

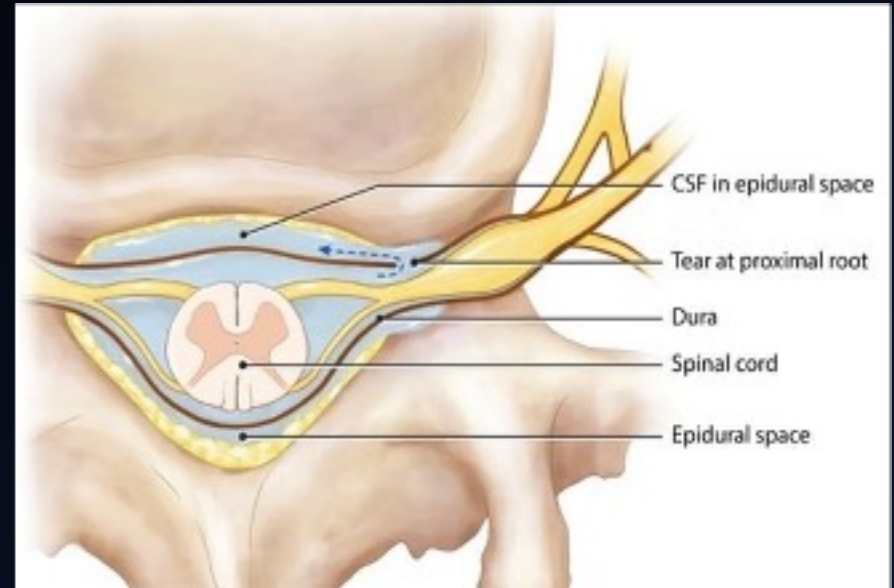
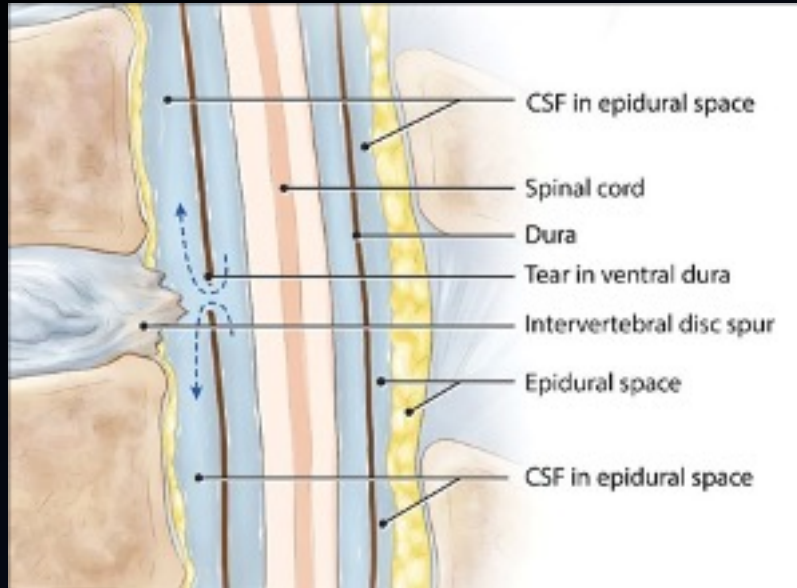
# Recognizing Traumatic Spinal Dural Tears: A Case Series

REA, BRITTANY MD; GIRGIS, MONIQUE BS;  
NOURELDINE MOHAMMAD HASSAN MD, MSC;  
GERMAIN, DAVID MD; ZAMORE, ROBERT MD  
UNIVERSITY OF SOUTH FLORIDA

# Background

- CSF leaks result from damage to the dura resulting in direct communication of the subarachnoid and extradural spaces.
- Radiology literature regarding diagnosis of spinal dural tear with CSF leak is limited despite being a well-established neurological entity.
- Although many CSF leaks occur idiopathically, trauma is a common cause.
- Prompt neurosurgical evaluation to determine need for intervention is critical; therefore, it is important for radiologists and trainees to be familiar with the imaging appearance of spinal dural tear to identify and communicate its presence.

