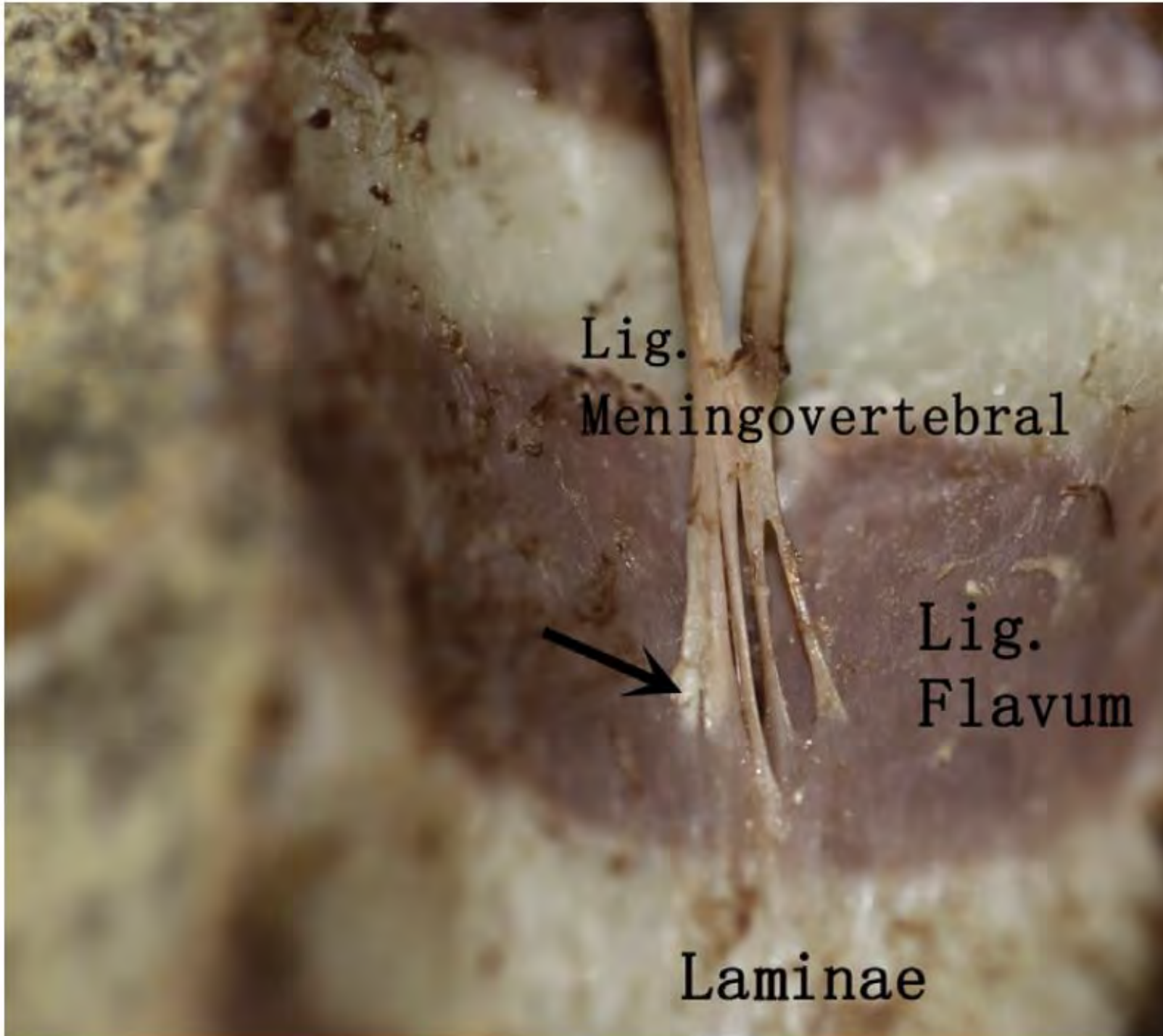
Meningovertebral Ligament



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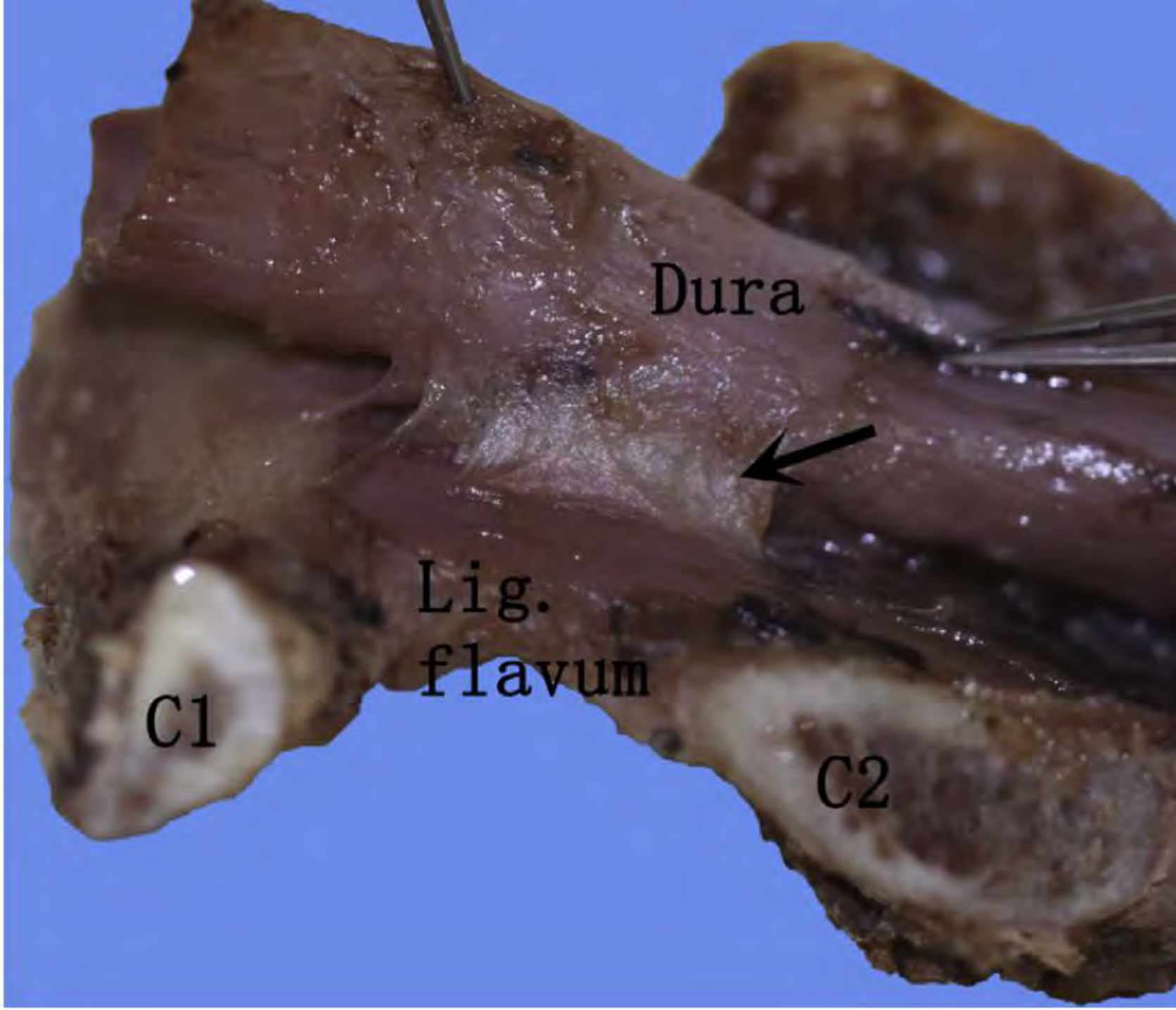
"At **C1 & C2** the Dorsal Meningovertebral Ligaments become thicker and become known as **Myodural bridges"**



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Title: The morphology and clinical significance of the dorsal meningovertebra ligaments in the cervical epidural space.
Source: *The spine journal* [1529-9430] yr:2014 vol:14 iss:11 pg:2733-9

MyoDural Bridges

"There is **strong evidence** about the existence of a soft tissue continuity between the dura mater and three suboccipital muscles: rectus capitis posterior major & minor (**RCPmi, RCPma**) and obliquus capitis inferior (**OCI**)."

