

Syringomyelia and Hydromyelia

Cavity anatomy • spinal cord injury • clinicopathologic localization

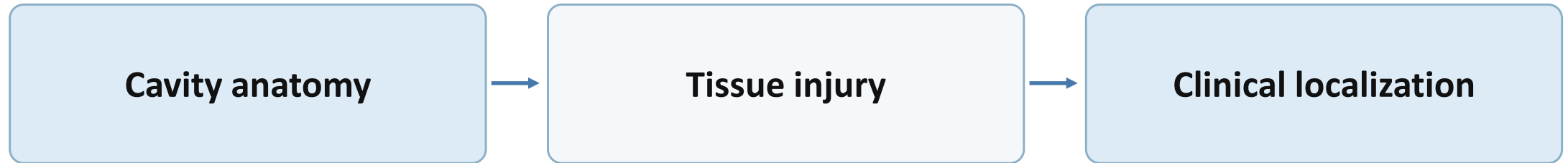
Pathology lecture

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Learning outcomes: Distinguish cavity types



- Differentiate expansion of the central canal from an intramedullary syrinx.
- Explain how cavity location predicts tissue injury and a sensory phenotype.
- Connect Chiari malformation, tumor, and trauma with cavitation and clinical assessment.

Clinical starting point: Selective sensory loss

Apply the anatomy to the vignette

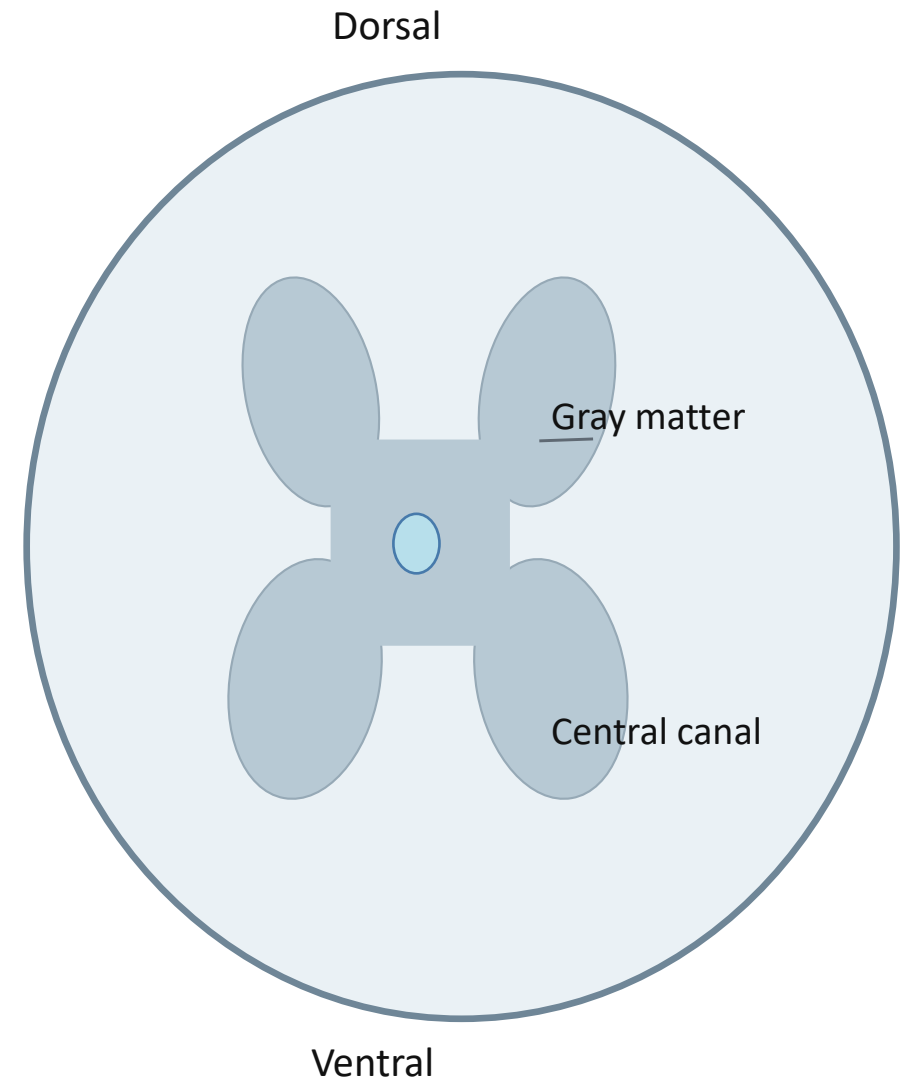
- An adult reports reduced ability to perceive pinprick and temperature in both upper limbs.
- Preserved vibration would suggest relatively spared posterior-column pathways.
- The anatomical question: Which central spinal cord fibers are vulnerable?

Two anatomical categories; One central location

Feature	Hydromyelia	Syringomyelia
Defining cavity	Expanded central canal	Intramedullary syrinx
Lining	Ependyma-lined	Not defined by ependymal lining
Location	Canal-centered	Inner spinal cord

Spinal cord cross-sectional orientation

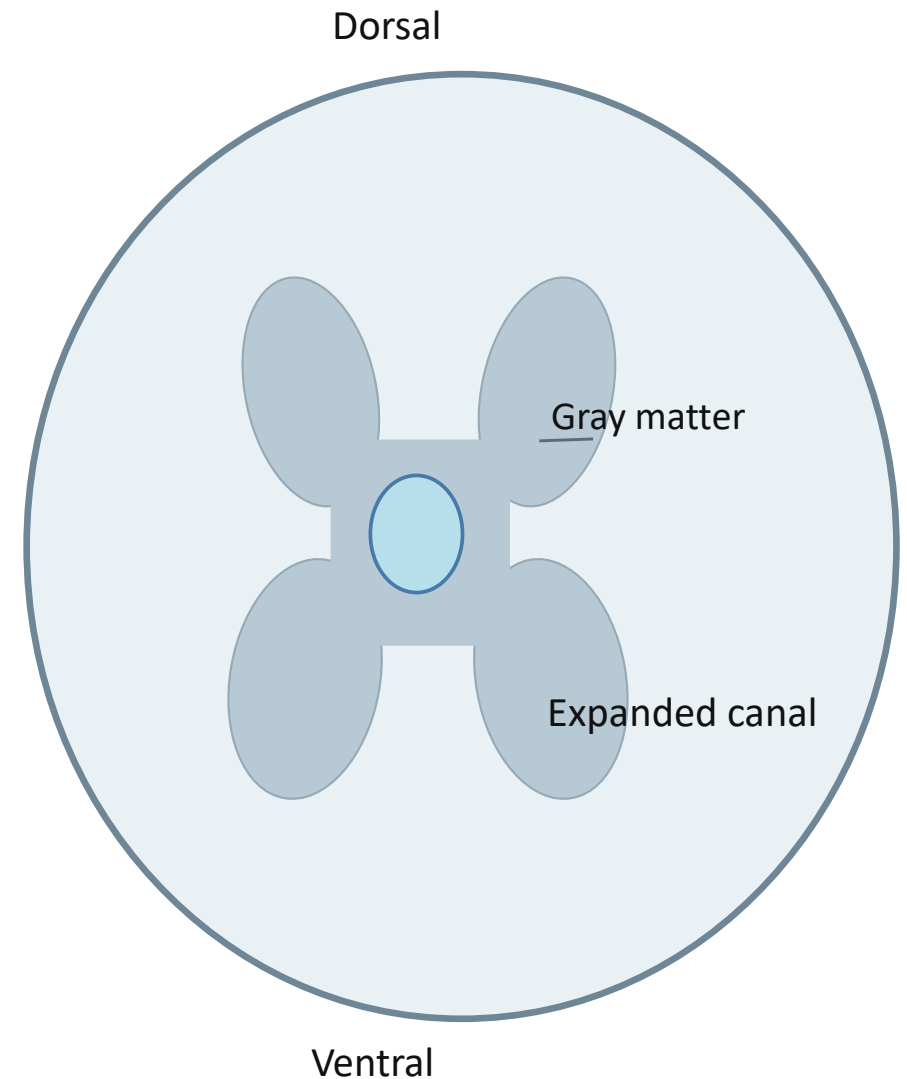
- Posterior (dorsal) structures are shown above and anterior (ventral) structures below.
- Gray matter occupies a central butterfly-shaped region.
- White matter surrounds the gray matter and contains long ascending and descending tracts.



Schematic cross-section

Central canal: An epithelial boundary

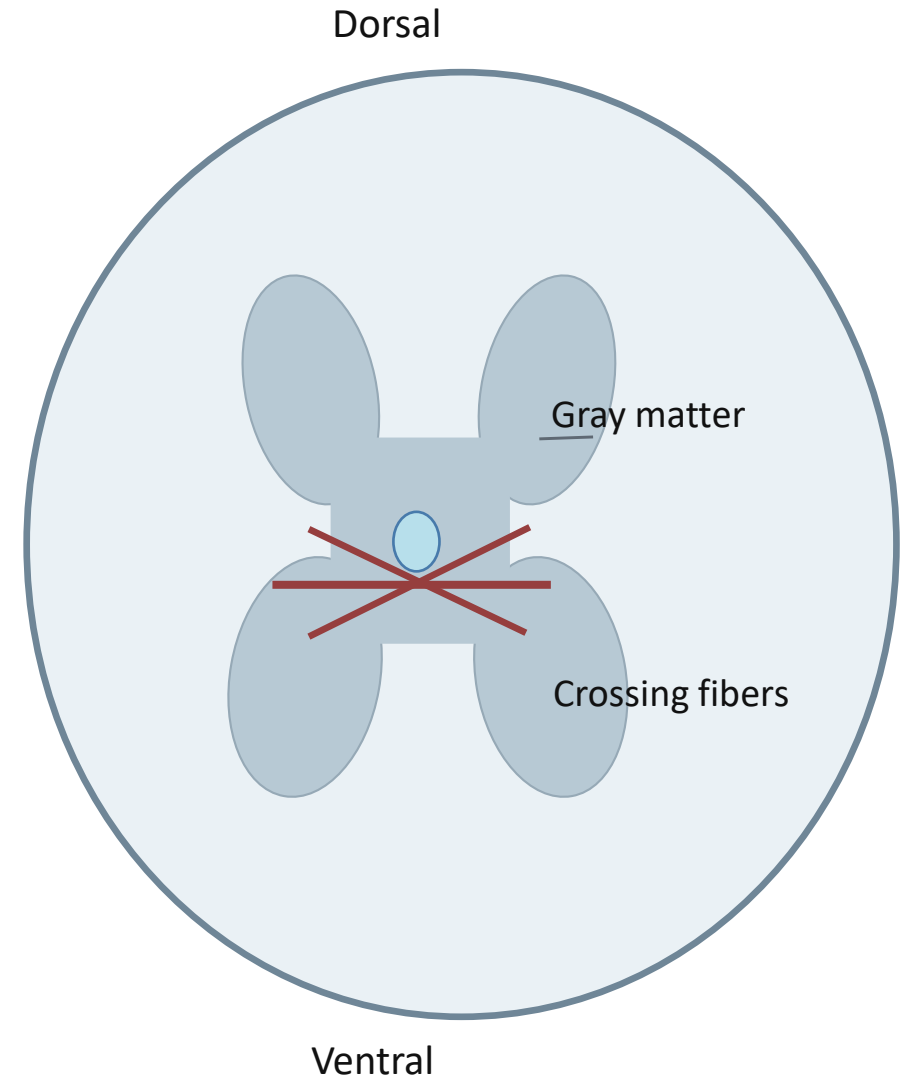
- The central canal lies within central spinal cord tissue.
- Ependymal cells line the normal canal; Hydromyelia expands this pre-existing lumen.
- A cavity in adjacent tissue is not defined as hydromyelia merely because it is centrally located.



Schematic cross-section

Anterior white commissure: Crossing fibers

- Second-order nociceptive and thermal fibers cross near the central canal.
- The crossing occurs in the anterior white commissure before ascent contralaterally.
- A central expanding lesion can interrupt decussation on both sides.