# Anatomy of a Spinal Dural Tear



R.I. Farb, P.J. Nicholson, P.W. Peng, E.M. Massicotte, C. Lay, T. Krings and K.G. terBrugge. Spontaneous Intracranial Hypotension: A Systematic Imaging Approach for CSF Leak Localization and Management Based on MRI and Digital Subtraction Myelography. *American Journal of Neuroradiology* April 2019, 40 (4) 745-753; DOI: <https://doi.org/10.3174/ajnr.A6016>

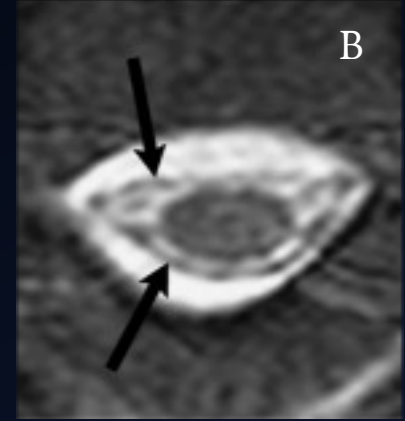
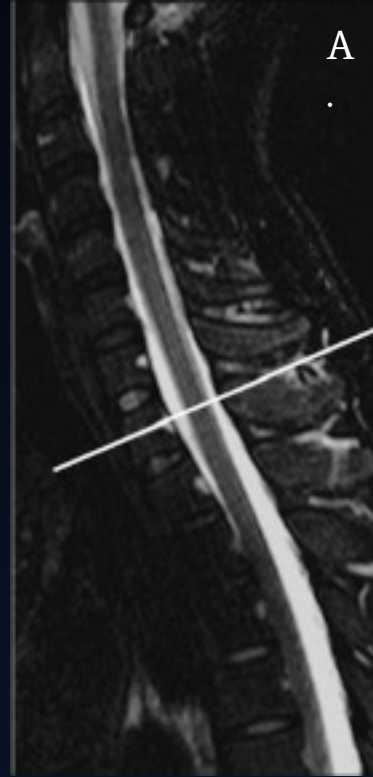
When a tear in the spinal dural lining occurs, CSF leaks into the epidural space where typically no CSF is otherwise present. This allows for the underlying tear to be suggested on imaging when epidural CSF is noted.

# Purpose/Our Cases

- We present three cases of spinal dural tears due to acute trauma, aiming to educate radiologists on the imaging appearance of spinal dural tears.
- Two of the previously established radiologic signs for spinal dural tears, the floating sac sign and the dinosaur tail sign, are well demonstrated in our cases.
- All three of our patients were involved in vehicular or motorcycle accidents. None required operative repair, with all cases being managed conservatively.
- Other comorbid traumatic injuries included nerve root avulsion, cervical spine ligamentous injury, and various vertebral fractures and dislocations.

# Imaging: The “Floating Sac” Sign

- The “Floating sac” sign describes the appearance of the dural sac “floating” in CSF that has leaked outside of the subarachnoid space due to a dural tear.
- This sign is best appreciated on an axial T2-weighted MRI of the spine.
- A study by T Hosoya et al found the “floating sac” sign to have a 92% sensitivity rate for diagnosing spinal dural tears.

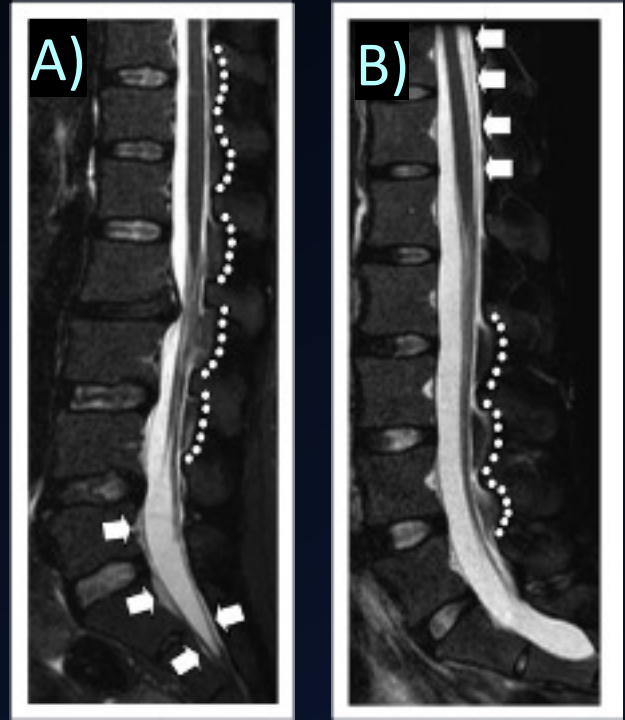


A) Sagittal fat saturated T2-weighted MRI marked at the level T1

B) Axial fat saturated T2-weighted MRI at the level of T1. Arrowheads are highlighting the dural sac “floating” in the surrounding hyperintense CSF fluid

# Imaging: The “Dinosaur Tail” Sign

- The “Dinosaur Tail” sign describes the appearance of the expanding epidural sac filled with CSF intercollating around the epidural fat.
- This is best appreciated on a sagittal fat saturated T2-weight MRI.
- This sign was found to have an 84% sensitivity rate in diagnosing spinal dural tears in a study by K Sekurai et al.

