Acute Paralysis in an Adolescent: The Race to Diagnosis

Casey Hribar MS
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History and Initial Work-Up

11yoF picking flowers around 12pm and noticed pain between her shoulder blades. Within 2-3 hours, she noticed weakness in her legs and truncal instability with a wobbly walk. She tried to go to the bathroom shortly after and could not stand up or pull her pants up due to weakness of all 4 extremities. She lacked fine motor movements in the hands at this time and was unable to grasp objects. She has been unable to urinate since before the pain began.

- No sick contacts, no recent illness, no current “sick” or other symptoms
- Mental status intact, no changes in hearing/vision, no seizures
- Typical adolescent diet; eats canned foods including Spaghettio’s but no honey
- No relevant family history including neurologic disorders
History and Initial Work-Up

Initial Physical Exam

- Vitals unremarkable, no fevers
- PERRL, CN II-XII intact
- Extremities warm, sensation intact in all extremities but unable to distinguish sharp from dull pressure
- Brachial and patellar reflexes 2+
- 0/5 strength in LE’s; UE’s 5/5 strength in flexion, 3/5 in extension
- No spontaneous movement of LE’s

Initial Labs

- CMP wnl, CBC with WBC 12.6 (+left shift), CRP wnl, CK wnl, salicylates, acetaminophen, drug screen negative, COVID-19 negative, enterovirus negative
- CSF wnl (protein 23, glucose 65, culture/gram stain/cell count normal)

Differential: Guillain-Barre, CNS mass, transverse myelitis, Carolina Jessamine ingestion (above), acute flaccid myelitis, MS, neurotoxin, psychosomatic weakness...
List of Initial Imaging Studies (First 48hrs)*

In the ED...
- MR Head w/out Contrast
- MR Cervical Spine w/out Contrast
- MR Thoracic Spine w/out Contrast
- MR Lumbar Spine w/out Contrast

Areflexia overnight

Initial Neuro Consult...
- MR Lumbar Spine w/ and w/out Contrast

After Full Neuro Exam...**
- MR Cervical Spine w/ and w/out Contrast
- MR Thoracic Spine w/ and w/out Contrast

* Repeat MR of Cervical and Thoracic spine w/ and w/out contrast ordered about 1 week after presentation
**Additional images recommended within 24-hours of first contrasted study and needed to be delayed until the following day.
Non-Contrast Head MR

T1-Weighted MR images in the axial plane...
Overall normal images!

Level of the lateral ventricles

Level of the 3rd ventricle

Level of the brainstem (midbrain-suprasellar cistern)

Structures to ID:
- Gray/White Matter Junction
- Ventricles and cerebral aqueduct
- Corpus callosum
- Caudate bodies
- Superior sagittal sinus
- Sylvian fissure
- Basal ganglia
- Thalamus
- Internal capsule
- Midbrain
- Orbits and optic chiasm
- Suprasellar and quadrigeminal cisterns
- Vermis
Non-Contrast Cervical and Thoracic Spine MR

T1-Weighted MR Images
Sagittal Plane
Again...NORMAL!

Left image: Cervical
Right image: Thoracic

Structures to ID:
• Vertebral bodies
• Vertebral discs
• Dens (odontoid process)
• Subcutaneous fat
• Spinal cord
• Cerebellum
• Foramen magnum
• Spinous processes of vertebrae
• Spinal cord ligaments
Non-Contrast and Contrast MR of Lumbar Spine

T1-Weighted Lumbar Spine MR Images Sagittal Plane

You guessed it...another set of normal images!

Left image: Pre-Contrast

Right image: Post-Contrast
Repeat MR of Cervical and Thoracic Spine

Important findings:
- T2 hyper-intensities not previously appreciated on other studies
- Patchy hyper-intensity of the R cord at the C4/C5 level (left image)
- Additional area of hyper-intensity within L cord at the C7 level (below)

Comparison Image (above):
- Initial image of the ~C4-C5 level 2 days prior
- Homogenous cord with no hyper-intensity seen

T2-Weighted Axial MR Images of Cervical Spine (~48hrs after presentation)
Important findings:
- Several foci of spinal cord enhancement
- R central cord at C5
- L central cord at C6-7
- But these are short segments of inflammation...
Background on Transverse Myelitis

• Acquired neuro-immune disorder of the spinal cord—rare!
• Peak onset between 10-19 and 30-39 years old
• Rapid onset of sensory changes, weakness, bowel/bladder dysfunction
• Can occur post-infection or on a spectrum of neuro-inflammatory and/or autoimmune disorders (MS, ADEM, MOG antibody disease, NMOSD, AFM, lupus, Sjögren’s…)—Also often idiopathic!
• Important to rule out non-inflammatory myelopathies and compressive myelopathy when evaluating
• Diverse spectrum of potential pathologies/histology (lymphocytic infiltration, axonal degeneration, gray matter involvement, white matter demyelination)
• Can be quite hard to differentiate from Guillain-Barre (problematic because different treatments!)
• TM treated with high dose steroids +/- plasma exchange (PLEX)
• Recovery is slow over months to years—about half have permanent deficits
Patient Treatment and Outcome

- Initially treated with 1 g/kg IVIG for possible Guillain-Barre Syndrome
- Repeat, focused neurological exams and second set of cervical spine images led to diagnosis of transverse myelitis instead
- Started on high dose IV steroids immediately; began to wiggle her fingers and could hold her phone
- Transferred to UNC for PLEX and femoral dialysis catheter placement
- Received three additional doses of IVIG at UNC
- Remained inpatient for 2wks and was d/c to acute inpatient rehab facility.
- On discharge, slightly improved strength of LE’s, especially at the hips. Sensation essentially normal. Able to spontaneously void on own without need for Foley. UE strength overall improving, but still deficits from baseline.
- Did require another set of Cervical and Thoracic MR imaging and XR abdomen for line check.
Work-Up of Transverse Myelitis

MRI often study of choice for diseases of the spine, especially with bowel/bladder dysfunction and/or concern for myelopathy or myelitis!