Author: Luis, Palomeque-del-Cerro
Title: A Systematic Review of the Soft-Tissue Connections Between Neck Muscles and Dura Mater
Source: *Spine* [0362-2436] yr:2017 vol:42 iss:1 pg:49-54

MyoDural Bridges

"… **conflicting evidence** about the existence of a continuity between the dura mater and the **Ligamentum Nuchae**, in which several muscles such as **upper trapezius (UT), splenius capitis (SC), rhomboideus minor (RM),** and **serratus posterior superior (SPS)** are attached."

Author: Luis, Palomeque-del-Cerro
Title: A Systematic Review of the Soft-Tissue Connections Between Neck Muscles and Dura Mater
Source: *Spine* [0362-2436] yr:2017 vol:42 iss:1 pg:49-54

MyoDural Bridges

"… evidence about a bridge between the **rectus capitis anterior** (**RCA**) is limited"

Author: Luis, Palomeque-del-Cerro
Title: A Systematic Review of the Soft-Tissue Connections Between Neck Muscles and Dura Mater
Source: *Spine* [0362-2436] yr:2017 vol:42 iss:1 pg:49-54

MyoDural Bridges Histology

"Researchers have inferred that the MDB might have physiological functions such as

1. sensorimotor function [12],
2. postural control [13], and
3. maintenance of the integrity of the subarachnoid space and the cerebellomedullary cistern [2]."

Author: Zheng , Zheng
Title: Orientation and property of fibers of the myodural bridge in humans
Source: *The spine journal* [1529-9430] yr:2018 vol:18 iss:6 pg:1081-1087

MyoDural Bridges Histology

"Sui et al. [14] proposed that the contraction of the suboccipital muscles may be a **dynamic source of** the cerebrospinal fluid **(CSF) circulation** via the MDB.

In addition, clinicians have shown that the pathologic change of MDB might cause **cervicogenic or chronic tension-type headache** [15,16]."

Author: Zheng , Zheng
Title: Orientation and property of fibers of the myodural bridge in humans
Source: *The spine journal* [1529-9430] yr:2018 vol:18 iss:6 pg:1081-1087

MyoDural Bridges Histology

"…Fibrous connective tissues between the rectus capitis posterior minor (RCPmi), rectus capitis posterior major (RCPma), obliquus capitis inferior (OCI), nuchal ligament, and cervical spinal dura mater (SDM)."

Author: Zheng , Zheng
Title: Orientation and property of fibers of the myodural bridge in humans
Source: *The spine journal* [1529-9430] yr:2018 vol:18 iss:6 pg:1081-1087

MyoDural Bridges Histology

"Myodural bridge is mainly formed by parallel running **type I collagen fibers**; thus, it can transmit the strong pull from the diverse suboccipital muscles or ligaments during head movement."

"… a tendon-like structure…"

Author: Zheng , Zheng
Title: Orientation and property of fibers of the myodural bridge in humans
Source: *The spine journal* [1529-9430] yr:2018 vol:18 iss:6 pg:1081-1087

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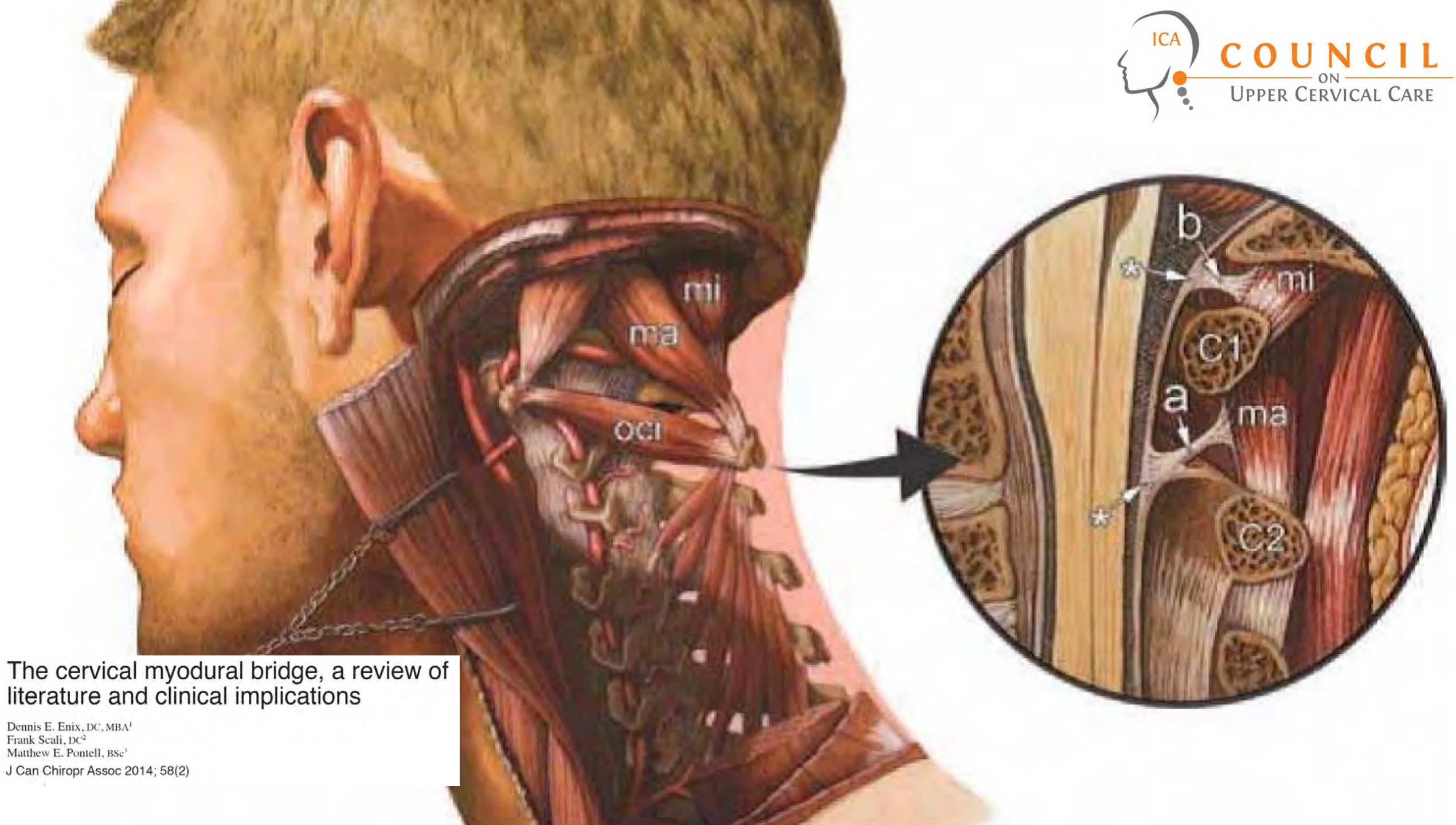

The cervical myodural bridge, a review of literature and clinical implications

Dennis E. Enix, DC, MBA[1]
Frank Scali, DC[2]
Matthew E. Pontell, BSc[3]

J Can Chiropr Assoc 2014; 58(2)

