Radiographic Features of Cavernous Sinus Thrombosis

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Core Radiology Clerkship
Learning Objectives

1. Recognize the symptomatology of cavernous sinus thrombosis through a case presentation
2. Review paranasal sinus, orbit, and cerebral venous system anatomy.
3. Consider the menu of radiologic tests for evaluating proptosis and painful vision loss.
4. Interpret the radiologic features of our patient’s imaging and consider their differential diagnoses.
5. Provide a case summary and take home points.
Our Patient: Clinical Presentation

- **CC:** Headache

- **HPI:** 72 year-old female presented to emergency room with frontal headache lasting 4 days.
  - **ROS:** Limited secondary to somnolence:
    - Denies neck stiffness, photophobia, double vision, flashes, or floaters
    - Endorses nasal congestion, adds that she feels like her eyes are swollen

- **PMH:**
  - Systemic Lupus Erythematosus (on steroids)
  - Type 2 Diabetes Mellitus (on insulin)
  - History of L sided stroke without residual deficits

- **Exam:** Somnolent with PERRL and bilateral proptosis with mild erythema over R eyelid. Otherwise, exam unremarkable.

- **Labs:** Notable for WBC 12.4K with 86% PMNs

- **CT Head w/o contrast:** Notable for opacification of bilateral maxillary and sphenoid sinuses, scattered fluid in ethmoid air cells, hyperostosis of sphenoid sinus, suggestive of acute on chronic sinusitis.
Our Patient: Hospital Day 2

Ophthalmology consulted with positive exam findings of:

- Bilateral proptosis OD > OS
- EOM:
  - OD -2.5 restriction in all directions of gaze
  - OS -0.5 restriction in all directions of gaze
- Lid/Lashes/Lacrimal
  - OD: Periorbital edema, erythema, warmth
  - OS: Upper lid fullness, non-erythematous, non-tender
- Conjunctiva
  - OD: 360-degree chemosis
  - OS: Inferior chemosis

ENT consulted with endoscopic exam findings of:

- Nasal cavity with mucus, mildly edematous turbinates, crusting near osteomeatal complex (OMC) bilaterally
- No frank purulence for culture
Overnight, progression of our patient’s exam included

• Eyes:
  • Visual acuity 20/200 OD 20/100 OS
  • Pupils minimally reactive, ptosis
  • Pain with OU movement
  • Prominent periorbital edema with purulence and crusting around eyes.

• Nose/Sinuses: No tenderness to palpation of frontal or maxillary sinuses.

• Neuro: Tenderness to palpation of CNV1 distribution bilaterally.
Our patient’s cumulative presentation of bilateral periorbital edema, proptosis, and chemosis in the context of acute on chronic sinusitis is most concerning for orbital cellulitis.

Her rapid progression of reduced visual acuity with bilateral ophthalmoplegia and minimally reactive pupils suggests cranial nerve dysfunction, specifically of CNs 3, 4, 6.

Let us review orbital, paranasal sinus, and cerebral venous anatomy to gain a better understanding of how her symptomatology summates.
Paranasal Sinuses

**MS** = Maxillary Sinus
**NLD** = Nasolacrimal duct
**IT** = inferior turbinate

**SpS** = Sphenoid Sinus
**AE, PE** = Anterior Ethmoid, Posterior Ethmoid
**CC** = Carotid canal

• **Superior orbital septum** connects the periosteum of the superior orbital rim to the levator aponeurosis.

• **Inferior orbital septum** connects the periosteum of the inferior orbital rim with the inferior tarsal plate.

• Together, both comprise the **orbital septum** which separates the preseptal and orbital spaces.

Four rectus muscles (MR, LR, IR, SR) and their intermuscular septa divide the orbit into two compartments: intraconal and extraconal spaces.
Orbit on CT

The superior ophthalmic vein and a branch of inferior ophthalmic vein pass through superior orbital fissure into cavernous sinus.

Cavernous Sinus

The cavernous sinus receives deoxygenated blood from eye and superficial cortex.

It is bordered by the temporal bone, sphenoid bone, and sella turcica.

A number of critical neurovascular structures border or transverse the cavernous sinus including:

- **Internal Carotid Artery**
- **CN III, IV, VI** responsible for extraocular movements
- **CN V1 and V2** responsible for facial somatosensation and corneal reflex (V1)
- **CN II** responsible for visual perception
- **Sella turcica** housing the pituitary
Cavernous Sinus

Here the cavernous sinus and its surrounding neurovascular structures can be seen on coronal MRI.

Notice the convex lateral border of the cavernous sinus (outlined in white).

Now, let us consider the imaging modalities that would be most beneficial in determining the underlying cause of our patient’s proptosis and painful vision loss.
# ACR Appropriateness Criteria:

**Clinical Condition:** Orbits, Vision and Visual Loss

**Variant 4:** Adult patient with proptosis and/or painful visual loss.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
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<tbody>
<tr>
<td>MRI head and orbits without and with IV contrast</td>
<td>8</td>
<td>CT may be considered the preferred imaging modality when rhinologic or paranasal sinus disease is the suspected etiology for the symptoms and signs.</td>
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<td>6</td>
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<td>CT head without IV contrast</td>
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<td>★★★</td>
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<tr>
<td>MRA head and neck without IV contrast</td>
<td>4</td>
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<td>O</td>
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<tr>
<td>MRA head and neck without and with IV contrast</td>
<td>4</td>
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<td>O</td>
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<tr>
<td>CTA head and neck with IV contrast</td>
<td>4</td>
<td>If vascular disease is suspected.</td>
<td>★★★</td>
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<td>X-ray orbit</td>
<td>1</td>
<td></td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