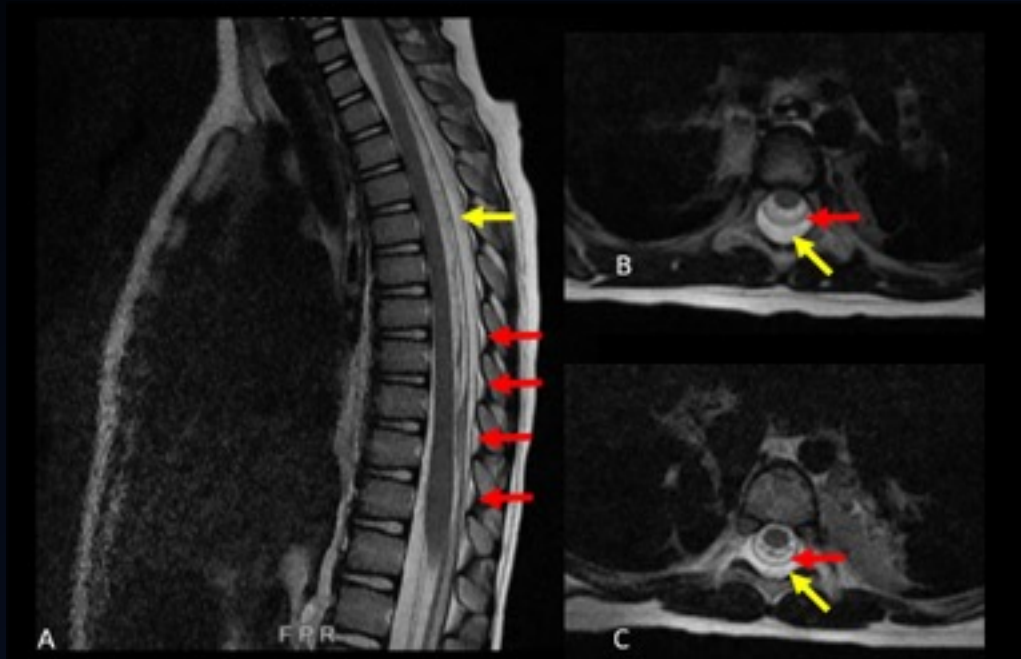


A) and B) Sagittal fat saturated T2-weight image of the lumbosacral spinal. Dashed lines follow the contour of the dorsal epidural fat tissue, which are accentuated by the hyperintense CSF, creating a “dinosaur tail” appearance. The arrows are showing the expanded epidural sac filled with CSF from the subarachnoid space.

# Case 1: Thoracic Spine Dural Tear

3-year-old female brought in after unrestrained motor vehicle collision with a GCS of 3.

- Imaging revealed non-compressive dorsal epidural fluid within the thoracic spine, suggesting a spinal dural tear
- Concurrent odontoid fracture and atlanto-axial dissociation
- Odontoid fracture treated with Halo collar by neurosurgery; No surgical intervention for thoracic spine dural tear