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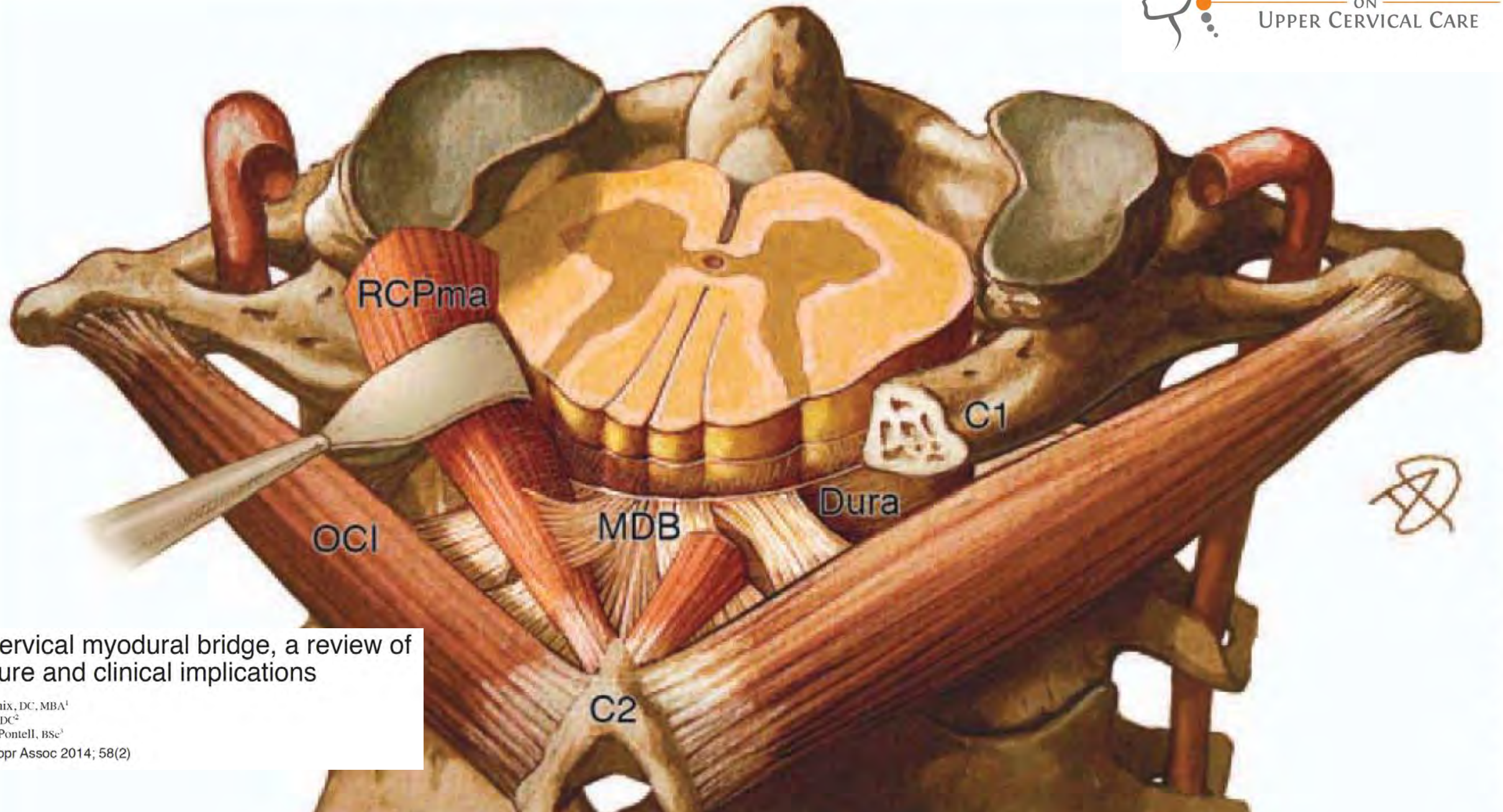

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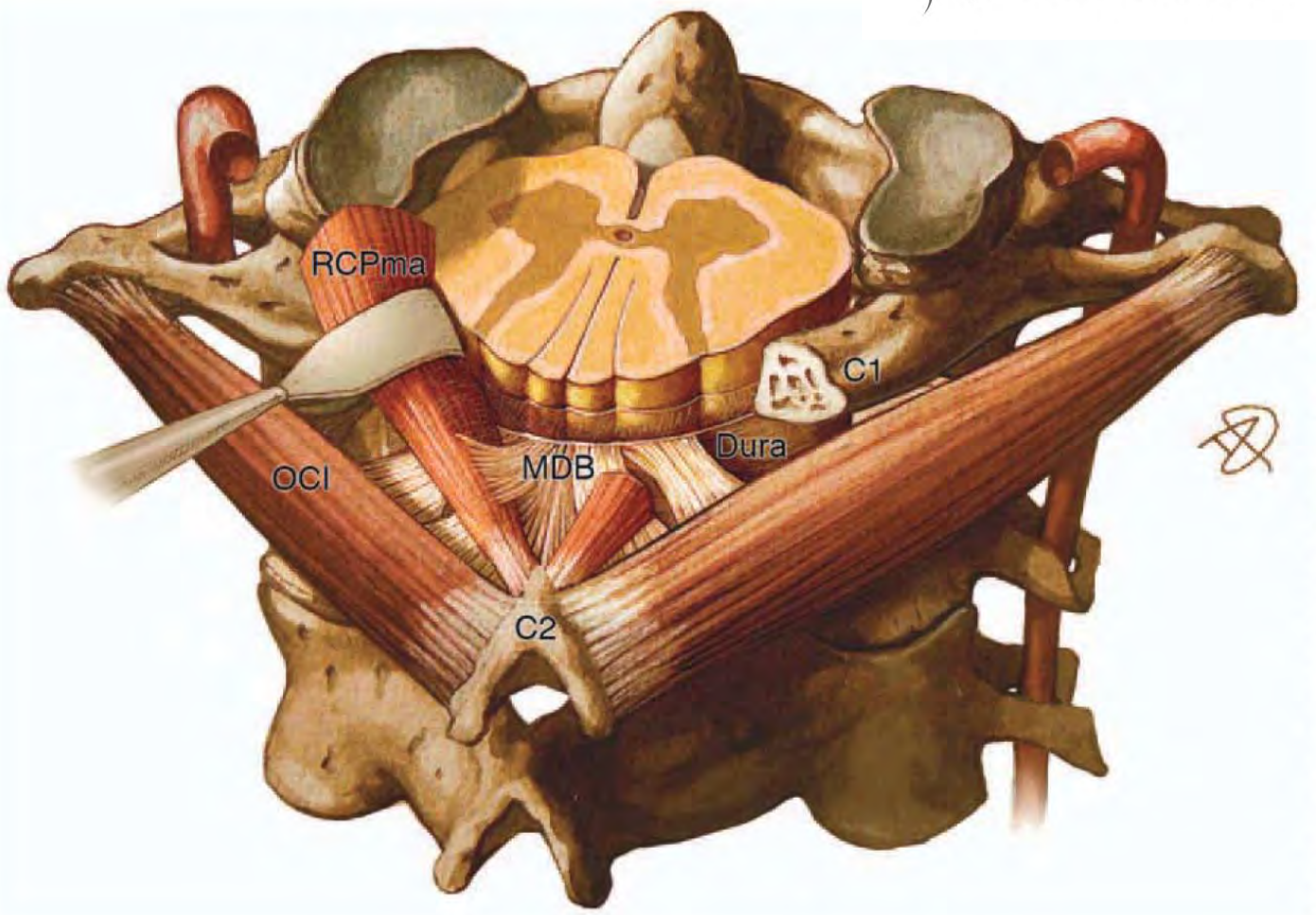
J Can Chiropr Assoc 2014; 58(2)

