Internal Carotid Artery Dissection: Radiological Findings

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Outline

1. Patient presentation
2. Overview of internal carotid artery (ICA) anatomy and the pathophysiology of dissection
3. Menu of radiologic tests
4. Differential diagnosis

Our Patient, J.M.

ID/CC: 48 F, “sinus infection”

HPI:

•Right-sided facial pain x 7 days

•PCP diagnosed sinus infection, prescribed azithromycin
→ no improvement in pain

•1 day prior to presentation, developed diffuse headache and “whooshing,” “fluttering” sensations in right ear

•Went to BID Needham ER

A contrast-enhanced CT of the facial bones and paranasal sinuses was performed.

Patient JM: Contrast-Enhanced CT

Axial C+ Head CT

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"No evidence of sinus disease, abscess, or orbital cellulitis."

Patient JM: ICAs on CT

Axial C+ Head CT

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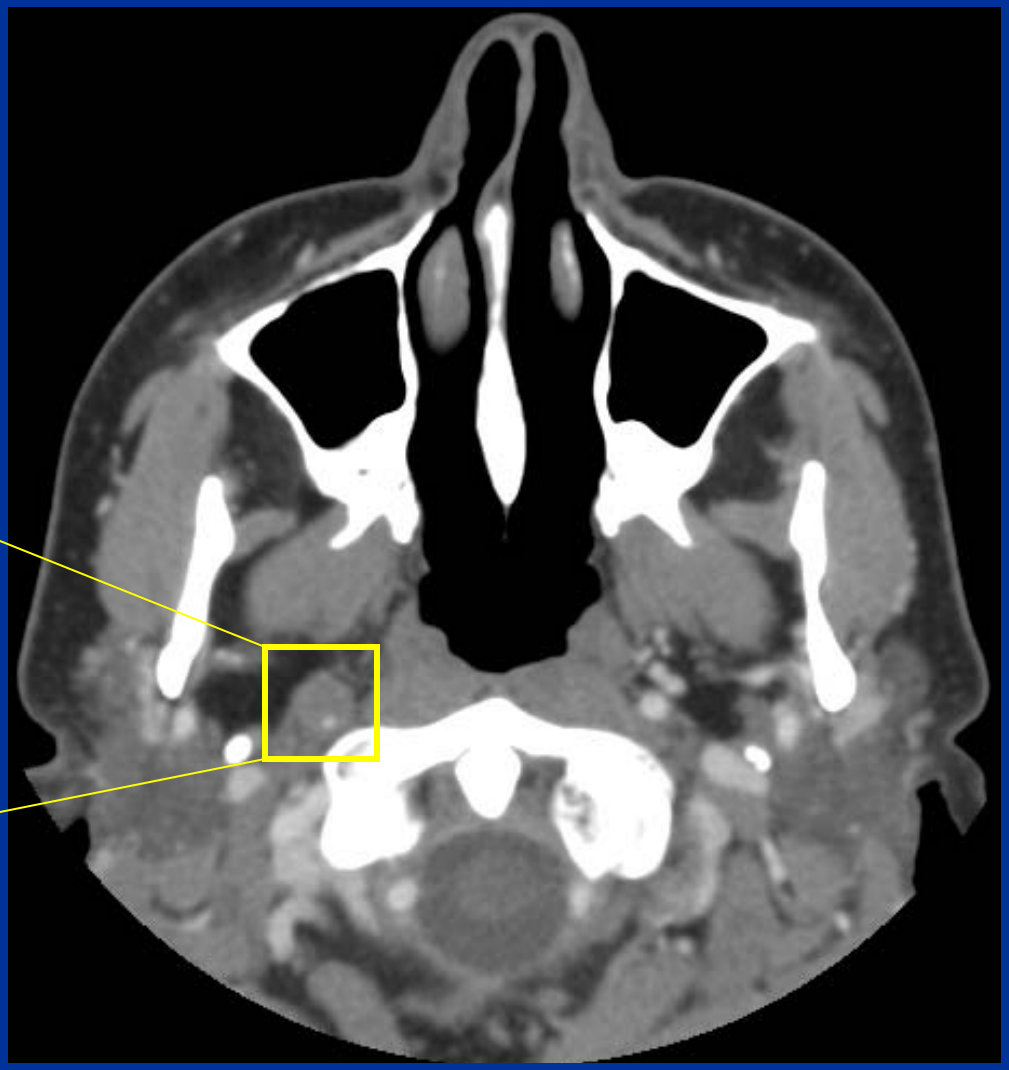
Patient JM: Marked stenosis of the Right ICA on CT