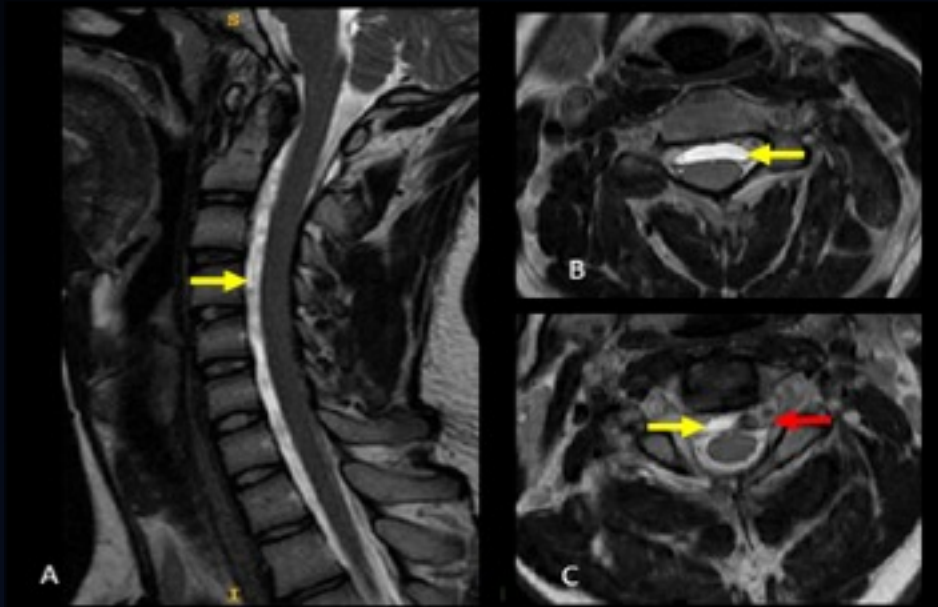


A: Sagittal and B/C: Axial T2 images through the thoracic spine revealing posterior epidural fluid collection (yellow arrows) with mass effect and anterior displacement of the thecal sac. Fluid is CSF intensity, suggesting CSF leak from dural tear. A: Epidural fat demarcated with interspinous epidural fluid representing “dinosaur tail sign” (red arrows). B/C: Thecal sac surrounded by CSF intensity on either side, representing “floating sac sign”. (red arrows).

# Case 2: Cervical Spine Dural Tear

18-year-old male with history of multiple prior high-impact head traumas was brought in after motorcycle collision with loss of consciousness, neck pain, left arm pain/paresis, and new onset seizure.

- Found to have CSF leak within anterior epidural space of the cervical spine, consistent with traumatic spinal dural tear
- Concurrent nerve root avulsion with left pseudomeningocele
- Managed conservatively by neurosurgery



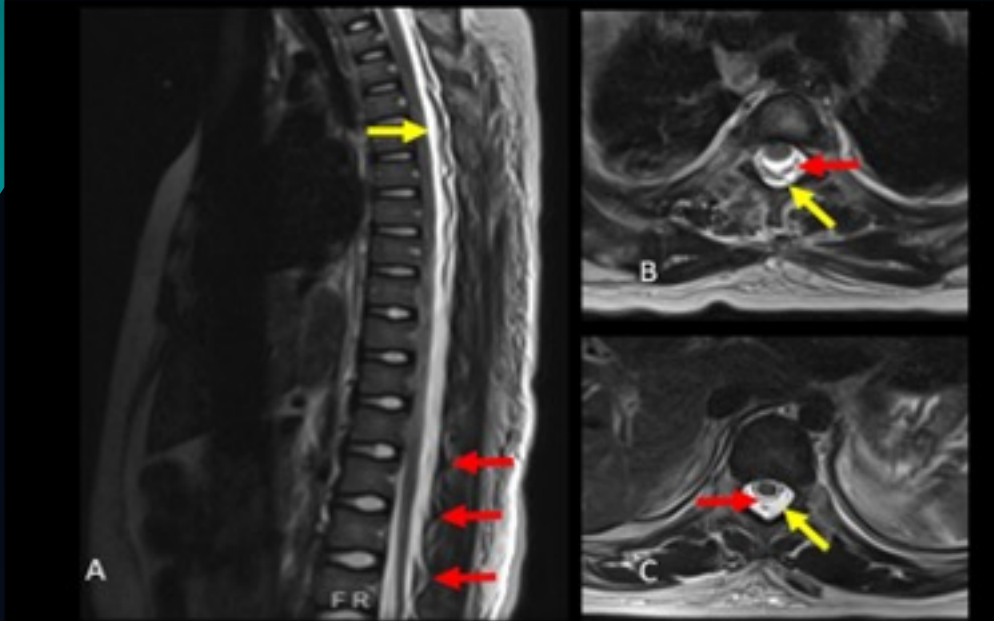
A: Sagittal and B/C: Axial T2 images through the cervical spine revealing anterior epidural fluid collection (**yellow arrow**) with mass effect and dorsal cord displacement. Fluid is CSF intensity, suggesting CSF leak from dural tear. Left cervical nerve root avulsion with pseudomeningocele (**red arrow**) at C6-C7 level.



# Case 3: Thoracic Spine Dural Tear

8-year-old male who was transferred intubated from local hospital after a motor vehicle collision.