MDB

RCPMa & OCI attaching to the posterior aspect of the cervical dura mater



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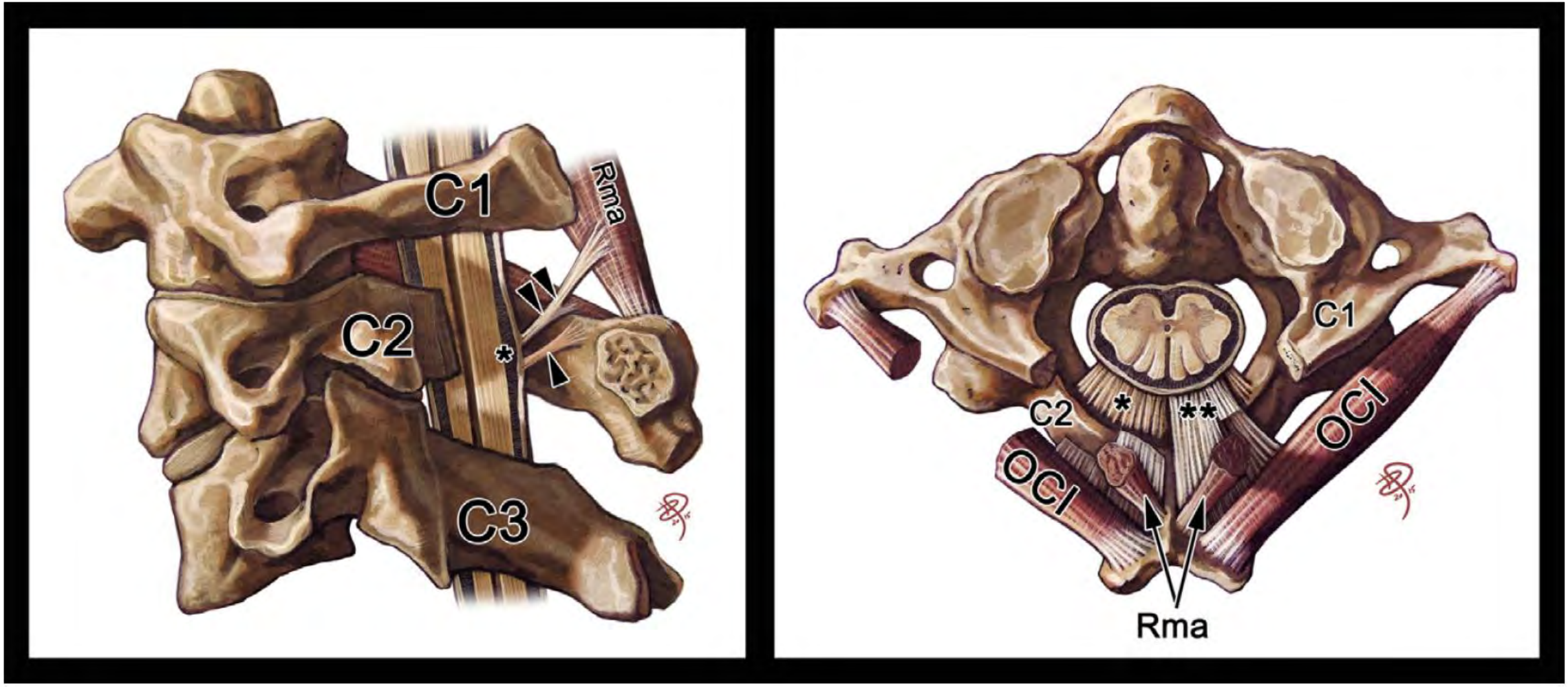


Myodural Bridge (two arrow, **), Inferior Dorsal **Meningovertebral Ligament** (one arrow, *)

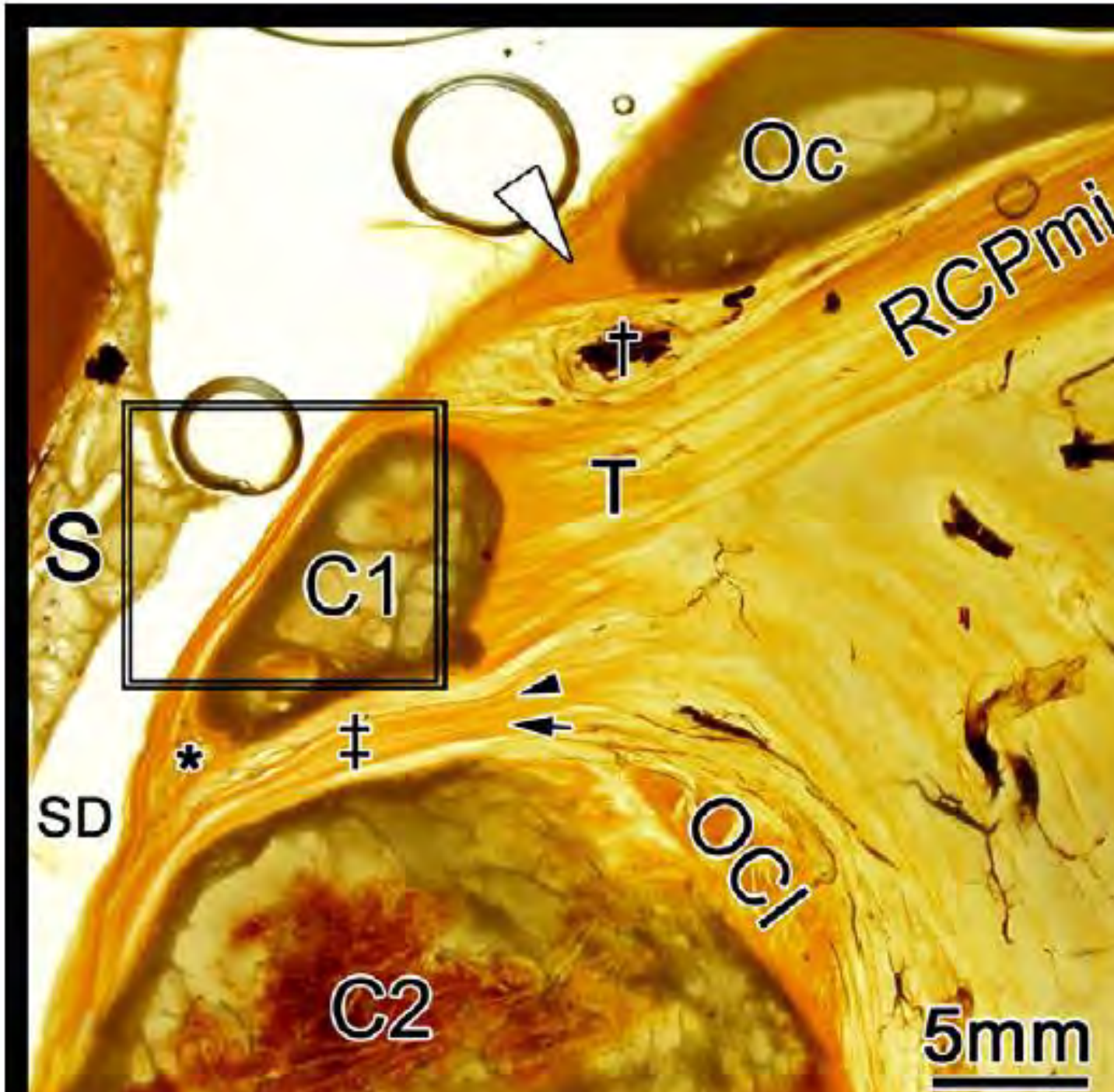
Author: Scali , Scali

Title: Investigation of meningomyovertebral structures within the upper cervical epidural space: a sheet plastination study with clinical implications

Source: *The spine journal* [1529-9430] yr:2015 vol:15 iss:11 pg:2417-2424

ICA COUNCIL ON UPPER CERVICAL CARE

Opisthion
Posterior Tubercle
Spinous Process C2
Obliquus CI
RCPMi
Tendon
SD – SubDural Space
S – Spinal Cord