Schematic cross-section

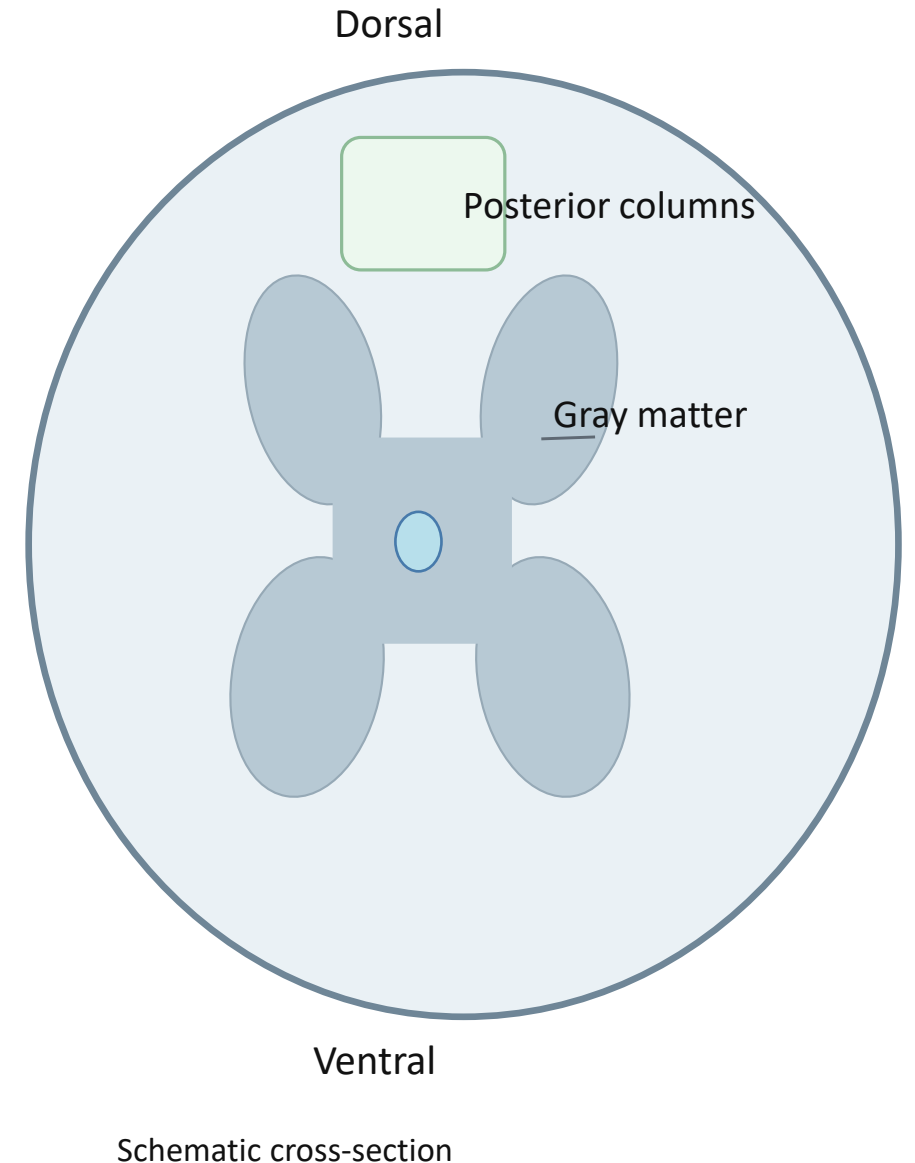
Pain and temperature: Circuit logic



- Primary afferents enter the spinal cord and synapse in dorsal-horn circuitry.
- Second-order fibers cross toward the opposite anterolateral system.
- A commissural lesion preferentially impairs segmental pain and temperature perception.

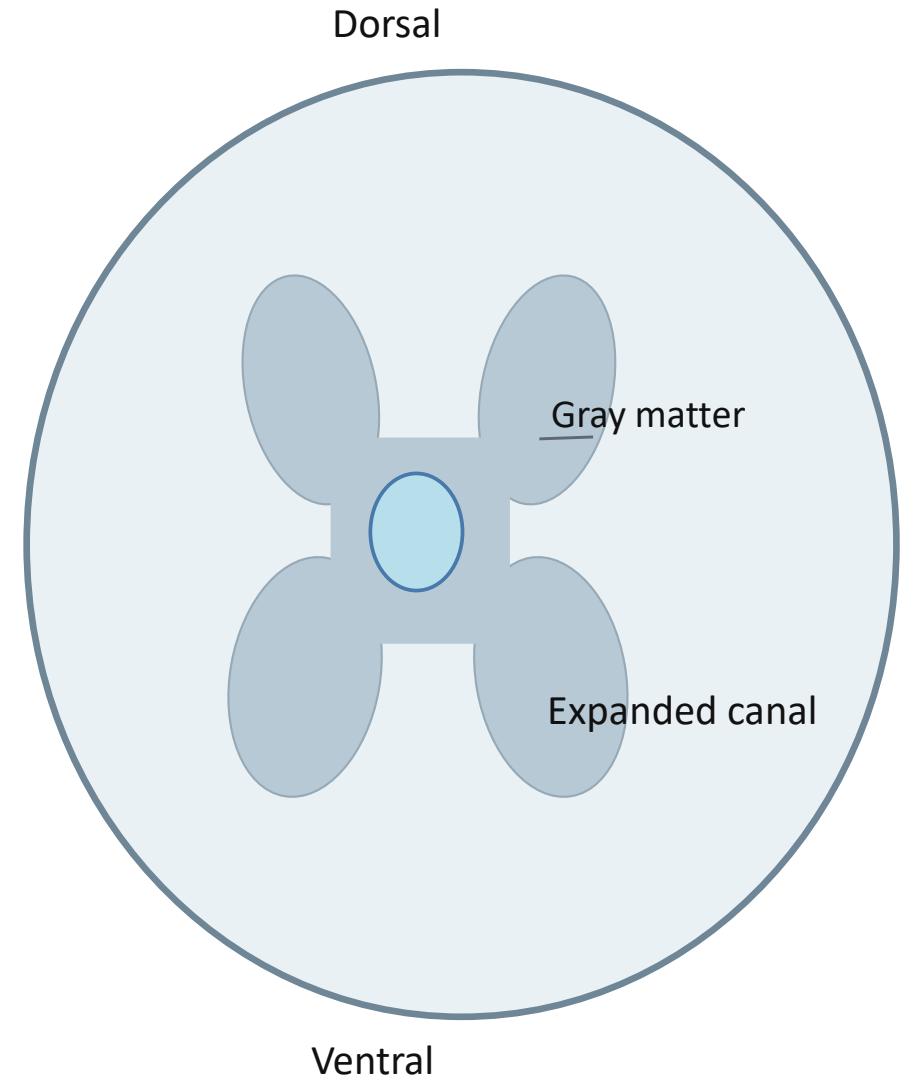
Posterior-column function offers a contrast

- Vibration and joint position largely ascend in posterior columns.
- Posterior columns are anatomically separated from the anterior commissural crossing.
- Their relative preservation helps explain dissociated sensory loss in an early central lesion.



Hydromyelia: Expansion of a canal

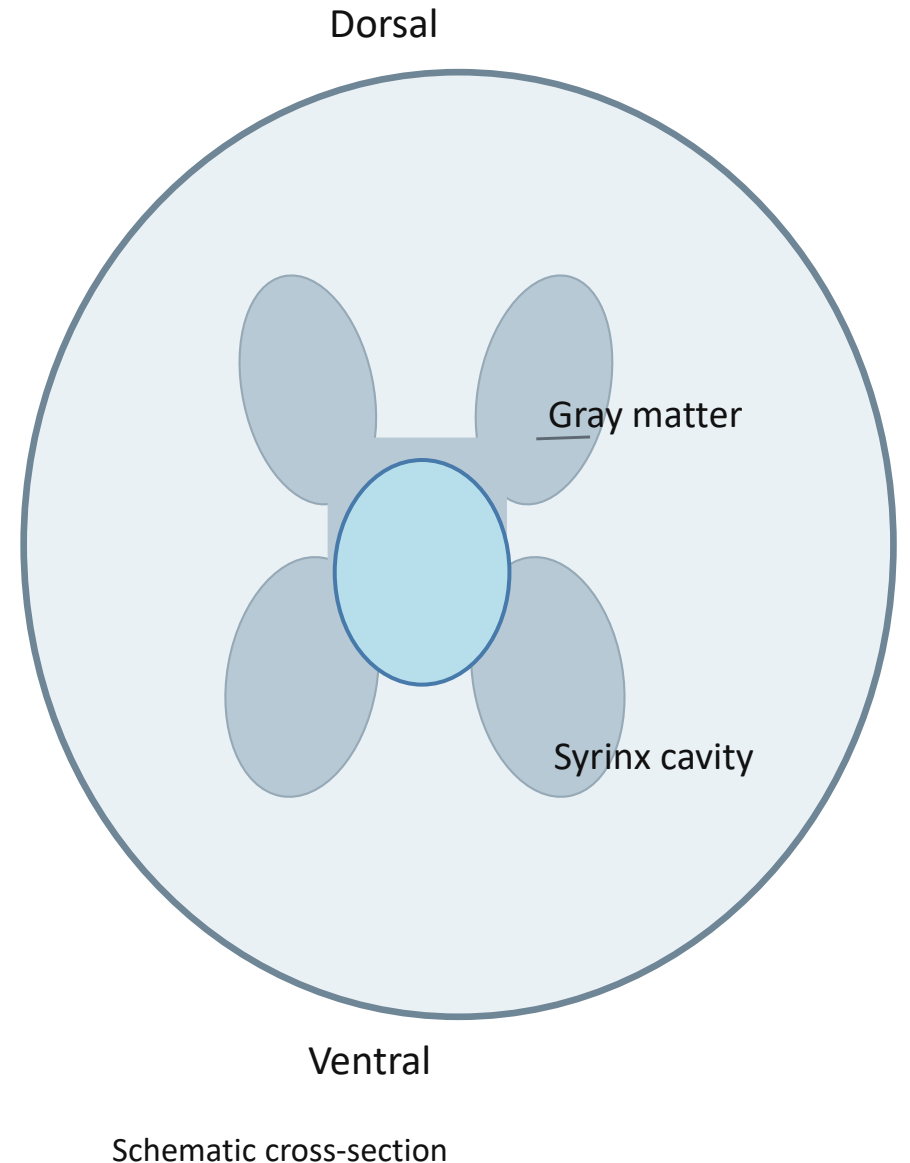
- The definition requires enlargement of the ependyma-lined central canal.
- Its shape follows the original central-canal compartment rather than a free intraparenchymal cleft.
- Clinical consequences depend on whether expansion damages surrounding neural tissue.



Schematic cross-section

Syringomyelia: A cavitory cord lesion

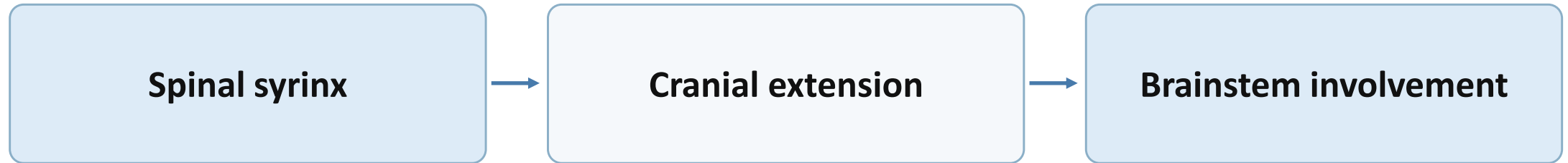
- A syrinx is a fluid-containing cleft or cavity in the inner cord.
- The cavity may disrupt both central gray matter and neighboring white matter.
- Its anatomical extent determines which pathways and segments are affected.



Hydromyelia versus syringomyelia: Core distinctions

Dimension	Hydromyelia	Syringomyelia
Principal space	Central-canal lumen	Inner spinal cord cavity
Key tissue relation	Expanded ependymal lining	Parenchymal cleft
Possible overlap	Both may coexist within a complex lesion	Both may coexist within a complex lesion

Syringobulbia: Extension beyond the cord

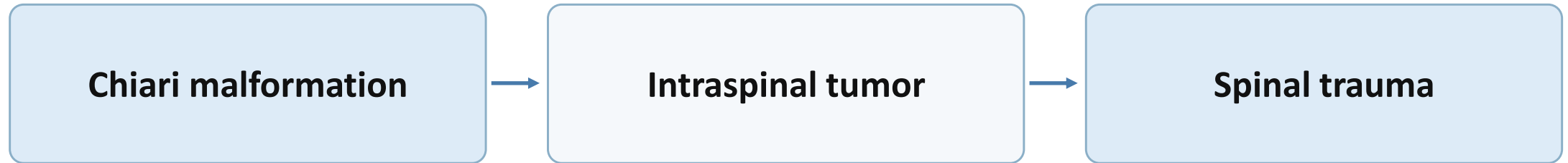


- A spinal syrinx can extend cranially into the brainstem.
- The name syringobulbia indicates brainstem involvement.
- New bulbar findings require anatomical reassessment rather than attributing all deficits to a cervical cord lesion.

Cavity shape is a diagnostic clue—not a mechanism

Question	Morphologic answer	Etiologic question
Where?	Central canal or cord parenchyma	What altered CSF dynamics?
How far?	Segmental / longitudinal extent	What associated condition exists?
What damage?	Gray / white matter injury	What process caused it?