- Imaging revealed compressive dorsal epidural fluid within the thoracic spine, suggesting spinal dural tear with resultant anterior displacement of the cord
- Concurrently right frontal subarachnoid hemorrhage and T1-T6 interspinous/supraspinous ligamentous injury
- Managed conservatively by neurosurgery



A: Sagittal and B/C: Axial T2 images through the thoracic spine. Posterior epidural fluid collection (**yellow arrows**). Fluid is CSF intensity, suggesting CSF leak from dural tear. A: Epidural fat demarcated with interspinous epidural fluid representing “dinosaur tail sign” (**red arrows**). B/C: Thecal sac surrounded by CSF intensity on either side, representing “floating sac sign”. (**red arrows**).

# Indications for Neurosurgical Repair

Indications include:

- Worsening intracranial hypotension headaches
- Symptomatic pseudomeningoceles
- Herniated nerve root entrapment
- Symptomatic subdural hematoma
- Meningitis

# Discussion/Teaching Points

- Although many CSF leaks occur idiopathically, trauma is a common cause. Therefore, all high-grade spinal trauma should be evaluated for evidence of dural tears with CSF leak.
- All high-grade trauma with evidence of spinal cord injury or instability on CT should be promptly evaluated on MRI, with spinal dural tear included in a radiologist's search pattern.
- Simple-appearing extradural fluid in the setting of trauma should raise immediate suspicion for dural tear with CSF leak.
- The floating sac sign and the dinosaur tail sign should become recognized signs for a radiologist reading trauma scans.
- High resolution, thin-cut MRI may help detect exact tear location.

# Discussion/Teaching Points

- Despite conservative management for incidental spinal dural tears, post-traumatic symptomatic tears may warrant repair.
- Undiagnosed dural tears leading to chronic CSF leak can cause devastating symptoms and morbidity from intracranial hypotension.
- Indications for repair include worsening intracranial hypotension headache, symptomatic pseudomeningoceles, herniated nerve root entrapment, symptomatic subdural hematoma, and meningitis.
- Complexity of repair is often dictated by tear location, with ventral tear repair being more technically challenging than their posterior counterparts.
- Radiologists reading trauma or spinal imaging must be familiar with imaging appearance of dural tear in order to suggest CSF leak and expedite neurosurgical evaluation.

# Conclusion

- The etiology of many CSF leaks is idiopathic; however, trauma is a well-established cause.
- Given the relative lack of radiological literature surrounding spinal dural tears, we aim to educate radiologists on its appearance to better evaluate trauma patients.
- Prompt identification and communication to neurosurgical team is critical to decrease morbidity in cases of CSF leak.

# References

- R.I. Farb, P.J. Nicholson, P.W. Peng, E.M. Massicotte, C. Lay, T. Krings and K.G. terBrugge. Spontaneous Intracranial Hypotension: A Systematic Imaging Approach for CSF Leak Localization and Management Based on MRI and Digital Subtraction Myelography. *American Journal of Neuroradiology* April 2019, 40 (4) 745-753; DOI: <https://doi.org/10.3174/ajnr.A6016>
- Hosoya T, Hatazawa J, Sato S, Kanoto M, Fukao A, Kayama T. Floating dural sac sign is a sensitive magnetic resonance imaging finding of spinal cerebrospinal fluid leakage. *Neurol Med Chir (Tokyo)*. 2013;53(4):207-12. doi: 10.2176/nmc.53.207. PMID: 23615408.
- Lofrese G, Visani J, Cultrera F, De Bonis P, Tosatto L, Scerrati A. Anterior Dural Tear in Thoracic and Lumbar Spinal Fractures: Single-Center Experience with Coating Technique and Literature Review of the Available Strategies. *Life (Basel)*. 2021 Aug 25;11(9):875. doi: 10.3390/life11090875. PMID: 34575024; PMCID: PMC8465010.
- Ohtonari T, Noguchi S, Nishihara N. Acute-Phase Intraoperative Findings of Traumatic Spinal Cerebrospinal Fluid Leakage. *World Neurosurg*. 2021 Apr;148:90-92. doi: 10.1016/j.wneu.2021.01.043. Epub 2021 Jan 18. PMID: 33476775.
- Sakurai K, Kanoto M, Nakagawa M, Shimohira M, Tokumaru AM, Kameyama M, Shimoji K, Morimoto S, Matsukawa N, Nishio M, Shibamoto Y. Dinosaur Tail Sign: A Useful Spinal MRI Finding Indicative of Cerebrospinal Fluid Leakage. *Headache*. 2017 Jun;57(6):917-925. doi: 10.1111/head.13075. Epub 2017 Apr 16. PMID: 28419438.
- Vemuri NV, Karanam LSP, Manchikanti V, Dandamudi S, Puvvada SK, Vemuri VK. Imaging review of cerebrospinal fluid leaks. *Indian J Radiol*