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Hofmann's ligaments C6-L5

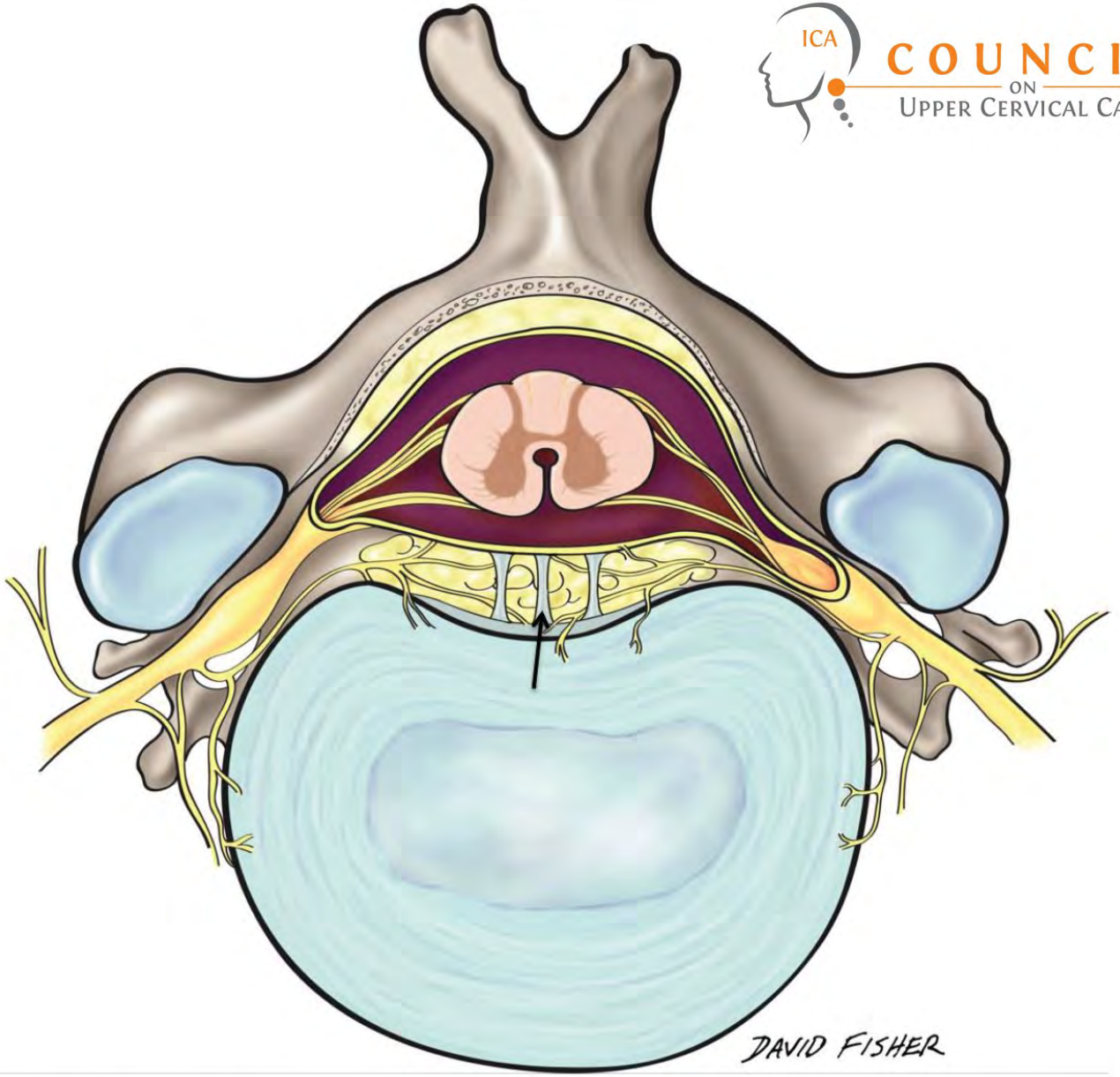


FIGURE 1: Schematic drawing illustrating Hofmann's ligaments (arrow) in the epidural space.

Author: Tardieu GG
Title: The Epidural Ligaments (of Hofmann): A Comprehensive Review of the Literature.
Source: *Curēus* [2168-8184] yr:2016 vol:8 iss:9 pg:e779

“There were three sets of Hofmann’s ligaments based on their connections;

1) midline (from anterior dural sac to PLL),
2) lateral (from anterolateral dura to the lateral extent of the PLL) and
3) proximal root sleeve (from the dural extension of the nerve root sleeve to the PLL and periosteum of the inferior pedicle”

Author: Tardieu GG
Title: The Epidural Ligaments (of Hofmann): A Comprehensive Review of the Literature.
Source: *Curēus* [2168-8184] yr:2016 vol:8 iss:9 pg:e779

“fibrous connective tissue bands that run ventrolaterally from the dura mater to the vertebral canal” “from the dura to the PLL”

- cervical & upper thoracic – caudocranial orientation
- lumbar vertebrae – craniocaudal orientation

Author: Tardieu GG
Title: The Epidural Ligaments (of Hofmann): A Comprehensive Review of the Literature.
Source: *Curēus* [2168-8184] yr:2016 vol:8 iss:9 pg:e779

Epidural/ Vertebral Dural Ligaments

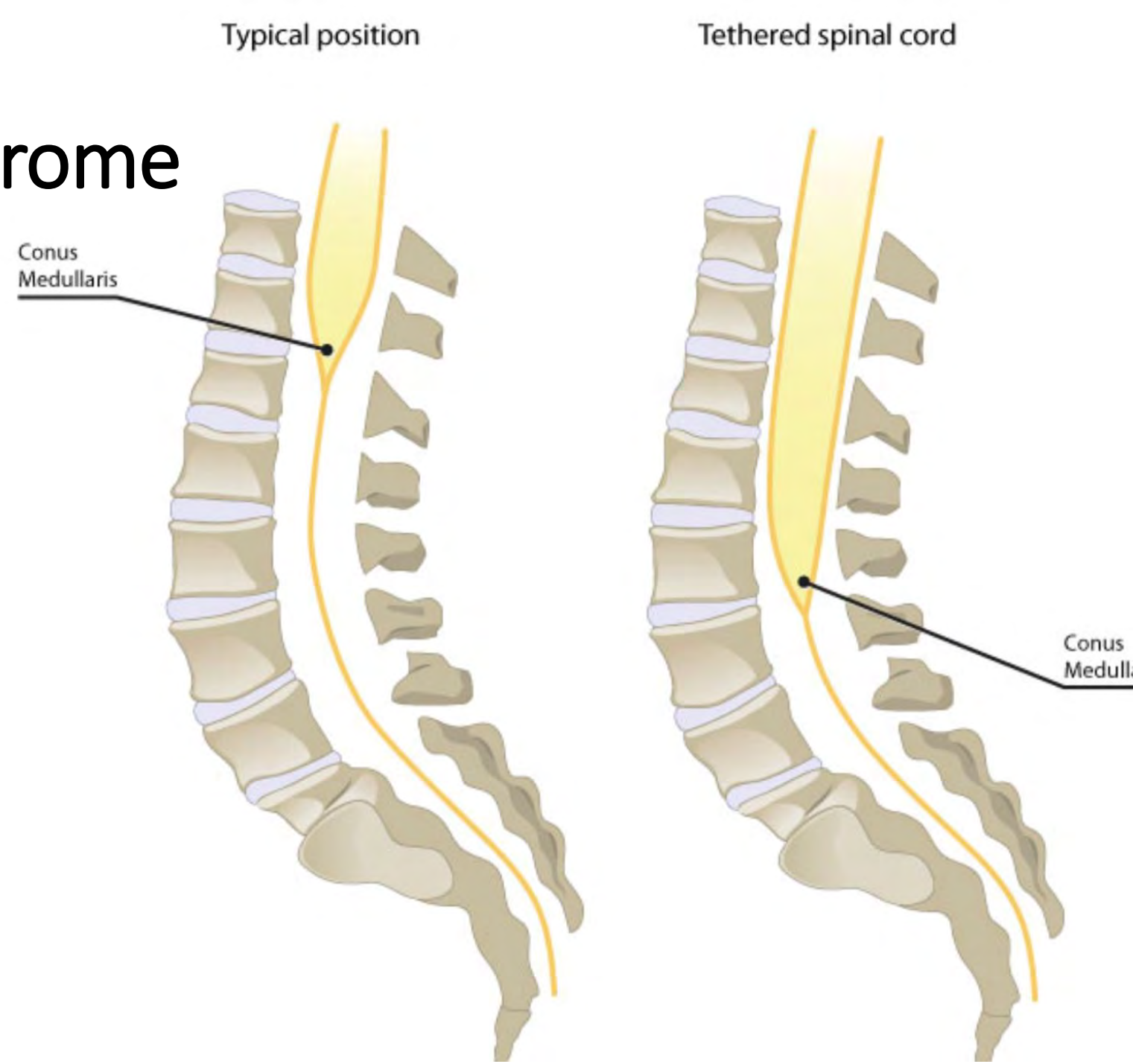
Posterior (Meningovertebral) Dura to lamina/ligamentum flavum

- V1 (atlantal)
- V2 (atlantoaxial)

Anterior (Hofmann's Ligament) Dura to PLL (begins C6)

Tethered Cord Syndrome

- Filum Terminale
- Conus Medullaris
  - T12-L3 Typical Range
  - L1 Adulthood
  - L3 Childhood