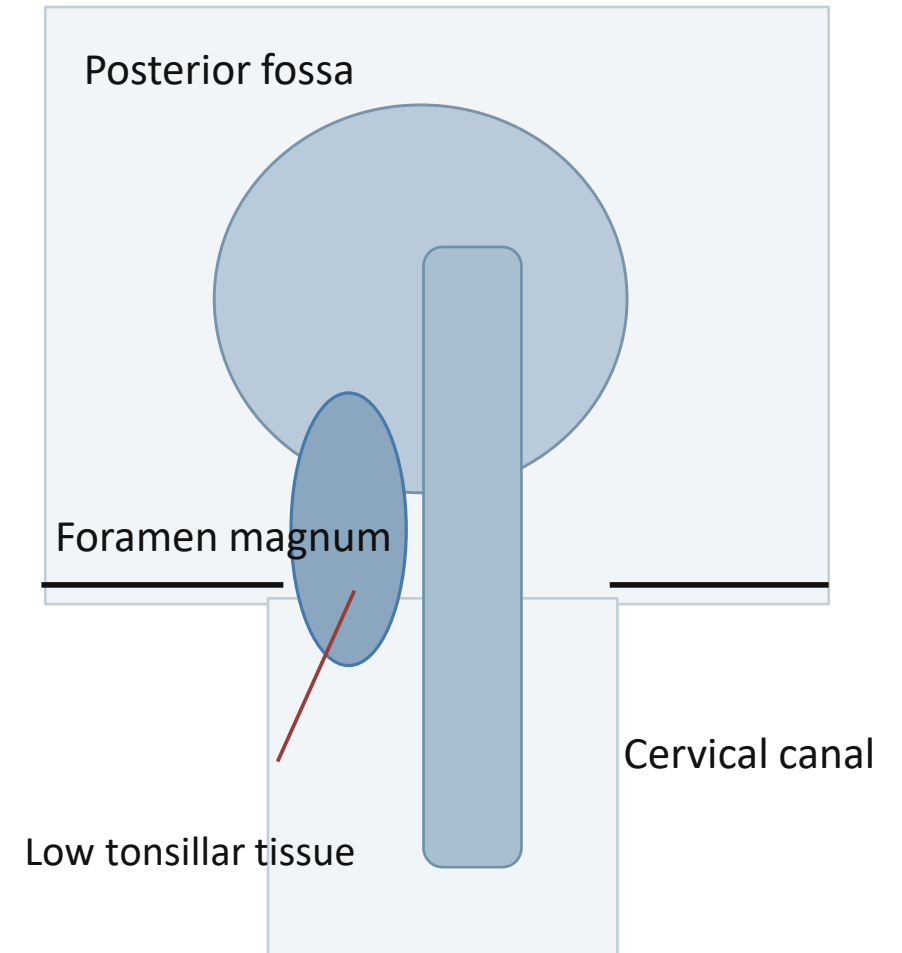
Three major associations



- Chiari malformation links hindbrain position to spinal CSF-flow disturbance.
- Intraspinal tumors may coexist with a syrinx.
- Syringomyelia can also occur following traumatic spinal injury.

Chiari I: Low-lying cerebellar tonsils

- Cerebellar tonsils extend downward through the foramen magnum region.
- The anomaly may be clinically silent.
- Symptoms may result from impaired CSF flow, medullary compression, or associated hydromyelia/syringomyelia.



Foramen magnum: A CSF-flow bottleneck



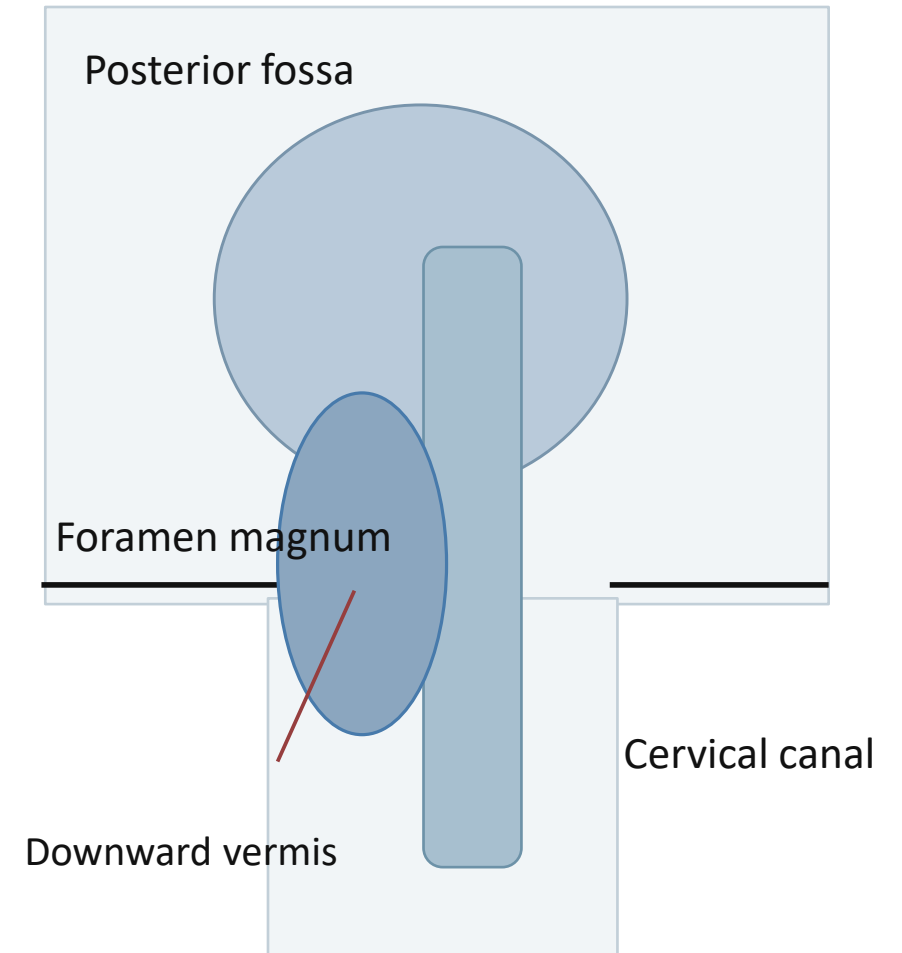
- CSF normally moves between cranial and spinal subarachnoid spaces.
- Low-lying tonsillar tissue may narrow the available pathway.
- Altered flow and pressure transmission are implicated in formation or enlargement of an associated syrinx.

Chiari I and the syrinx are related—not identical

Structure	Chiari I	Syrinx
Site	Craniovertebral junction	Spinal cord
Defining feature	Low tonsils	Intramedullary cavity
Study question	Foramen magnum anatomy	Cavity location and extent

Chiari II: A broader developmental malformation

- The posterior fossa is small, with a misshapen midline cerebellum.
- The vermis extends below the foramen magnum; Medullary displacement may also occur.
- Hydromyelia/syringomyelia is one possible associated change.



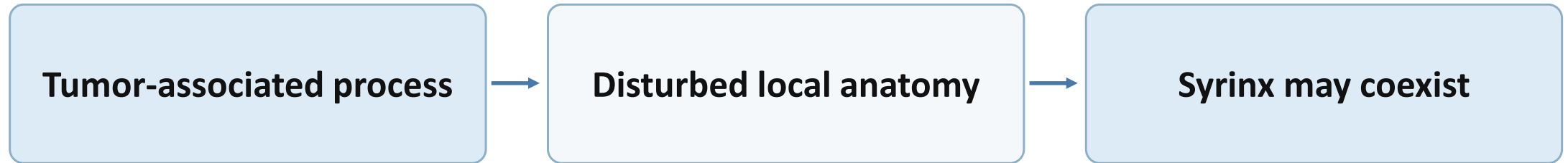
Chiari II: Linked anomalies matter

Anatomic compartment	Associated finding
Posterior fossa	Small, misshapen cerebellum
Ventricular system	Hydrocephalus $\pm$ aqueductal stenosis
Spine	Lumbar myelomeningocele; sometimes a syrinx

Chiari I versus II: Prevent category errors

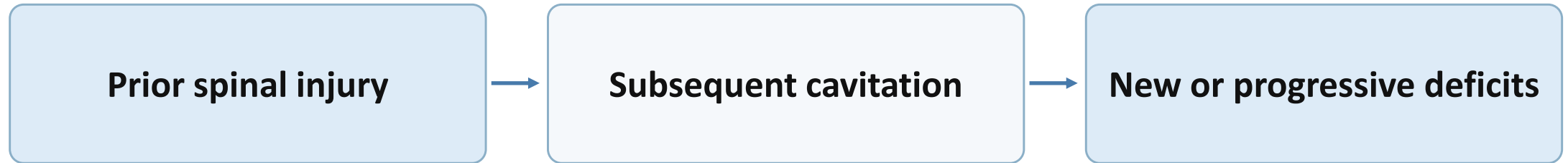
Comparison	Chiari I	Chiari II
Posterior fossa	Low cerebellar tonsils	Small; distorted midline cerebellum
Key associations	CSF obstruction / syrinx	Hydrocephalus; myelomeningocele
Cavitation	Possible	Possible

Intraspinal tumors: Examine the whole cord



- An intraspinal tumor as an association of syringomyelia.
- A cavity must not distract from a coexisting mass or abnormal tissue enhancement.
- MRI assessment should describe both the intramedullary fluid cavity and the possible underlying lesion.

Post-traumatic syringomyelia



- Spinal injury can precede syrinx formation.
- A delayed neurological deterioration in an injured segment deserves evaluation.
- Assessment must compare new symptoms with the patient's pre-existing neurological baseline.

Inflammation and arachnoid scarring



- NINDS includes meningitis and arachnoiditis among acquired associations.
- Scar-related CSF-flow obstruction is one plausible pathway to cavitation.
- These acquired causes are additional clinical context, not specified in the short Robbins excerpt.

Idiopathic syringomyelia requires careful labeling

Label	What it means	What it does not mean
Idiopathic	No known cause identified	Proof of a unique mechanism
Post-traumatic	History supports acquired association	Every deficit is due to syrinx
Chiari-related	Coexisting relevant malformation	A fixed symptom pattern

Pathogenesis: A mechanistic model



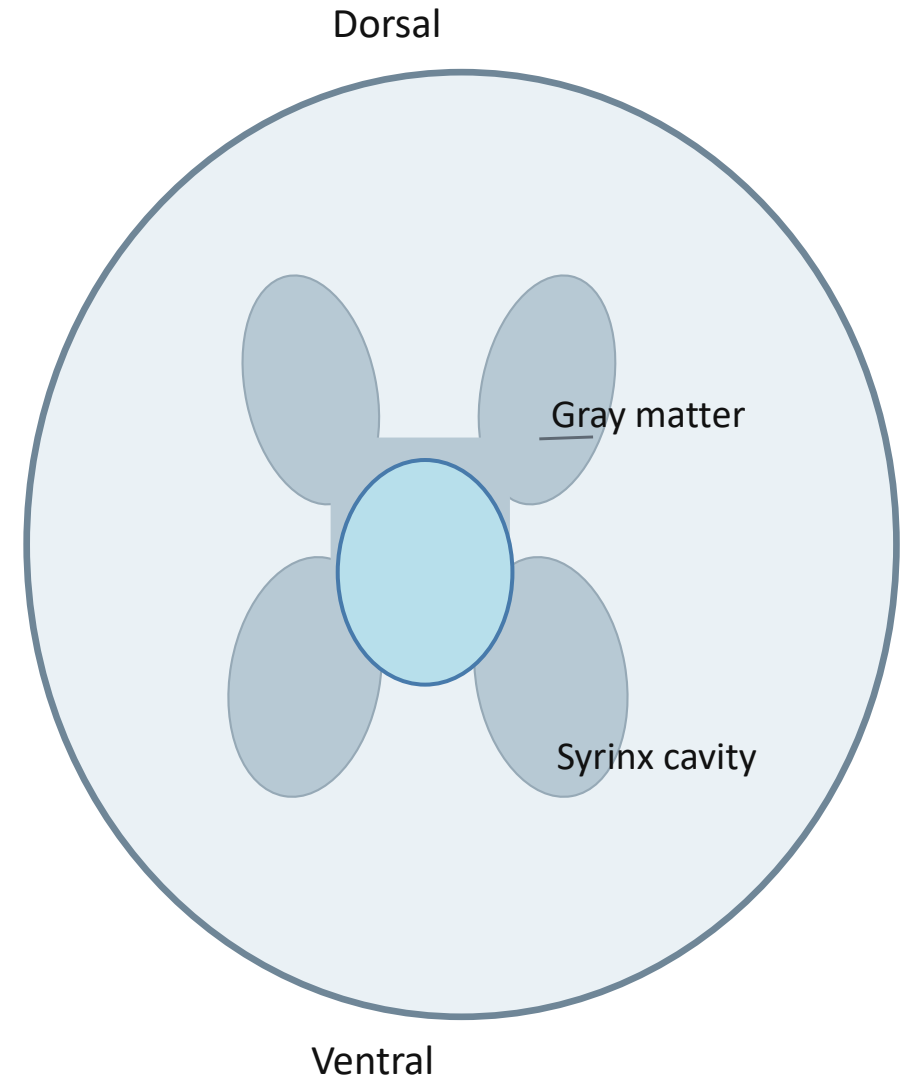
- Disturbance in normal CSF flow is implicated in several forms of syringomyelia.
- Abnormal pressure transmission may contribute to intramedullary fluid accumulation.
- No single fluid-dynamics model explains every case; Mechanisms remain debated.