• Can detect soft tissue abnormalities, spinal cord issues, and assess intervertebral discs in a multitude of planes with no radiation
• With and without contrast preferred (both sets helpful in this case!)
• Part of the diagnostic criteria for TM requires T2 hyperintense signal on spine MRI with no compressive cord lesion (CT typically considered inadequate for exclusion of compressive lesion or intrinsic cord lesion; can be used if MRI not possible)
• Inflammation can be detected via gadolinium enhancement on MRI
• Inflammation often not visualized initially, can repeat MRI 2-7 days after presentation
• Right imaging initially used in this case, but perhaps not the sequence of images afterwards, especially in relation to contrast usage (but who knows!)

In addition to taking a full history and repeated physical exams, common tests involved in work-up include lumbar puncture, infectious labs, CBC, electrolytes, drug/toxin screens, inflammatory markers, autoimmune factors/antibodies, and more based on presentation.
# Diagnostic criteria for transverse myelitis

- Sensory, motor or autonomic dysfunction attributable to the spinal cord
- Bilateral signs and/or symptoms
- Clearly defined sensory level
- No evidence of compressive cord lesion
- Inflammation defined by cerebrospinal fluid pleocytosis or elevated IgG index or gadolinium enhancement
- Progression to nadir between four hours and 21 days

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### ACR Criteria—Maybe Not The Most Appropriate?

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Procedure</th>
<th>Adult RRL</th>
<th>Peds RRL</th>
<th>Appropriateness Category</th>
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<td>Myelopathy, acute, cervicothoracic spine, initial imaging</td>
<td>MRI cervical and thoracic spine without IV contrast</td>
<td>0 mSv [O]</td>
<td>0 mSv [ped] O</td>
<td>Usually appropriate</td>
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<td></td>
<td>MRI cervical and thoracic spine without and with IV contrast</td>
<td>0 mSv [O]</td>
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<td>CT myelography cervical and thoracic spine</td>
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<td>CT cervical and thoracic spine without IV contrast</td>
<td>10-30 mSv [O]</td>
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<td>Radiography cervical and thoracic spine</td>
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**Food for thought:** After discussion with a UNC Neuroradiologist, the ACR criteria may be too broad here and not help with excluding certain pathologies. It may be more helpful to hone in on or use different, more specific criteria, like the MS criteria for imaging and evaluation. Something to consider!

https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria
Classic Imaging Findings of Transverse Myelitis

• Areas of T2 signal abnormalities (hyperintensity) at one or more levels of the cord
  • Usually not well demarcated
• Gadolinium-enhancing signal abnormality in the spinal cord
  • Often over multiple segments (in continuum or separate)
• Enhancements can be varied (patchy, diffuse, etc.)
• Lesions in white, gray, or gray and white matter
• Cord swelling at levels with inflammation
• Cord lesions typically multiple (>3) vertebral segments in length

(Sources for images in citations at end)
Sensitivity and Specificity of MR for Transverse Myelitis

• Not a strong consensus in the literature
• “High” sensitivity, lower specificity
  • Greater at ruling out than ruling in
  • Studies suggest 15-50% of cases are not visualized on imaging
  • Diagnosis that relies on imaging and clinical details; hard to quantify imaging alone
• True “idiopathic” cases decreasing as our diagnostic capabilities are improving
  • New antibodies, etc.
  • Some findings (like length of lesion) may point toward or away from different underlying causes
  • Newer research focusing on this and determining diagnostic values for specific etiologies
• Despite varying opinions on diagnosis, MR w/ and w/out contrast still viewed as the study of choice
Approximate Costs

- No radiation required
- Multiple and/or repeat MRIs can be expensive and time-consuming in an urgent situation
- MR contrast has time limitations (>24hrs apart) and potential (rare) adverse effects like nephrogenic systemic fibrosis—much less of a concern in children with newer contrast formulations and good kidney function
- Estimated monetary costs of imaging:
  - MR brain w/out contrast: ~$3,000
  - MR cervical, thoracic, and lumbar spine w/out contrast: ~$9,000 (each ~$3k)
  - MR lumbar spine w/ and w/out contrast: ~$4,000-$6,000
  - MR cervical and thoracic spine w/ and w/out contrast: ~$8,000-$12,000
  - Great price variation based on source, insurance, etc.!
  - Total cost for this patient, including second set of images at UNC: ~$37,000!

https://www.umchealthsystem.com/techtesting/procedure-price-lookup
https://costestimator.mayoclinic.org/find/mri-scan/carepaths
UNC Top Three!

• Transverse myelitis can be a devastating condition that initially presents without distinct imaging findings. A high level of clinical suspicion is needed and repeat imaging/diagnostic tests may be required.

• Always consider potential additional follow-up tests before ordering a contrasted study to avoid diagnostic delays.

• Never underestimate the power of physical exam to guide imaging!

(Bonus: When in doubt, call Poison Control! They can be SO helpful!)
References