?Periluminal thrombus

Stenotic arterial lumen



Axial C+ CT

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Patient JM: Further Workup and Management

JM was transferred to the neurology service at BIDMC for additional imaging and management.

On taking a detailed history, it was learned that JM had undergone cervical chiropractic manipulation the day prior to developing her headache.

On examination, she was now noted to have a marked right Horner's syndrome (ptosis/miosis).

UpToDate™

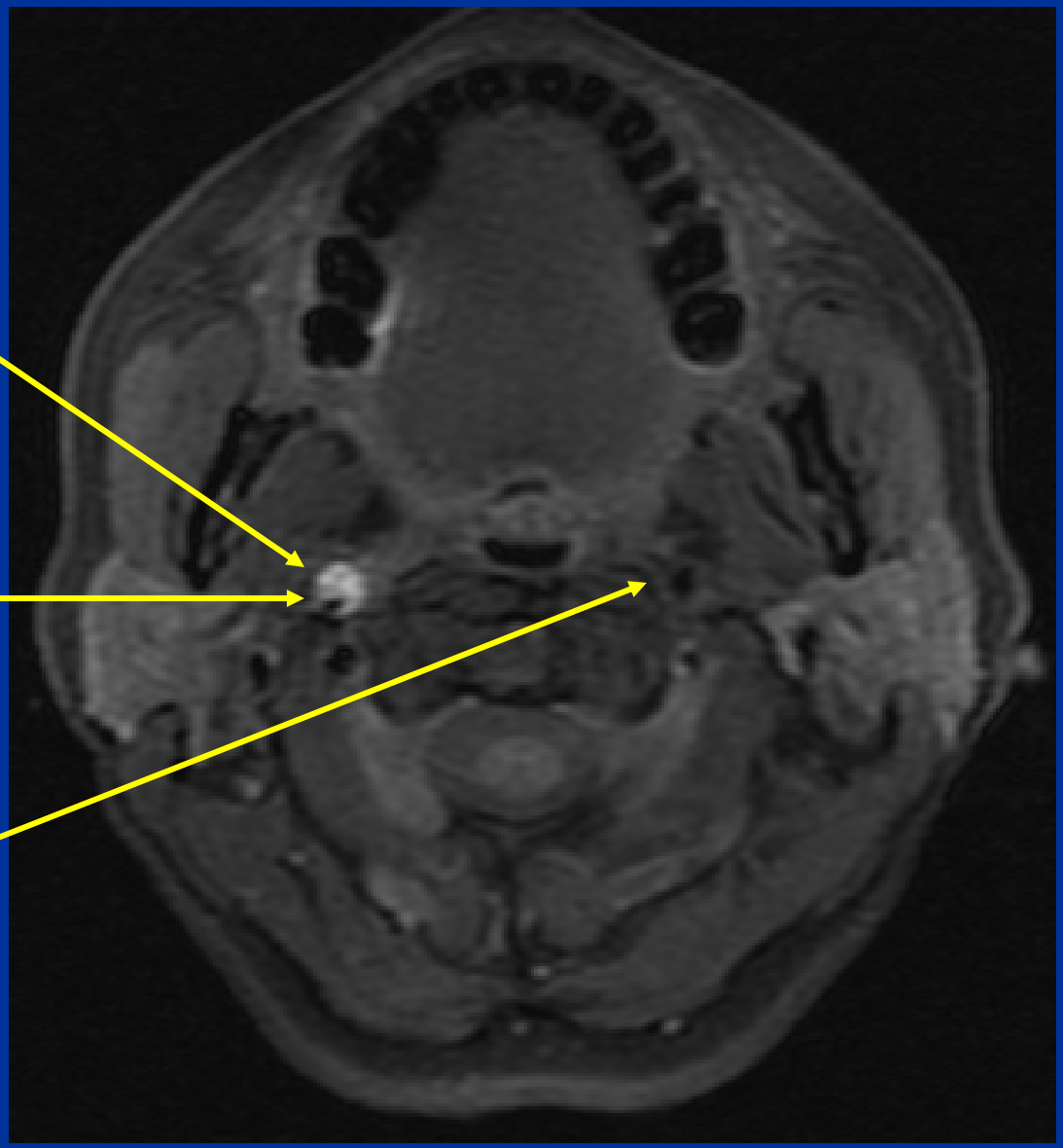
An MRI/MRA of the head and neck was performed.