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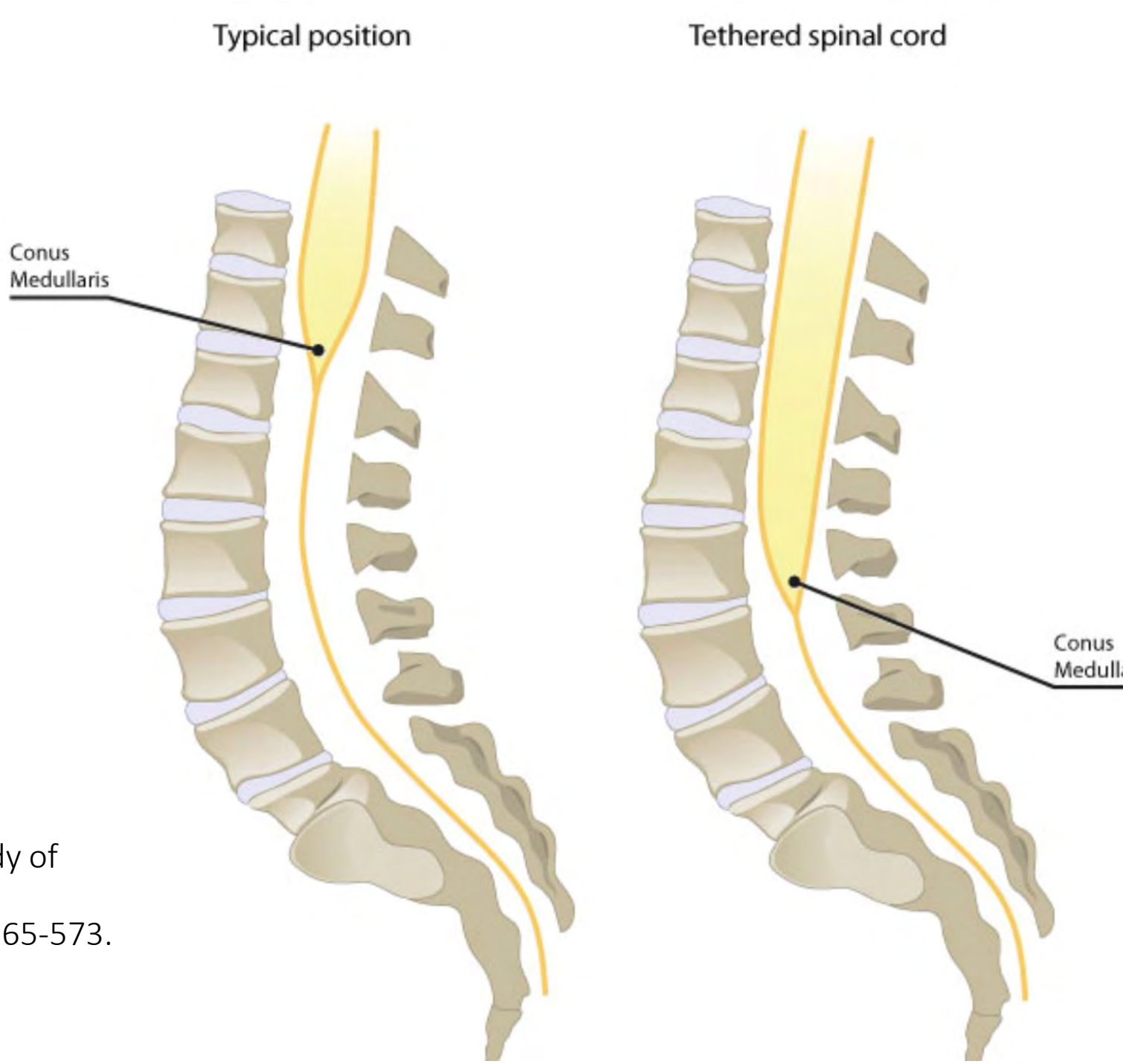
“**filum terminale internum** (FTI), connecting the conus medullaris (CM) with the dural sac (DS),…

… the **filum terminale externum** (FTE), connecting the DS with the coccyx. ”



De Vloo P, etal. The Filum Terminale: A Cadaver Study of Anatomy, Histology, and Elastic Properties
World Neurosurgery Volume 90, June 2016, Pages 565-573.

Coccygeal Ligament

Synonymous with

Filum Terminale Externum

Attaches at Co1

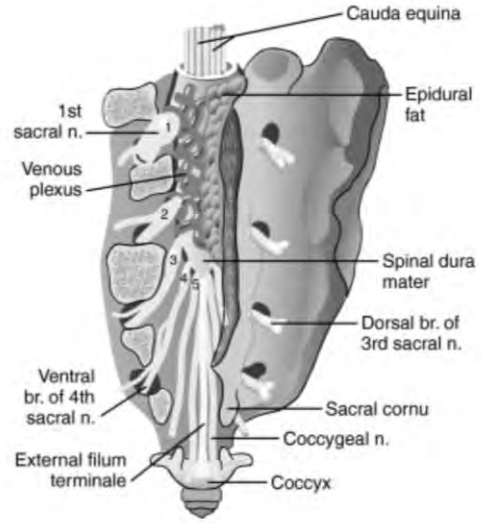


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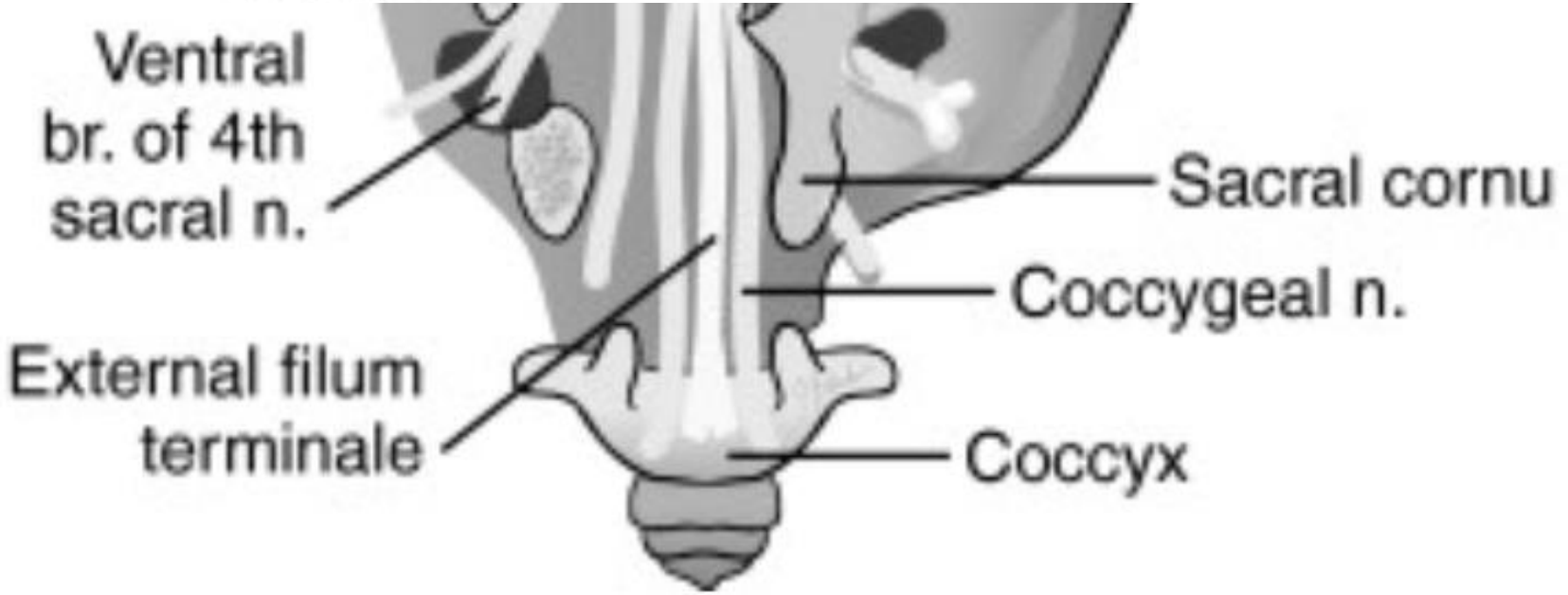
FIGURE 297–1. The sacral canal.

From Waldman SD: Atlas of Interventional Pain Management, ed 2. Philadelphia, Saunders, 2004, p 382.