Mechanism should not be confused with proof

Established observation	Interpretation requiring caution
Syrinx coexists with Chiari	Exact fluid transport pathway
Syrinx may follow trauma	Uniform mechanism in every patient
Flow can be abnormal	Same intervention for every cavity

Morphology: Cavitation damages the cord

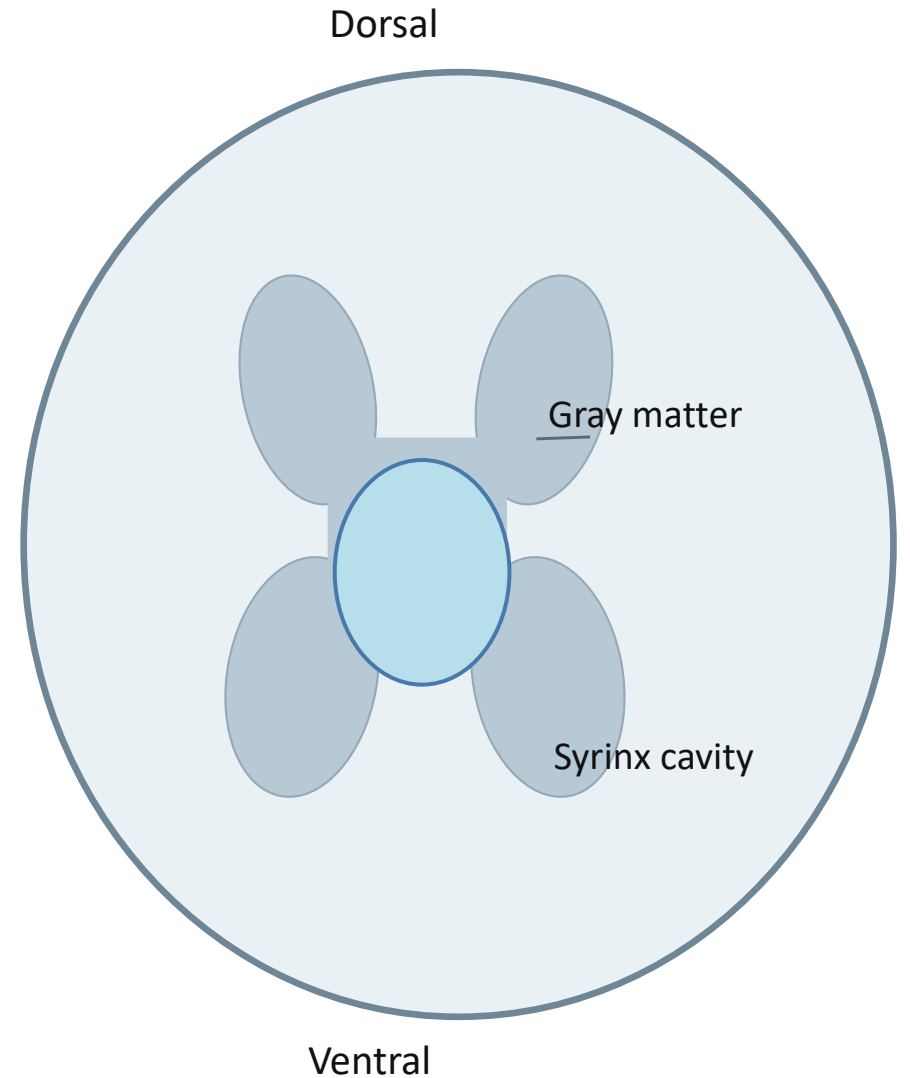
- Expansion produces a space where functional neural tissue has been displaced or destroyed.
- Both gray and white matter may be involved around a syrinx.
- Cavity size alone is not a substitute for assessing tissue injury.



Schematic cross-section

Gray matter injury: Local segmental effects

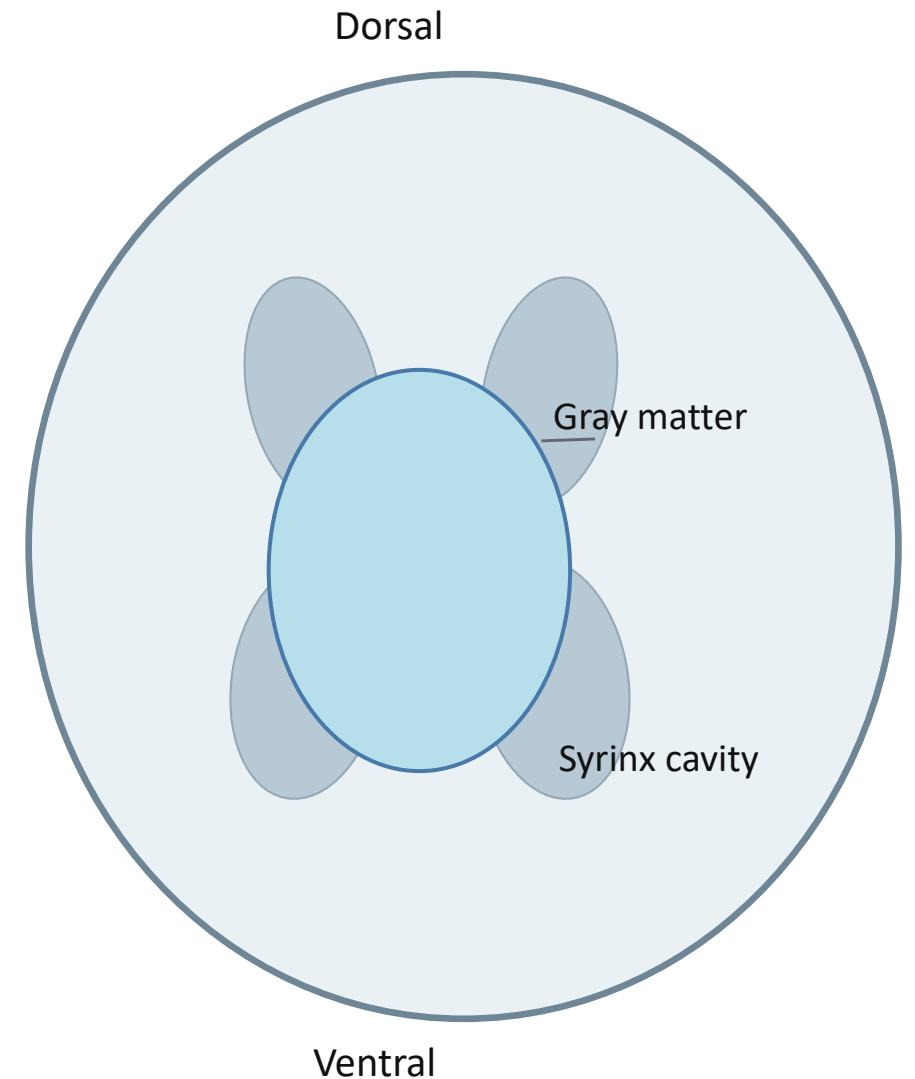
- Central gray matter is anatomically close to the canal and commissural region.
- Its disruption can produce segmental neurological deficits.
- Anterior-horn injury, when present, may cause lower motor-neuron weakness at affected levels.



Schematic cross-section

White matter injury: Tract involvement

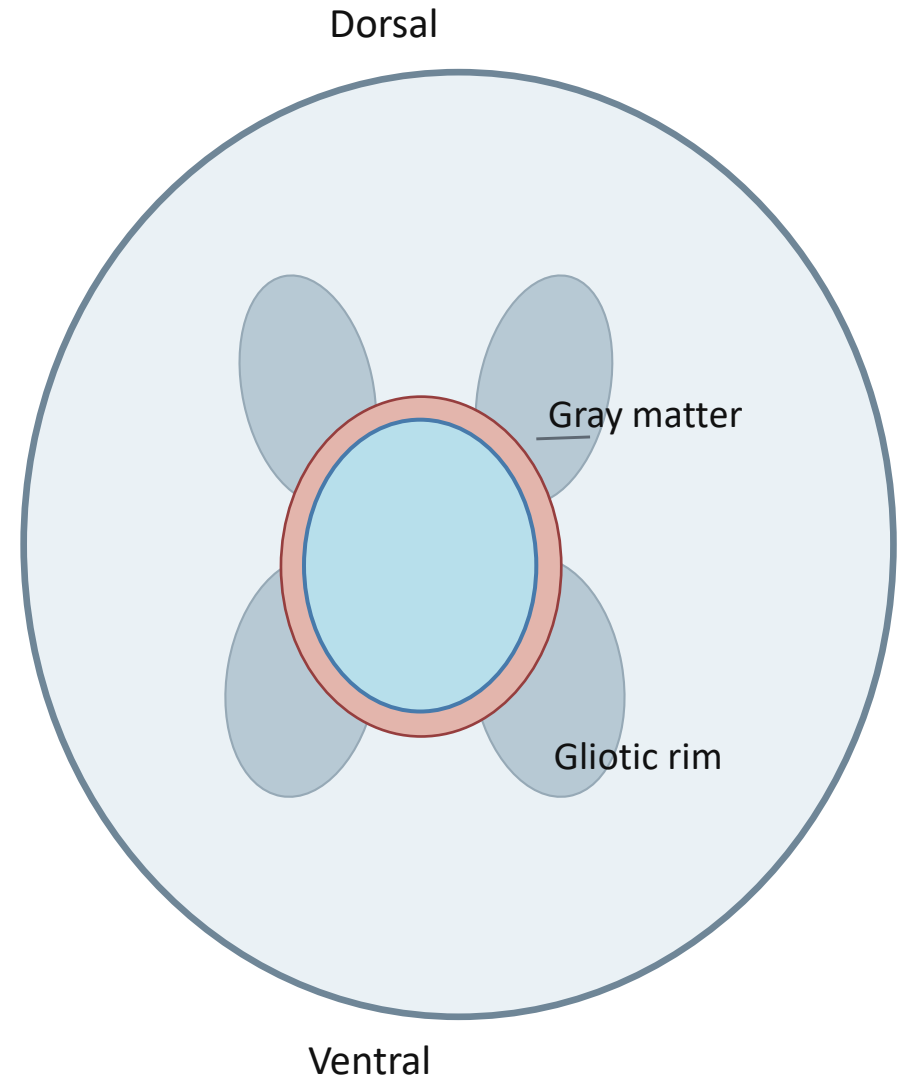
- Longitudinal tracts surround central gray matter.
- Extension of a cavity into white matter can disrupt ascending or descending pathways.
- Examination may become more complex as tract damage spreads beyond the initial commissural region.



Schematic cross-section

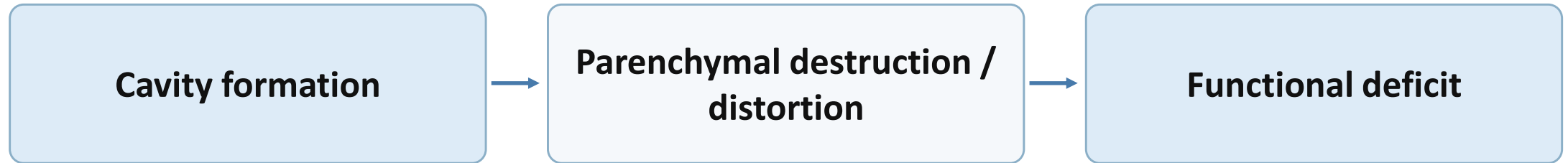
Dense reactive gliosis surrounds the lesion

- Destruction bordered by dense reactive gliosis.
- Gliosis is the CNS cellular response to chronic tissue injury.
- This microscopic reaction occurs across the listed associated conditions and is not etiologically specific.