Patient JM: MRI Findings of Dissection

Increased signal within right ICA confirms periluminal hematoma (diagnostic of dissection)

Small luminal opening

Patent left ICA



Axial C+ T1 Fat-Saturated MRI Head/Neck

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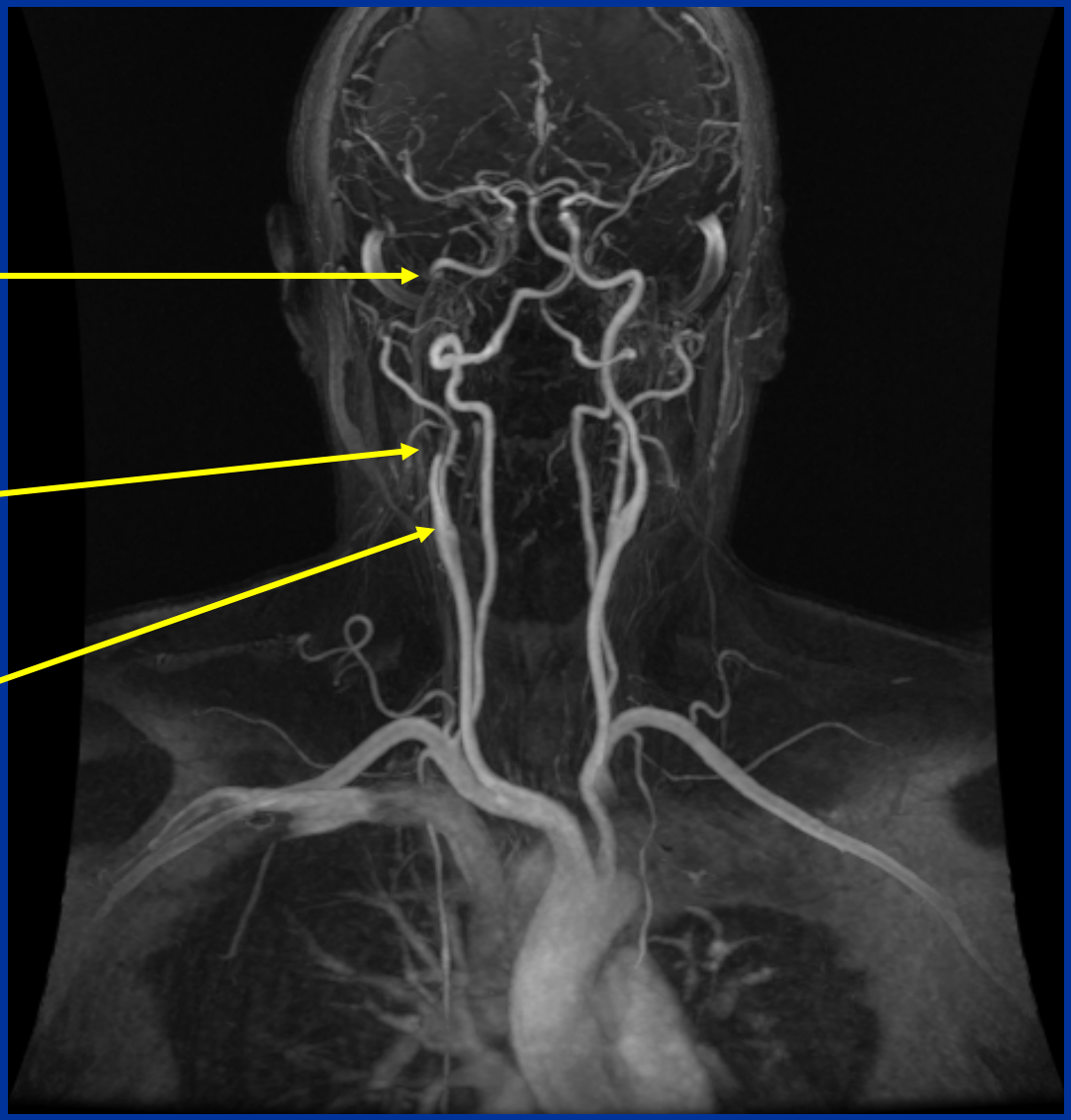
Patient JM: Three-Dimensional Reformatted MRI