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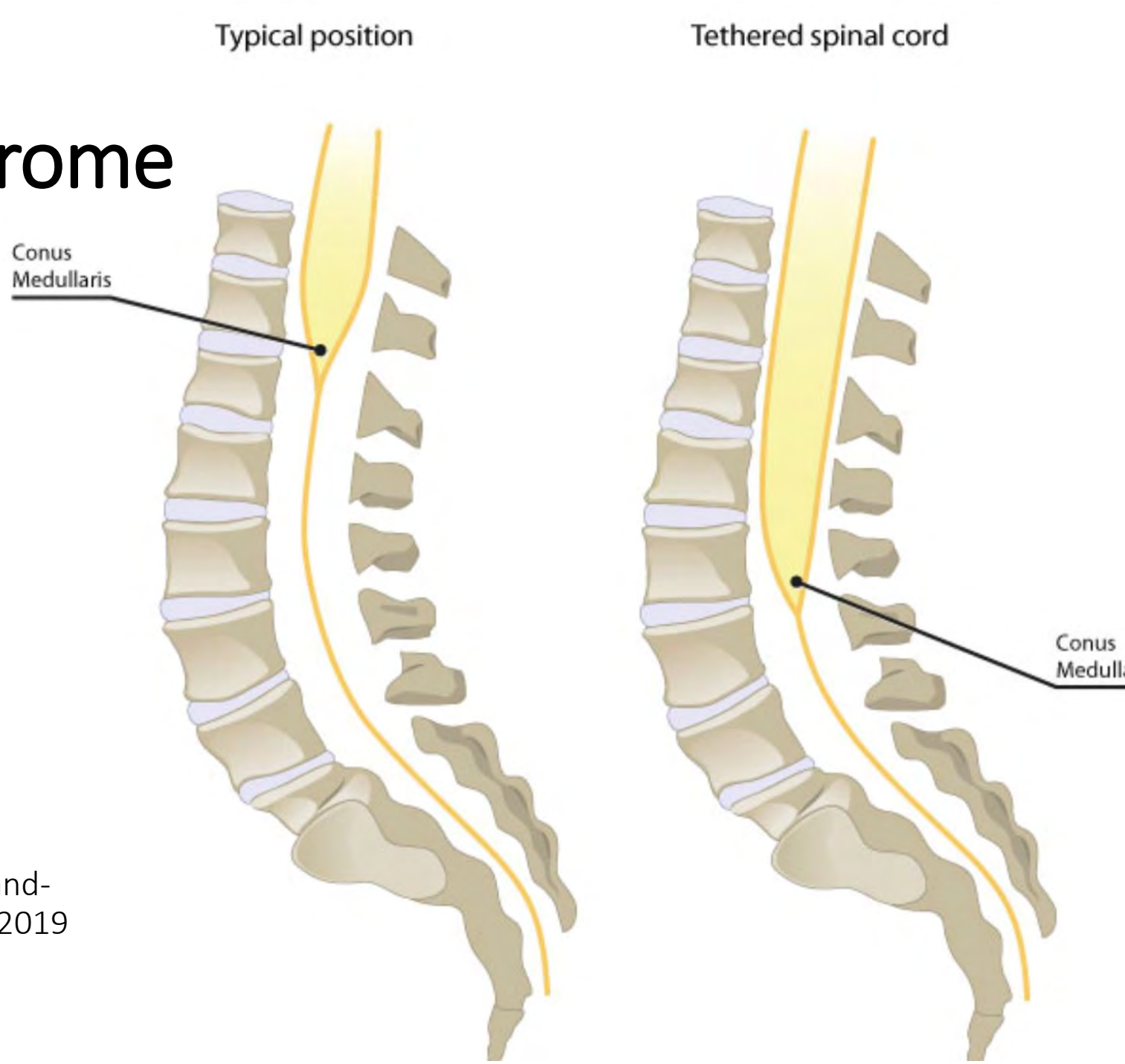
Tethered Cord Syndrome



"Symptoms can occur at any age but usually develop during **periods of rapid growth** in childhood or adolescence."

https://www.sciencedirect.com/topics/medicine-and-dentistry/tethered-cord-syndrome viewed 14 Oct 2019

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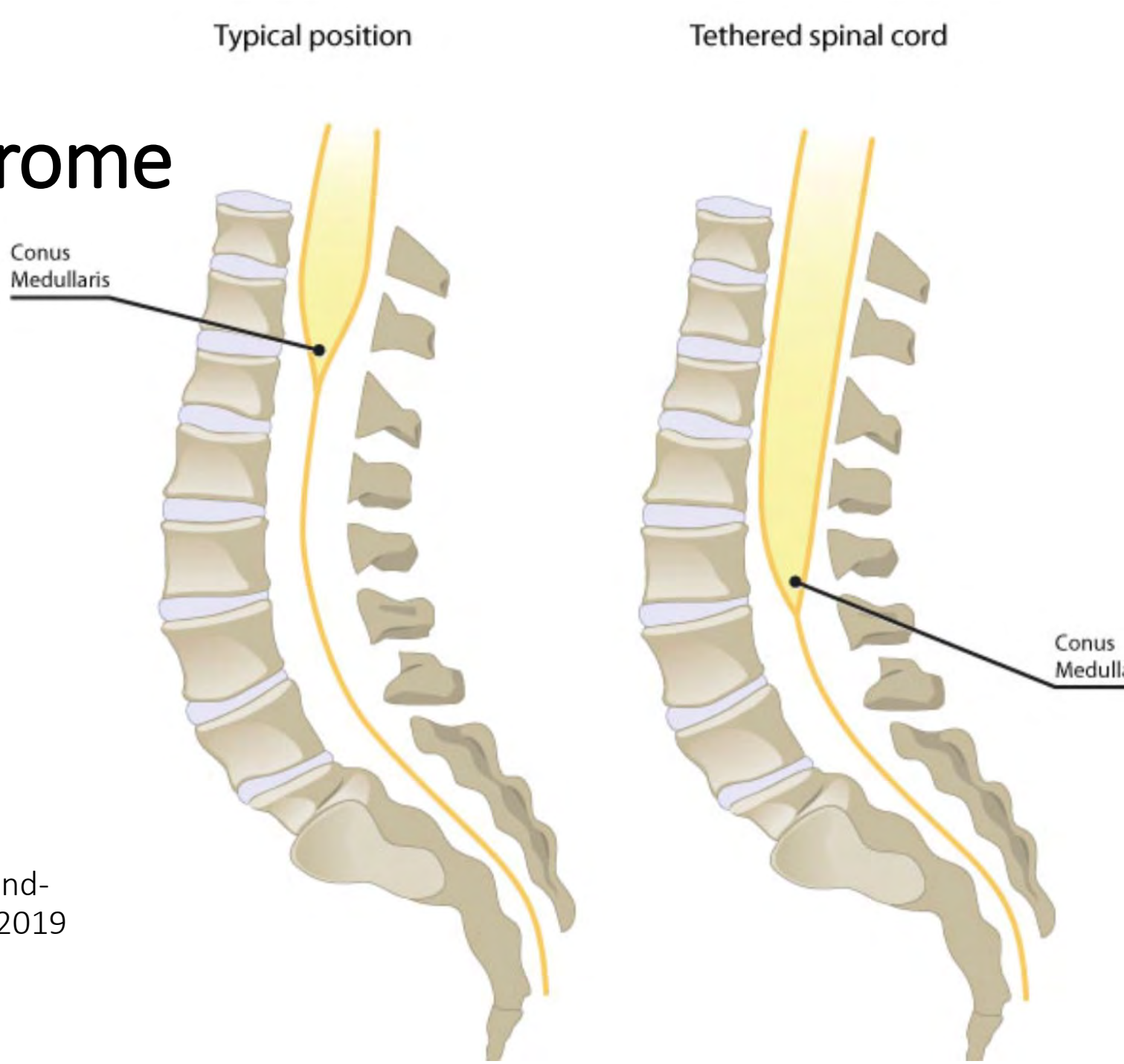
Tethered Cord Syndrome

"**Sensory and motor problems** and loss of **bowel and bladder control** emerge."

"Erectile dysfunction may occur in males.