Schematic cross-section

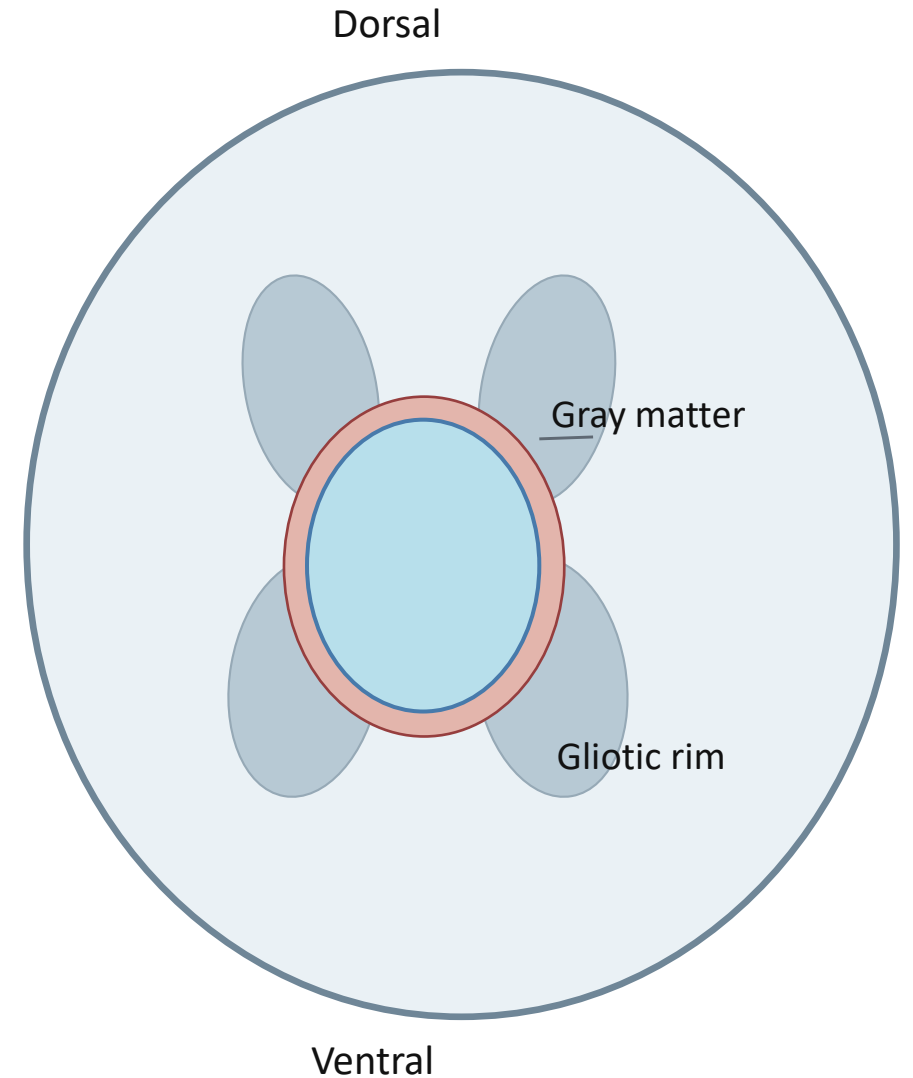
A lesion can destroy and compress simultaneously



- A cavity removes parenchymal continuity at its center.
- Adjacent viable axons may be compressed or distorted as it enlarges.
- The pattern of dysfunction reflects which fibers are injured, not simply the presence of fluid.

Histologic interpretation: What is supportable?

- Expect cavitation and adjacent gray/white matter damage.
- Dense reactive gliosis is the documented rim response.
- The supplied source does not provide a stained photomicrograph; The adjacent diagram is explanatory, not histologic evidence.



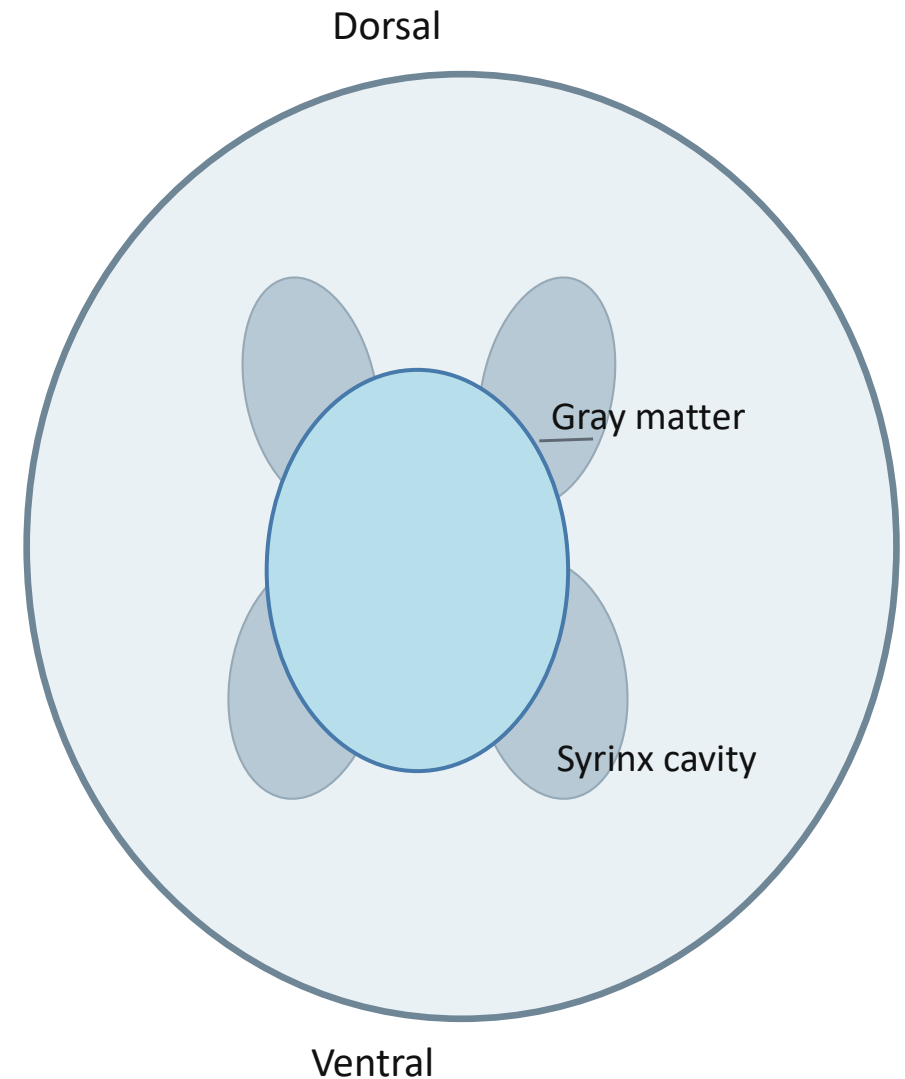
Schematic cross-section

Morphology does not pinpoint the cause

Microscopy / morphology	Necessary clinical context
Fluid cavity	Cord and hindbrain imaging
Neural tissue loss	Segmental neurologic findings
Reactive gliosis	Tumor, trauma, Chiari, inflammation history

Cross-section: Cavity location changes injury

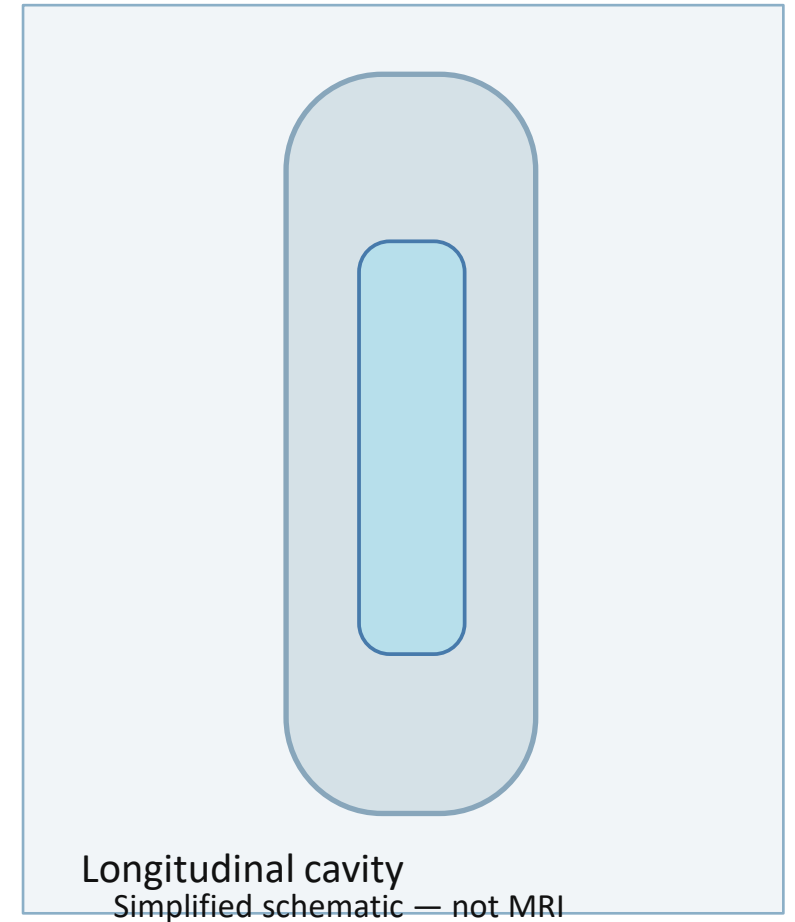
- A small central lesion first threatens short crossing fibers.
- A larger cavity can reach anterior horns and adjacent long tracts.
- No precise symptom threshold can be inferred from a schematic cavity diameter.



Schematic cross-section

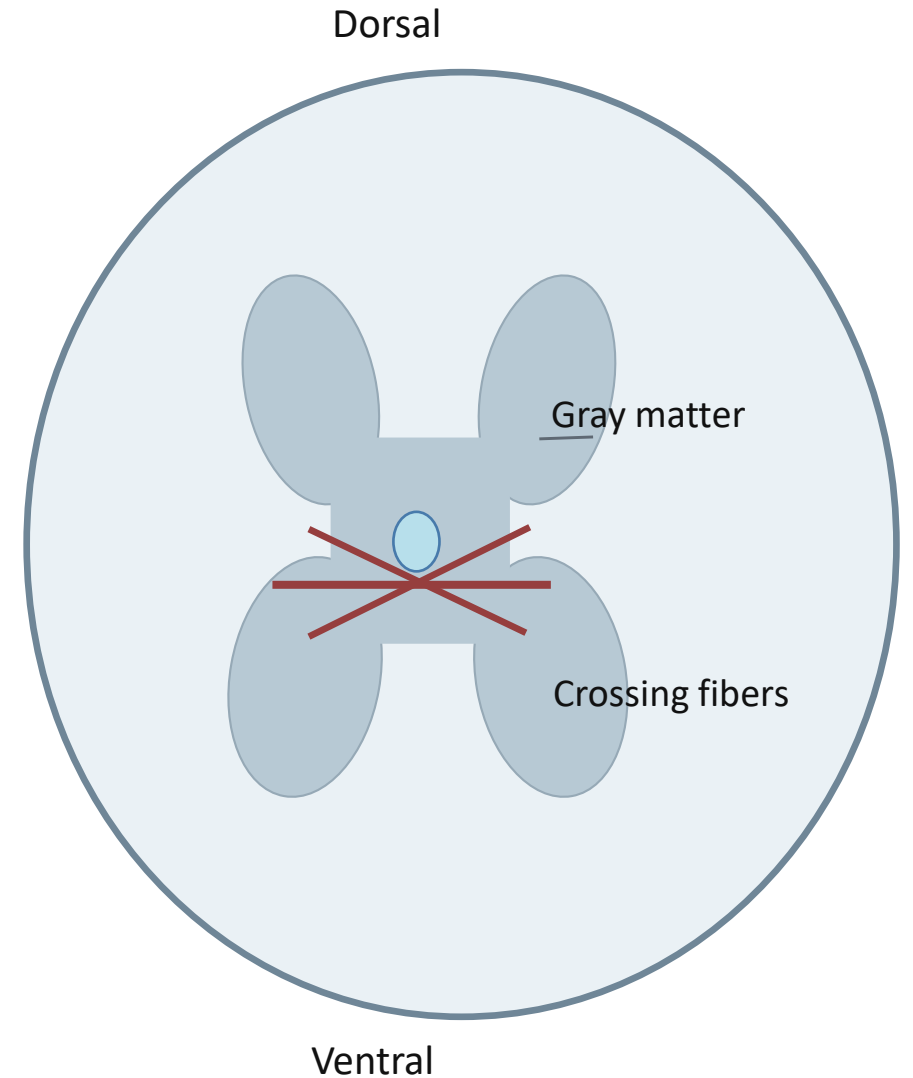
Longitudinal extent matters independently

- Spinal cavities may extend across multiple vertebral levels.
- A longer lesion potentially involves additional segmental sensory and motor structures.
- Sagittal MRI helps determine the craniocaudal extent; Axial images show local compartment involvement.



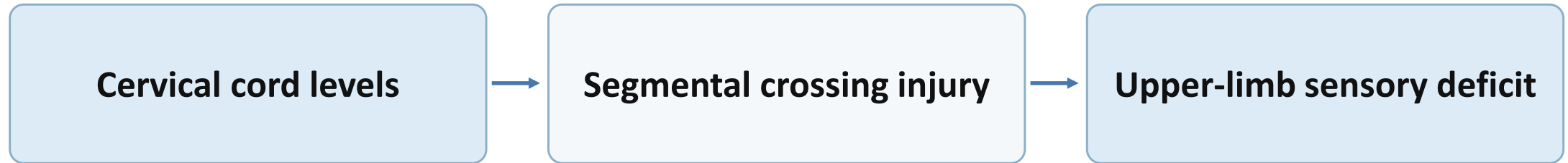
Why pain and temperature are affected first

- The anterior white commissure is close to the central canal.
- Decussating nociceptive and thermal fibers traverse this central vulnerable zone.
- Bilateral injury to crossing fibers creates a characteristic segmental sensory pattern.