Superior extent of lesion

Inferior extent of lesion

Carotid bifurcation



Coronal Post-gadolinium 3D Reformatted MRI Head/Neck

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Patient JM: Further Management

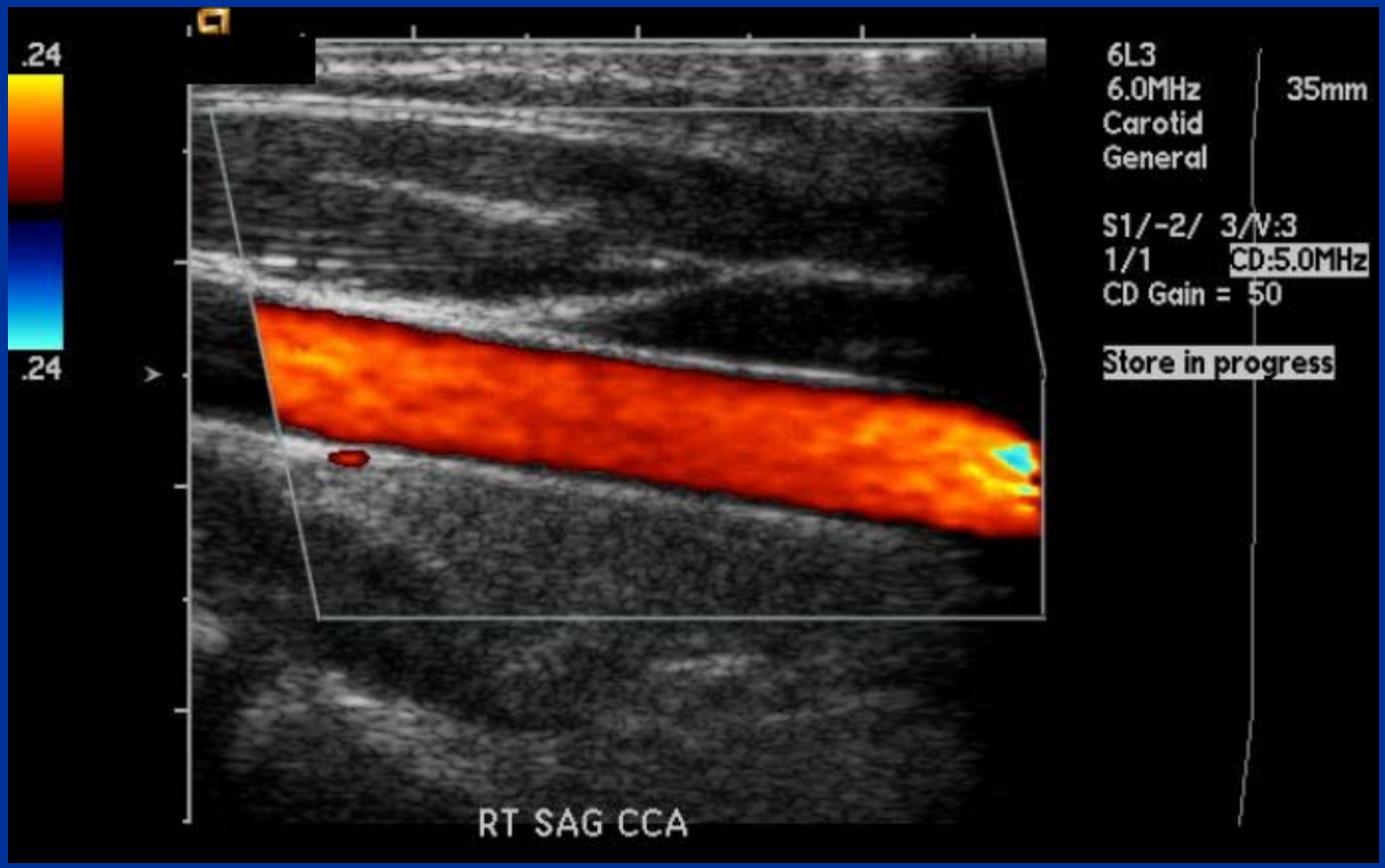
Further review of JM's head MRI was negative for infarct or hemorrhage.