Symptoms are typically **progressive**."



https://www.sciencedirect.com/topics/medicine-and-dentistry/tethered-cord-syndrome viewed 14 Oct 2019

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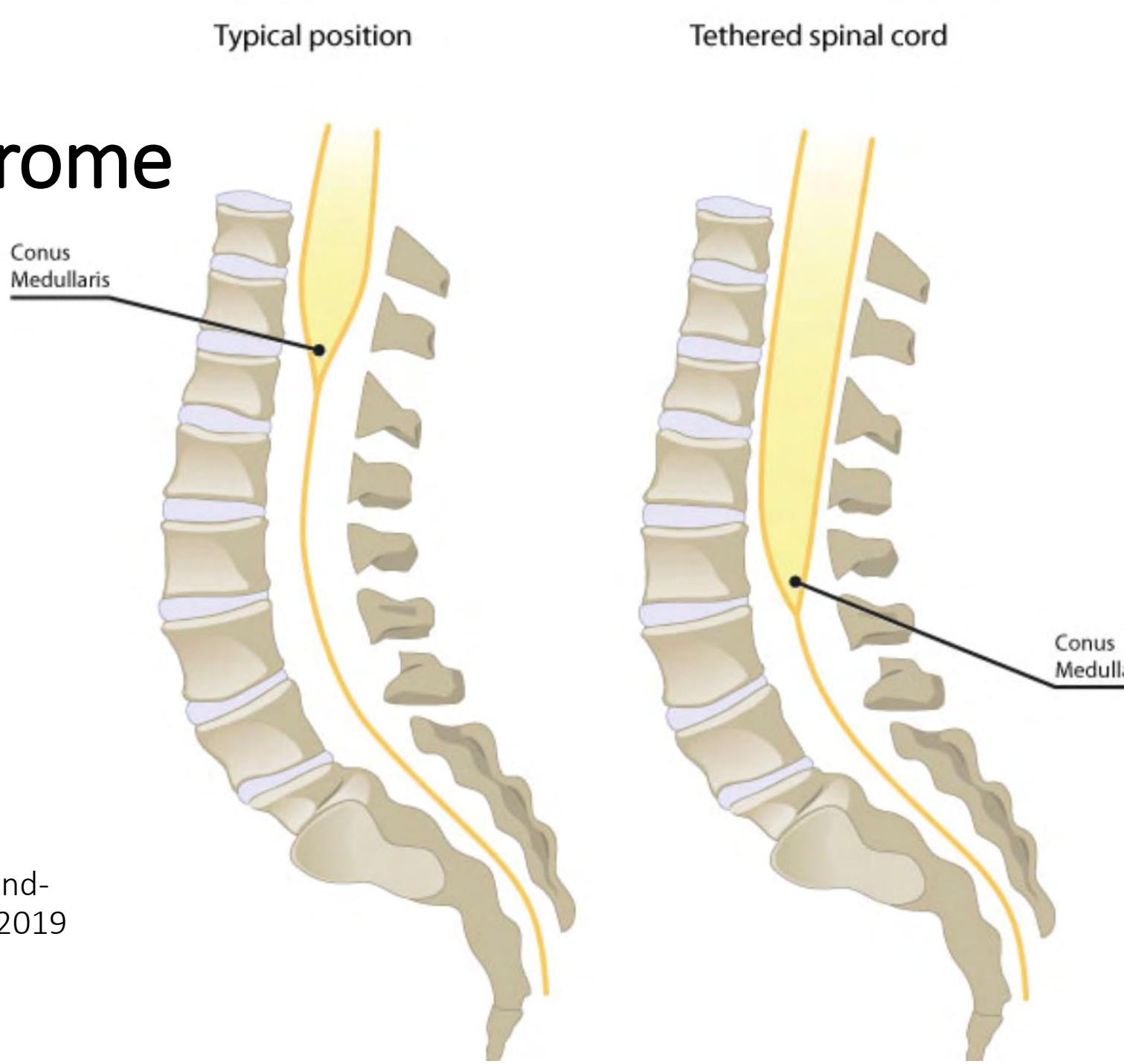
Tethered Cord Syndrome

"Diagnosis is made with MRI, which shows a low conus medullaris (i.e., below the bottom of the L2 vertebral body) or a thickened or fat-containing filum terminale."



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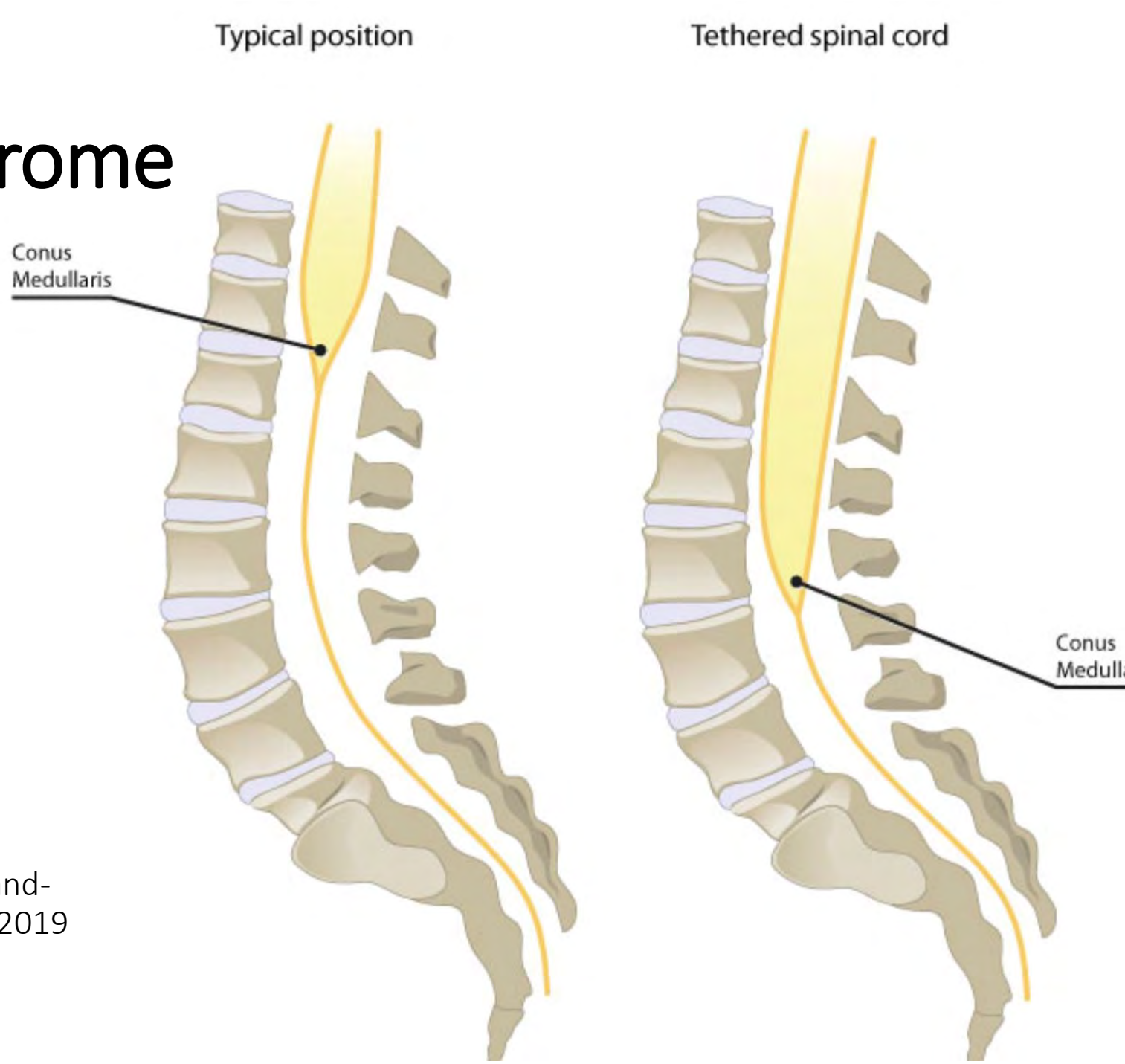
Tethered Cord Syndrome

"Treatment consists of surgical release of the tethered cord.

With successful surgery, symptoms typically do not progress and <u>may</u> improve."



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