Schematic cross-section

Segmental rather than whole-body loss



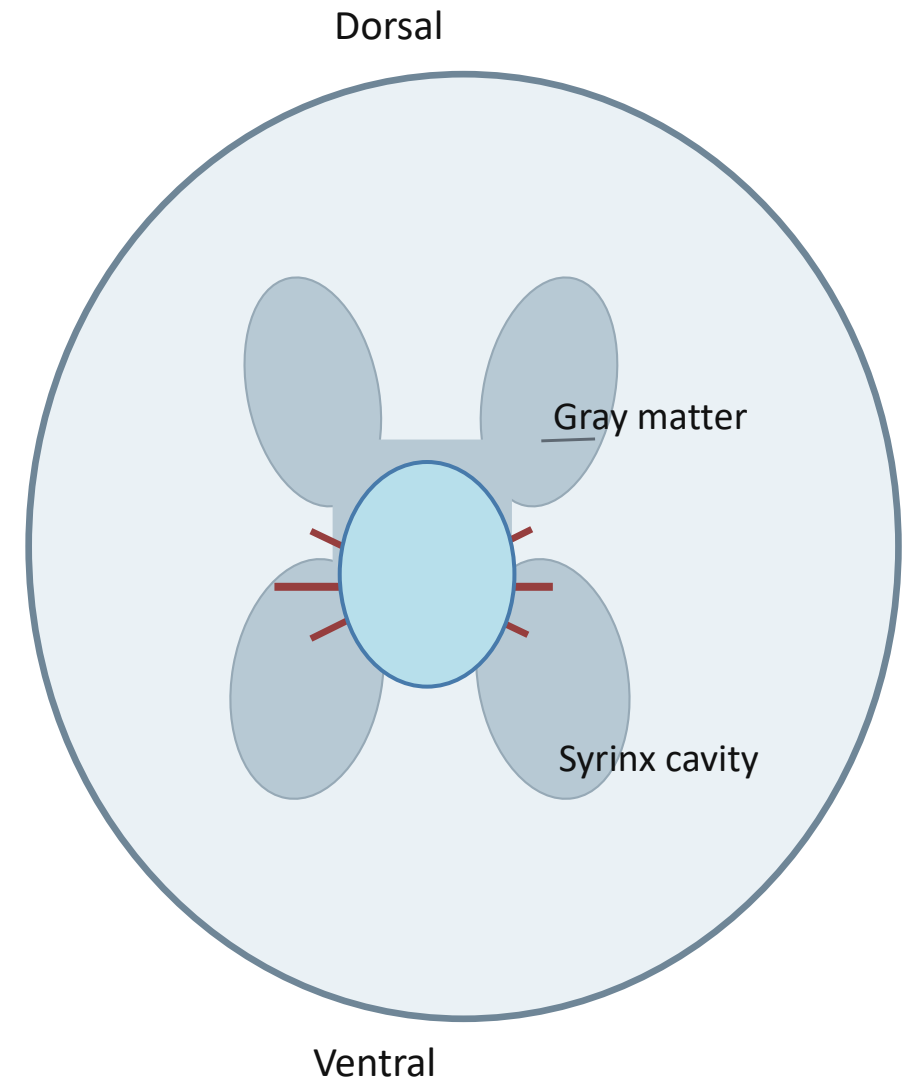
- Crossing fibers correspond to particular spinal levels.
- A syrinx may interrupt pain/temperature pathways at those involved levels.
- The deficit should be mapped by dermatome rather than assumed to include every segment below the lesion.

Dissociated sensory loss: Modality matters

Sensory modality	Early central lesion: expected pattern
Pinprick / thermal	Impaired at involved segments
Vibration / position	Often relatively preserved
Light touch	May be variably preserved; examine directly

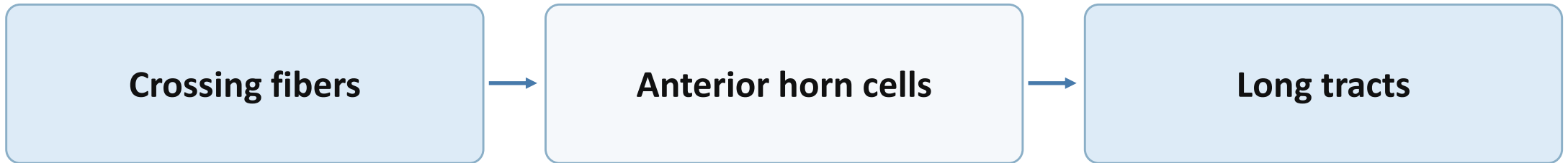
Cape-like involvement: Useful but not universal

- Cervical syringomyelia can produce sensory loss across shoulders and upper limbs.
- A cape-like distribution is a classic pattern of central cord segment involvement.
- Other cavity locations or extents create different sensory maps; Avoid requiring the classic pattern.



Schematic cross-section

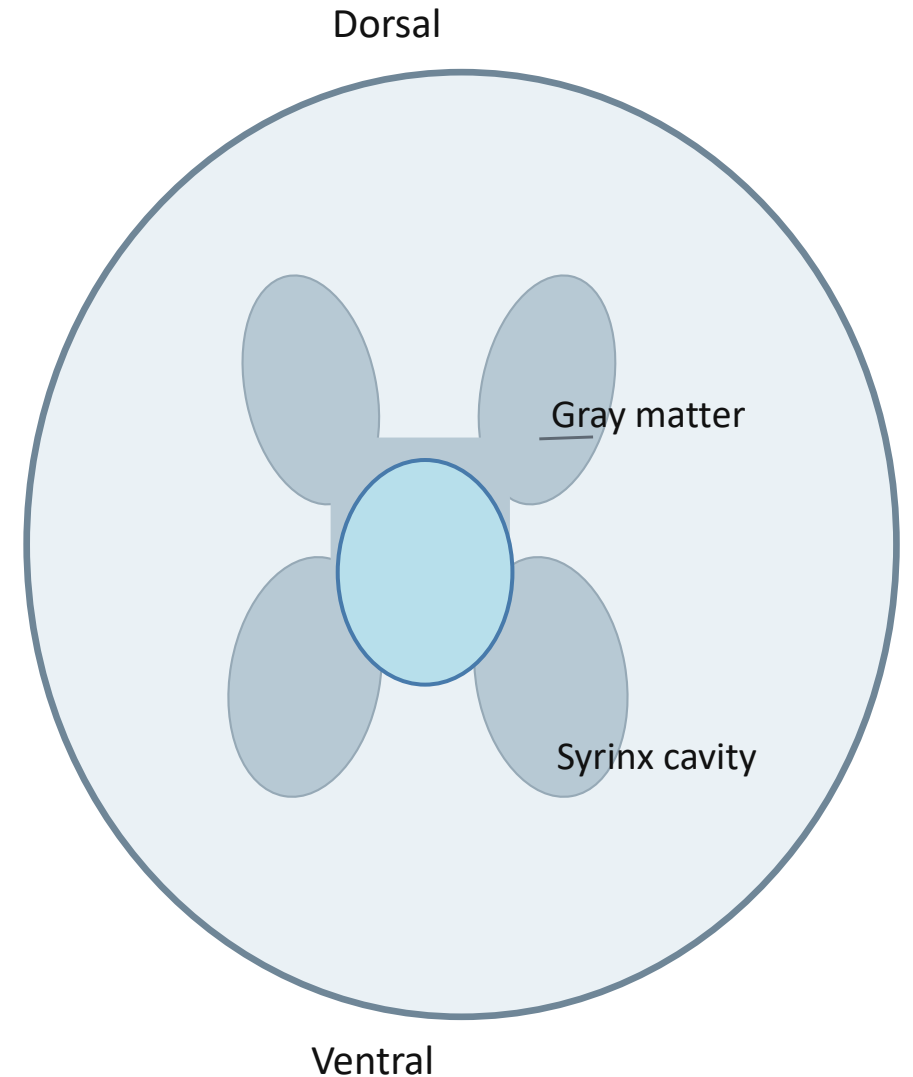
Clinical deficits follow anatomical spread



- Commissural fibers: Pain and temperature impairment.
- Anterior horn: Weakness, wasting, and segmental lower motor-neuron signs.
- Long tracts: Additional sensory or motor dysfunction as the cavity extends.

Anterior-horn involvement and the hand

- At affected cervical enlargements, anterior-horn damage can impair upper-limb motor units.
- Weakness and muscle atrophy reflect motor-neuron injury rather than loss of sensation alone.
- Strength, atrophy, reflexes, and sensory modalities should be documented separately.

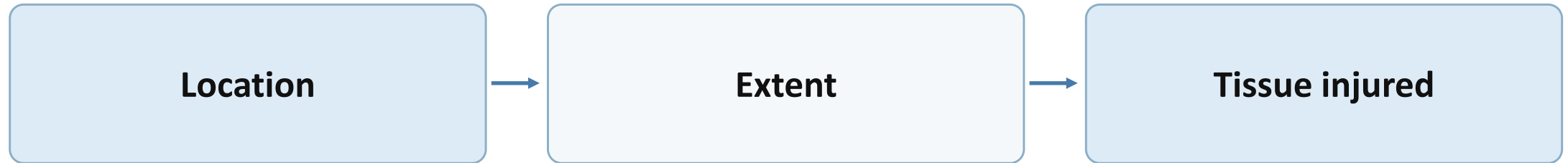


Schematic cross-section

Later motor findings require tract localization

Affected structure	Examination emphasis
Anterior horn	Atrophy, segmental weakness, reduced reflexes
Corticospinal tract	Long-tract motor signs below involved levels
Commissural fibers	Pain and temperature loss at involved segments

Clinical presentation can be heterogeneous

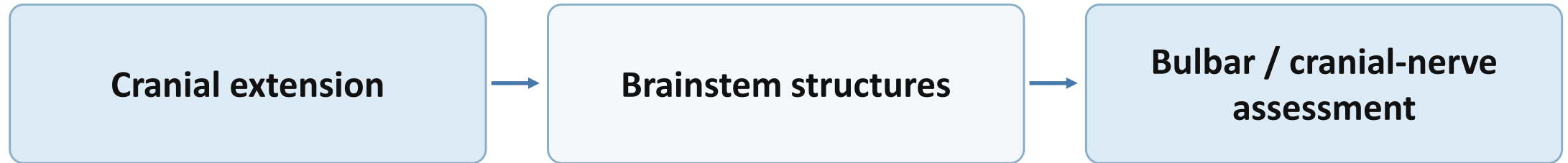


- Symptoms may include pain, abnormal sensation, stiffness, or weakness.
- Distribution and progression depend on the syrinx location, size, and extent.
- Absence of the textbook sensory pattern does not exclude a cavity.

Age at presentation is a pattern, not a rule

Teaching point	Clinical qualification
Classic onset	Second or third decade in Robbins
Acquired syrinx	May appear later following an insult
Interpretation	Age supports context, not diagnosis

Bulbar extension changes the examination

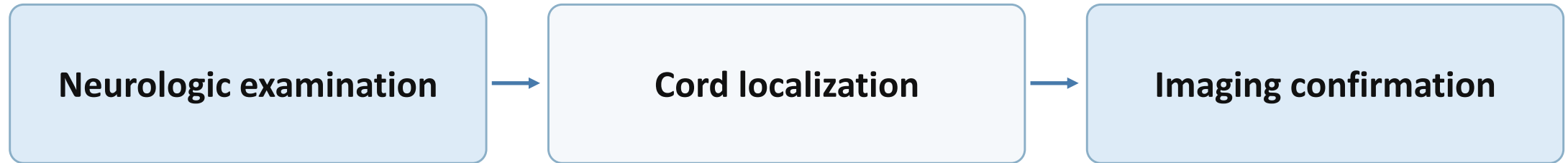


- Syringobulbia denotes extension into the brainstem.
- Cranial nerve and bulbar functional findings warrant attention when brainstem extension is suspected.
- Image the relevant region rather than assuming every deficit is confined to the spinal cord.

Bedside examination: Use multiple modalities

Assessment domain	Anatomic question
Pain / thermal	Crossing anterolateral fibers?
Vibration / position	Posterior columns spared?
Strength / reflexes	Gray matter or motor tract injury?