She was started on warfarin with a heparin bridge.

After 48 hours of monitoring, JM was discharged with plans for careful follow-up.

At 6 weeks post-discharge, a carotid ultrasound was performed…

Patient JM: Follow-up Carotid Ultrasound



Sagittal Carotid Duplex Ultrasound

Normal flow velocities throughout the right internal carotid artery suggest that it has successfully recanalized.

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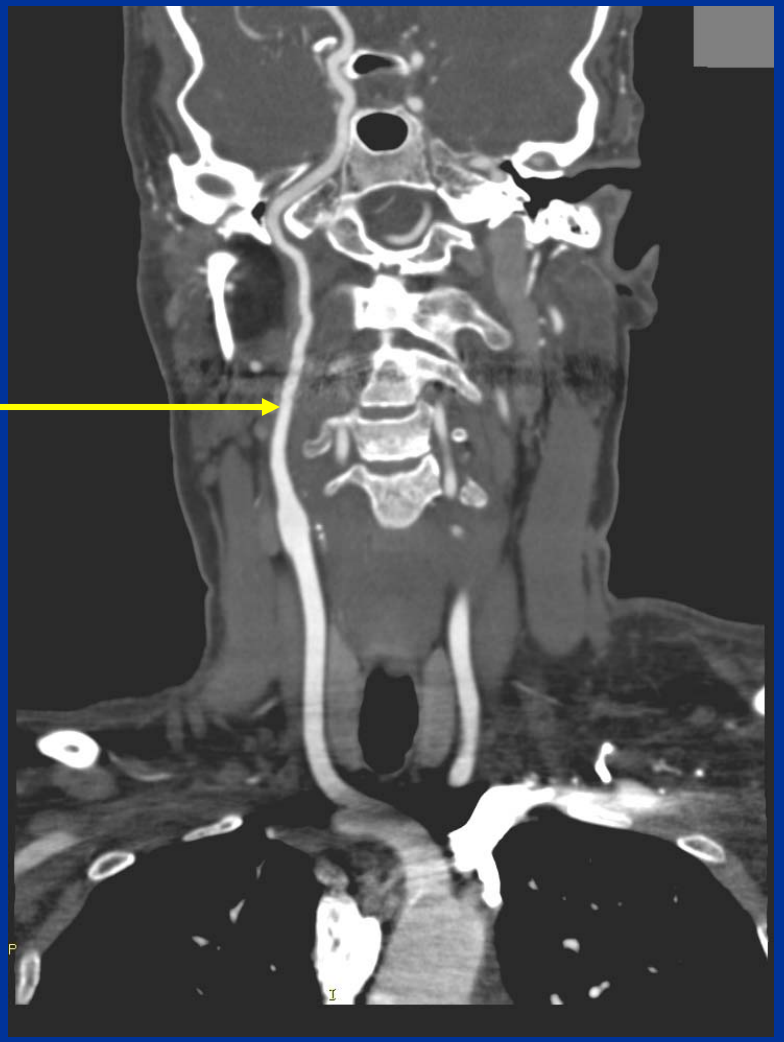
Patient JM: Follow-Up Head/Neck CTA 12 Weeks Post-Discharge