**Relative Radiation Level**

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<https://acsearch.acr.org/docs/69486/Narrative/>
Menu of Tests: CT

1. **Strengths:**
   - Faster speed
   - Relatively lower cost with greater availability
   - Preferred modality if evaluating bony structures
   - Preferred modality if paranasal sinus disease is likely etiology

2. **Weaknesses:**
   - Radiation exposure
   - Poorer soft-tissue resolution relative to MRI

3. **Notes:**
   - Ordering a “head CT” typically does not provide appropriate detail of the orbits, it is important to specify or select “CT orbits, sella, internal auditory canal” if provided.
Menu of Tests: MRI

1. **Strengths:**
   - Better evaluation of soft tissue details including optic nerve and the intraconal and extracanal spaces
   - Better evaluation of dilated orbital veins and regional venous sinuses
   - Absence of radiation exposure

2. **Weaknesses:**
   - Slower speed
   - Relatively greater cost with more limited availability

3. **Notes:**
   - MRI is reserved for patients with suspected intracranial involvement, including the cavernous sinus or fungal infection.
   - Contraindications include intraocular metallic foreign body and MRI incompatible devices (certain implanted hearing aids, neurostimulators, intracranial metal clips, pacemakers, etc)
With an understanding of the relative strengths and weaknesses of both CT and MRI for evaluating proptosis and painful vision loss, we are ready to review our patient’s images.

We will start with her initial non-contrast head CT in the emergency department.
Notice:

- Air-fluid level within L maxillary sinus
- Soft tissue density fluid-filled R maxillary sinus

These findings are suggestive of acute sinusitis
Notice:
• Hyperostosis of sphenoid sinus walls suggestive of chronic sinusitis.

Sclerosis is secondary to chronic mucoperiosteal reaction.
Our Patient: CT- Head at level of sphenoid sinuses (soft tissue window)

Notice:
• Opacification of bilateral sphenoid sinuses.

DDX for this finding includes:
• Acute sinusitis
• Chronic sinusitis
• Fungal sinusitis

Q: What past medical history may predispose our patient to fungal sinusitis?

Immunosuppression from her history of T2DM and steroid use for SLE!
Next, we will review a CT with contrast of the orbits, sella, and internal auditory canal obtained after our patient developed bilateral proptosis and ophthalmoplegia on hospital day 2.
Proptosis and soft tissue prominence of periorbital tissues with extension along bilateral zygoma.

Bilateral retrobulbar fat stranding with loss of intraconal fat planes

These are concerning for **orbital cellulitis**.

**DDX includes:**
- Preseptal cellulitis
- Orbital abscess
- Orbital pseudotumor
- Thyroid associated orbitopathy
- Orbital lymphoma
Notice:

Superior ophthalmic vein enlargement with vague enhancement of walls, concerning for thrombophlebitis.
Another view in a companion case:

Enlargement of vein with wall enhancement is due to venous congestion.

This may be secondary to a thrombus and resultant inflammation.
Lastly, our patient received a MRI of the head with and without contrast for further work-up of her CT findings.

Here we will review the MRI of a companion case which superbly demonstrates important findings in the cavernous sinus.
Notice:

Hyperintense enhancement at the bilateral cavernous sinuses

The cavernous sinus border is now concave suggesting expansion.
Notice:

Expansion and inflammatory changes at the bilateral cavernous sinuses

DDX includes:
- Tolosa Hunt syndrome
- Carotid cavernous fistula
Radiographic findings were cumulatively consistent with bilateral orbital cellulitis that had progressed to cavernous sinus thrombosis.

Our patient underwent CT-guided endoscopic sinus drainage emergently. Sinus tissue specimens were negative for fungi, however blood cultures were positive for gram positive cocci.

Post-operatively, our patient was continued on high-dose IV antibiotics and anticoagulated with a heparin drip before being bridged to warfarin.

She experienced marked improvement in her vision and extraocular motility, without pain or periorbital edema by time of discharge.
Cavernous Sinus Thrombosis

**Pathogenesis:** Septic thrombus forms within the cavernous sinus as a result of
1) orbital infections that drain via ophthalmic veins
2) sphenoid or ethmoid sinus infections via extension into the orbit or cavernous sinus directly
3) dental infections that drain via pterygoid venous plexus

**Clinical Manifestations:**
- Headache – over CNV1/V2 distributions
- Altered Mental Status
- Fever
- Periorbital edema
- Ophthalmoplegia- first CN6 lateral gaze palsy
- Ptosis and/or mydriasis
- Reduced visual acuity secondary to papilledema

**Treatment:**
- High-dose intravenous antibiotics: Include coverage for community-acquired MRSA
- Surgery: Endoscopic sinus drainage EMERGENTLY
- Anticoagulation
- Glucocorticoids after antibiotic course to reverse inflammatory damage to CNs
Learning Objectives

✓ We learned the pathogenesis, clinical manifestations, and treatment of cavernous sinus syndrome.

✓ We reviewed the relevant paranasal sinus, orbital, and cerebral venous anatomy including the critical neurovascular structures that transverse the cavernous sinus.

✓ We learned the menu of radiologic tests appropriate for evaluating proptosis and painful vision loss including CT and MRI.

✓ We identified the radiologic features of sinusitis, orbital cellulitis, and cavernous sinus thrombosis in addition to their differential diagnoses.
References


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