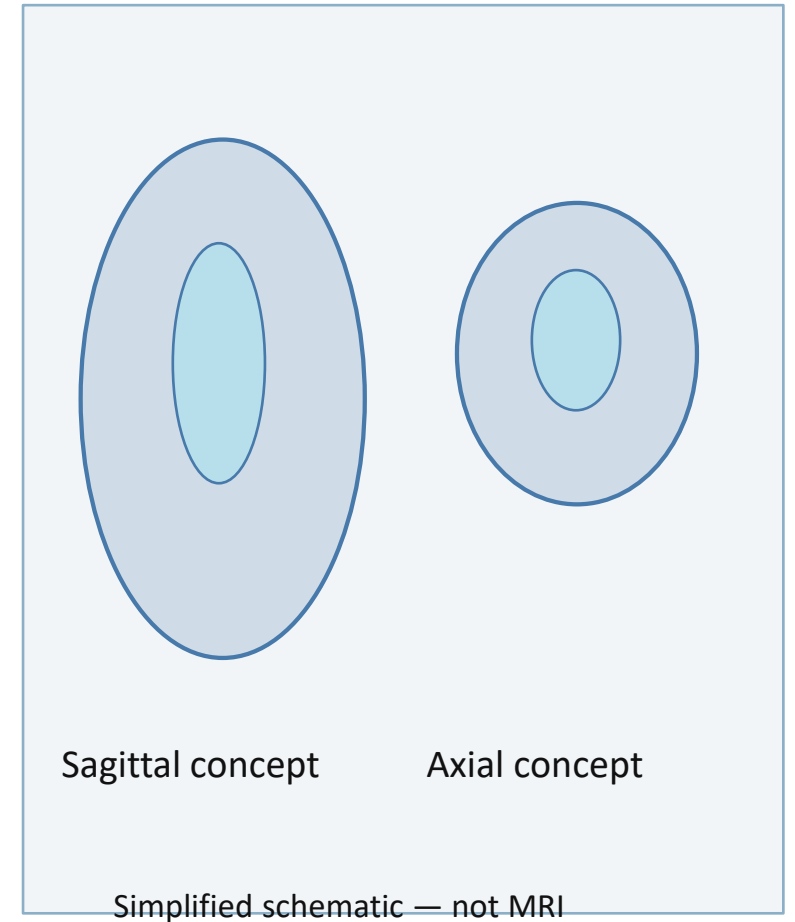
Clinical localization precedes imaging interpretation



- A bilateral segmental dissociated deficit points toward central cord structures.
- Motor and cranial-nerve signs refine the suspected level and extent.
- Localization should guide—but not substitute for—appropriate MRI review.

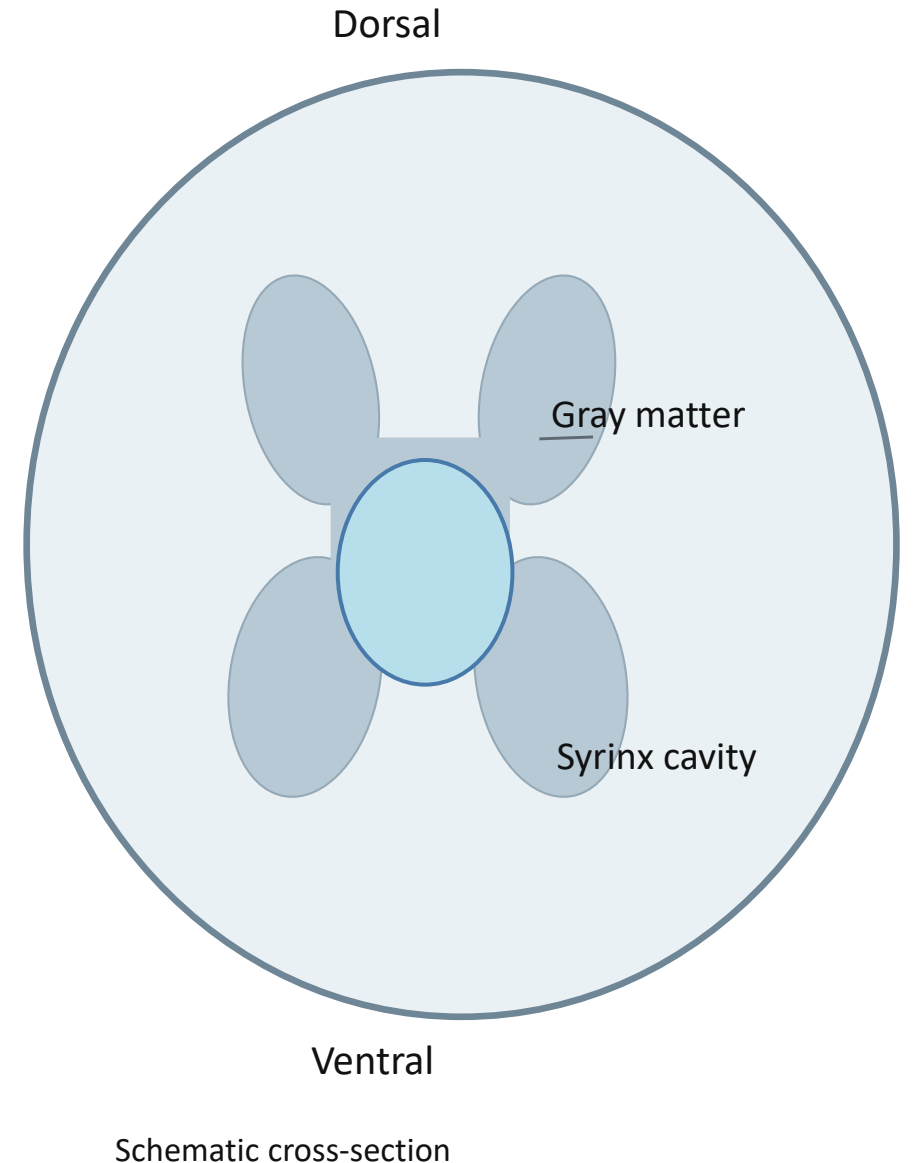
MRI: The main test for detecting a syrinx

- MRI visualizes a fluid-filled cavity within spinal cord parenchyma.
- Axial images define relationships to the central canal and gray/white matter.
- Sagittal images demonstrate the length of the cavity and possible cranial extension.



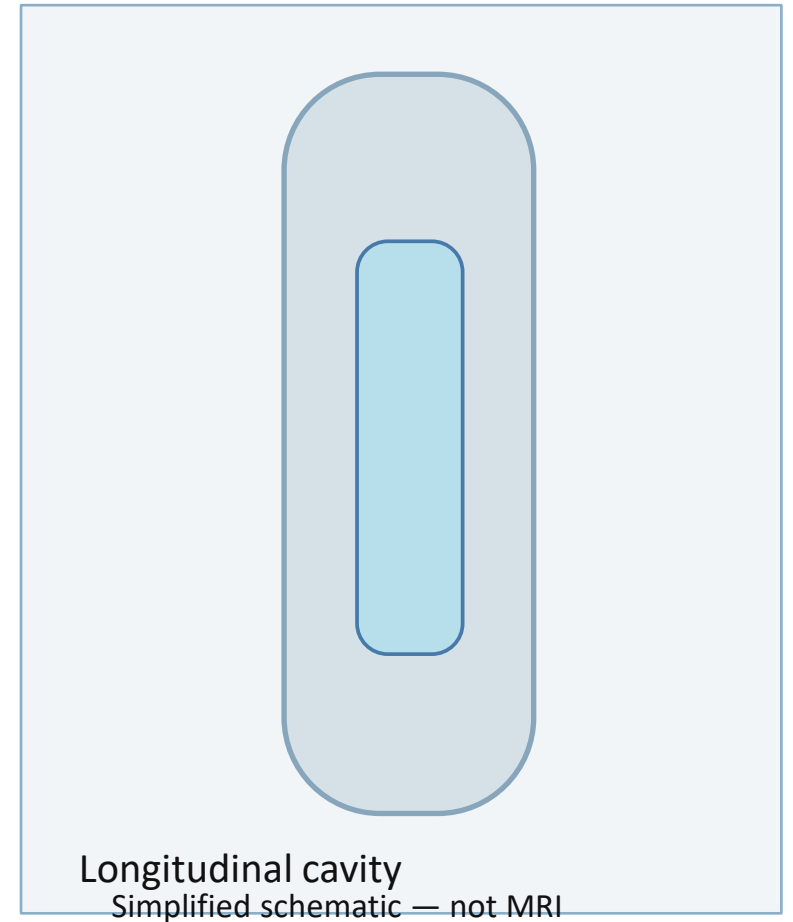
Axial MRI: Location is the first question

- Determine whether a fluid space is canal-centered or forms a larger intramedullary cleft.
- Describe cord expansion and remaining surrounding tissue.
- The adjacent drawing is a structural schematic, not a clinical MRI.

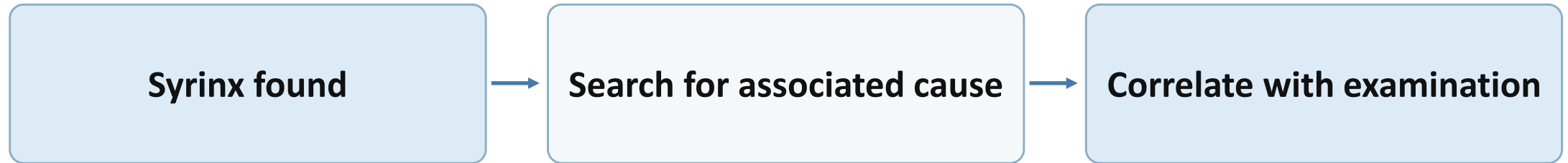


Sagittal MRI: Assess longitudinal extension

- Record the cranial and caudal limits of any visible cavity.
- Assess whether the cord and the cervicomedullary junction are involved.
- Relate the demonstrated extent to neurological levels examined at the bedside.



Imaging must search for an associated lesion



- Examine the craniocervical junction for Chiari-type abnormalities.
- Review the spinal cord for a tumor or other obstructive cause.
- Relevant history of injury, infection, or arachnoiditis shapes the differential.

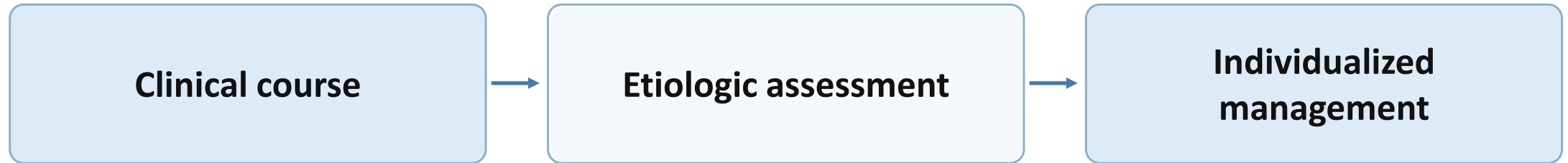
Contrast-enhanced MRI: Answer a specific question

Imaging question	Potential value
Is there a mass?	Assess solid or enhancing components
Is there inflammation?	Evaluate surrounding abnormalities
What is cavity extent?	Use multiplanar MRI anatomy

Diagnostic differential: Test competing explanations

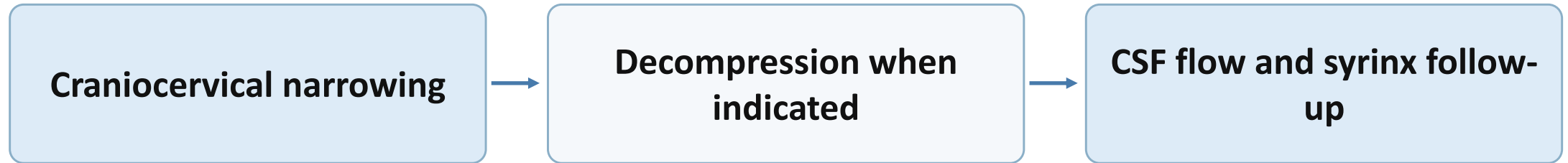
Possibility	Discriminator to investigate
Chiari-associated	Craniovertebral junction anatomy
Tumor-associated	Intramedullary mass / enhancement
Trauma-associated	Prior injury and interval change
Inflammation-associated	Meningeal history and imaging

Management depends on symptoms and cause



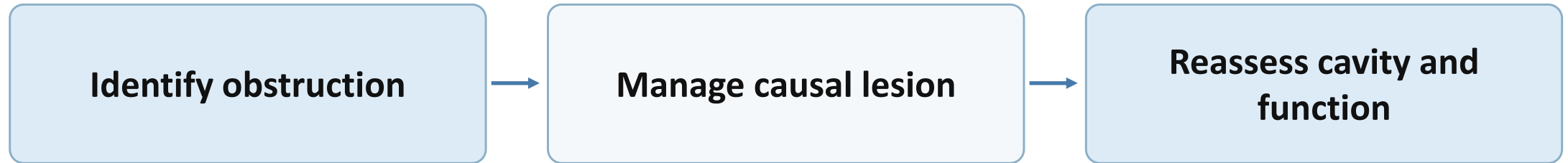
- An asymptomatic, stable cavity may be monitored clinically and radiologically.
- Progressive deficits or an enlarging symptomatic syrinx prompt specialist evaluation.
- Treating the associated cause may be more important than simply draining fluid.

Chiari-associated syrinx: Restore CSF passage



- Surgical management may create more room at the craniocervical junction.
- The aim is to improve CSF movement and reduce further cord injury.
- Anatomical decompression and symptoms need follow-up; Improvement is not guaranteed.

Tumor- or scar-associated cavities: Address cause



- Identify whether an associated mass or obstructive scar is treatable.
- Intervention must be individualized to the actual underlying process.
- Cavity drainage alone may not correct a persistent flow obstruction.

Shunting a syrinx is not a universal first step

Option	Conceptual role
Observation	Stable or asymptomatic lesions
Etiologic surgery	Correct CSF obstruction / associated lesion
Direct drainage	Selected cavities when indicated

Case: Sensory loss with low-lying tonsils

Apply the anatomy to the vignette

- A young adult has progressive loss of pinprick and temperature over the shoulders and hands.
- MRI demonstrates an intramedullary fluid cavity and low-lying cerebellar tonsils.
- Which two distinct anatomical abnormalities must the diagnosis report?

Case reasoning: Correlate two sites

Finding	Anatomic interpretation
Dissociated upper-limb sensory loss	Anterior commissural dysfunction
Intramedullary cavity	Syringomyelia
Low-lying tonsils	Associated Chiari I morphology

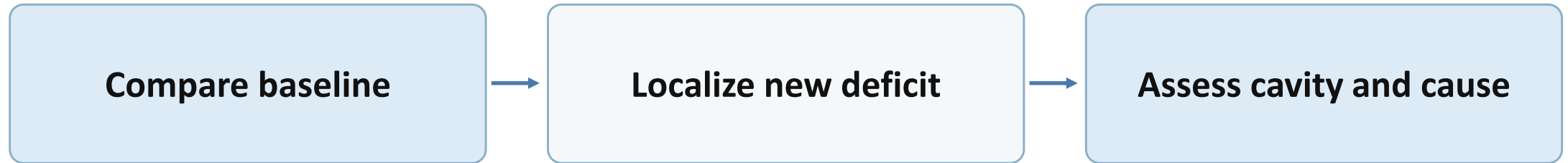
Case: A new deficit after remote trauma

Apply the anatomy to the vignette

- A person with a prior spinal cord injury develops a new level of sensory impairment years later.
- Imaging reveals a cavity at or near the injured cord region.
- The question is whether newly progressive cavitation is contributing to the clinical change.

Educational vignette; Fictional, not an observed patient.

Case reasoning: Avoid anchoring on old injury



- Record the pre-existing motor and sensory examination before attributing new abnormalities.
- Determine cavity extent and consider associated tethering or CSF-flow obstruction.
- Post-traumatic syringomyelia belongs in the evaluation of delayed neurological change.

Knowledge check: Identify the defining feature

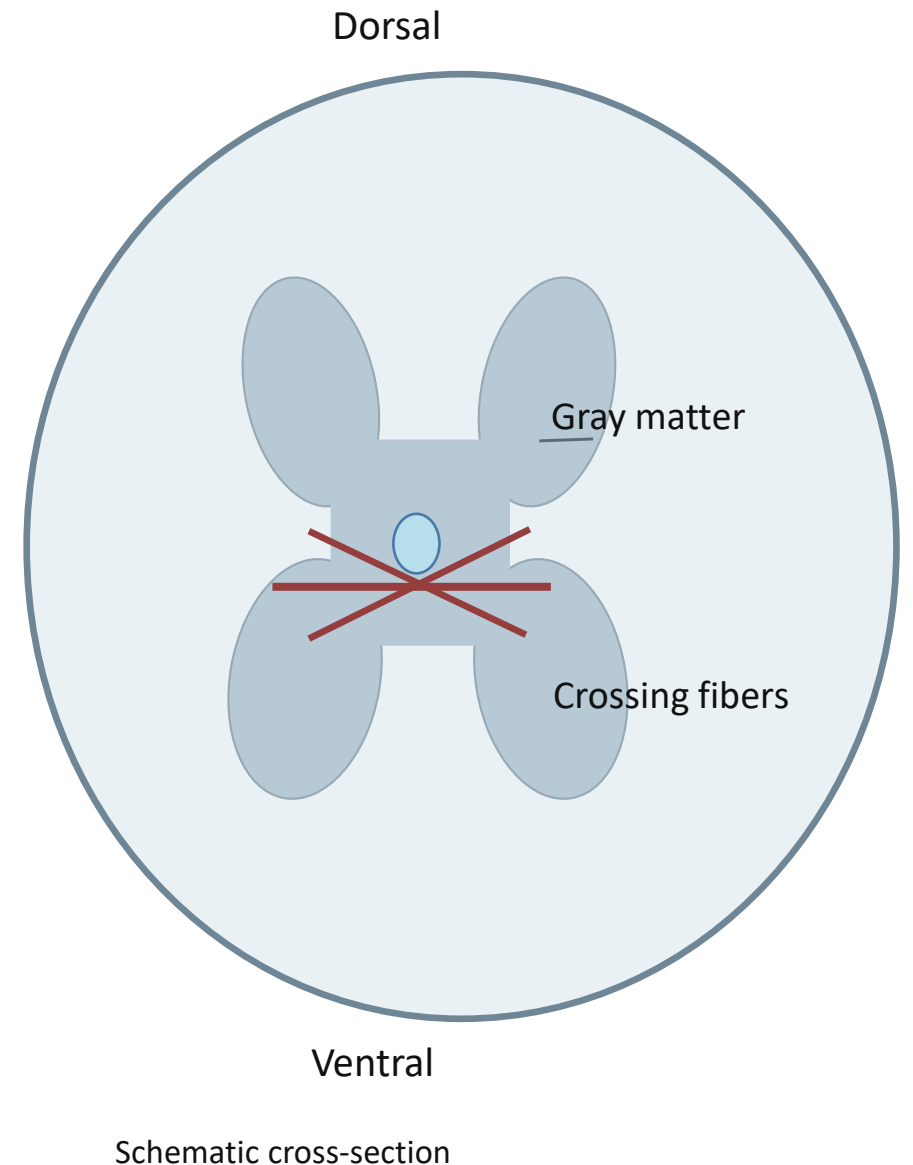
Apply the anatomy to the vignette

- Which observation uniquely supports hydromyelia rather than a generic central syrinx?
- A. Dense gliosis surrounding an intramedullary cavity
- B. Enlargement of an ependyma-lined central-canal lumen
- C. Loss of pain and temperature over the upper limbs

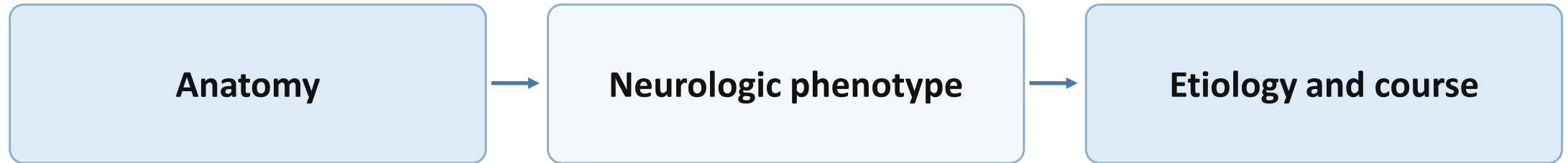
Correct answer: B. Both conditions can injure neural tissue; Lining and compartment establish the defining difference.

Knowledge check: Localize dissociated loss

- Pain and temperature are lost over selected upper-limb segments, whereas joint-position sense is retained.
- Which short crossing pathway lies near the central canal?
- Explain why sparing of posterior columns produces a modality dissociation.



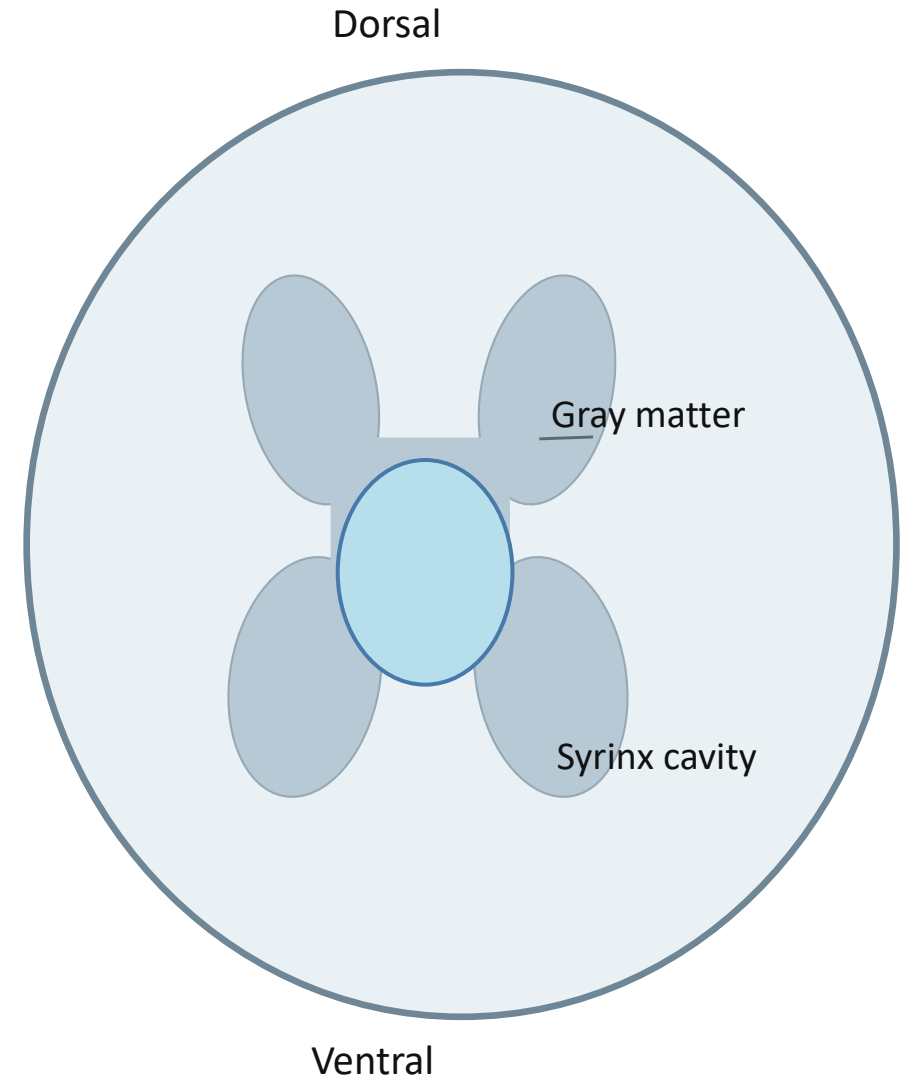
Integrated pathological reasoning



- Begin with cavity anatomy: Central canal or intramedullary cleft.
- Link tissue injury to local segmental fibers and adjacent long tracts.
- Investigate causes separately: Chiari, tumor, prior trauma, and other acquired conditions.

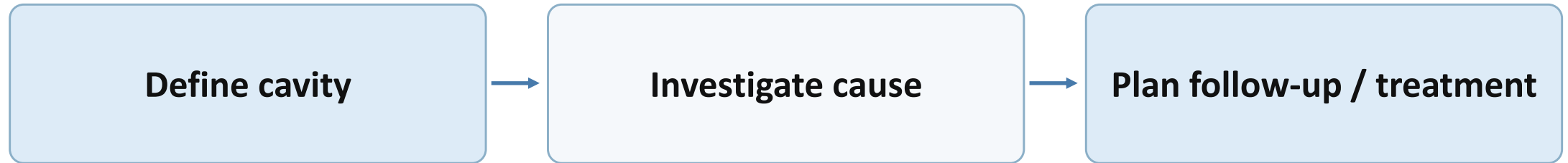
Final synthesis: Anatomy predicts the phenotype

- Hydromyelia is an expanded ependyma-lined canal; Syringomyelia is an inner-cord fluid cavity.
- Cavitation causes gray/white matter destruction with reactive gliosis.
- Anterior commissural injury explains selective segmental pain and temperature loss.



Schematic cross-section

Final synthesis: Morphology is not etiology



- A syrinx should trigger evaluation for Chiari malformation, tumor, trauma, and relevant acquired conditions.
- MRI defines cavity morphology and associated abnormalities.
- Treatment depends on symptoms, progression, and the underlying cause.

Selected references

- Robbins, Cotran & Kumar. Pathologic Basis of Disease. 11th ed. 2026. Chapter 28, p. 1135.
- NINDS. Syringomyelia. Current NIH clinical overview (accessed 12 October 2026).
- NCBI Bookshelf. Anterior White Commissure; Syringomyelia. Neuroanatomic and clinical context.
- Heiss JD. CSF Hydrodynamics in Chiari I Malformation and Syringomyelia. Neurosurg Clin N Am. 2023.