Patent lumen throughout the ICA



Coronal CTA Head/Neck

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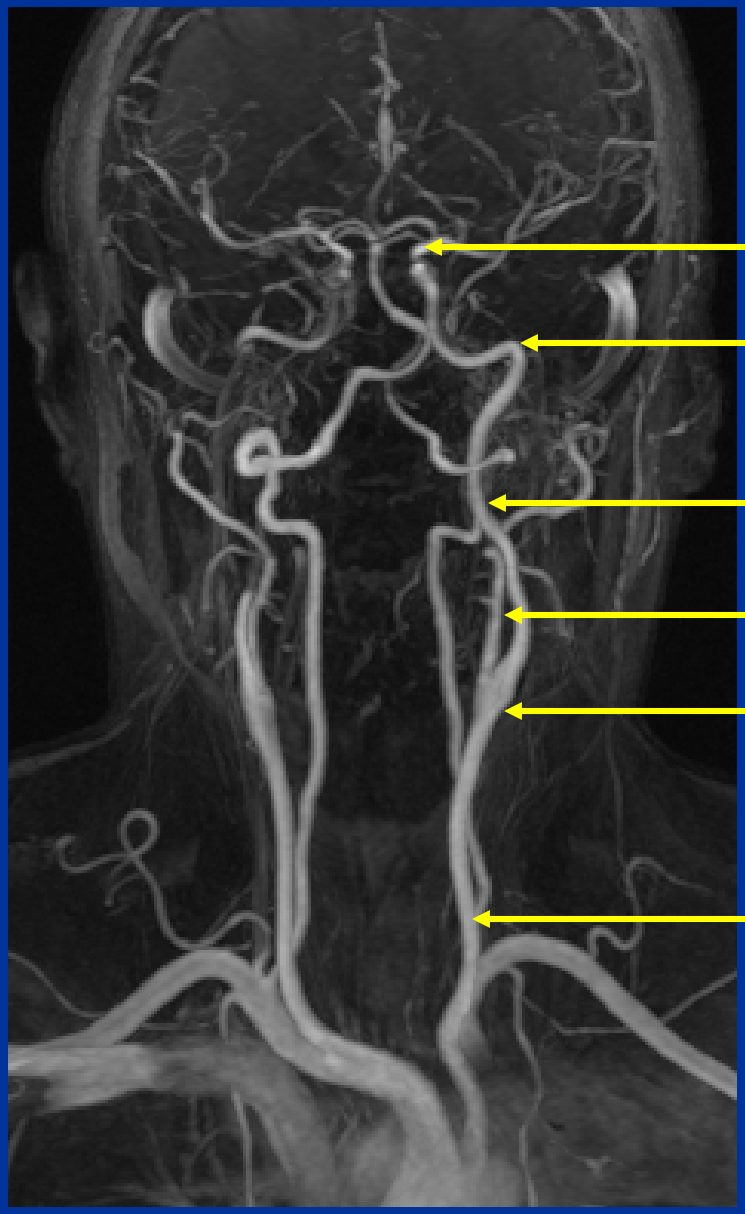
ICA Anatomy and Overview of ICA Dissection

ICA Anatomy



Circle of Willis

Carotid siphon

Internal carotid artery

External carotid artery

Carotid bifurcation

Common carotid artery

Coronal Post-Gadolinium 3D reformatted MRI

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Overview of Arterial Dissection

Arteries have three layers:

- intima, media, adventitia

Dissection = a tear in the media that causes bleeding within the arterial wall.

Blood then “dissects” through the arterial wall longitudinally

Associated risks:

- compressive occlusion of artery
- perforation into the lumen
- thrombogenesis

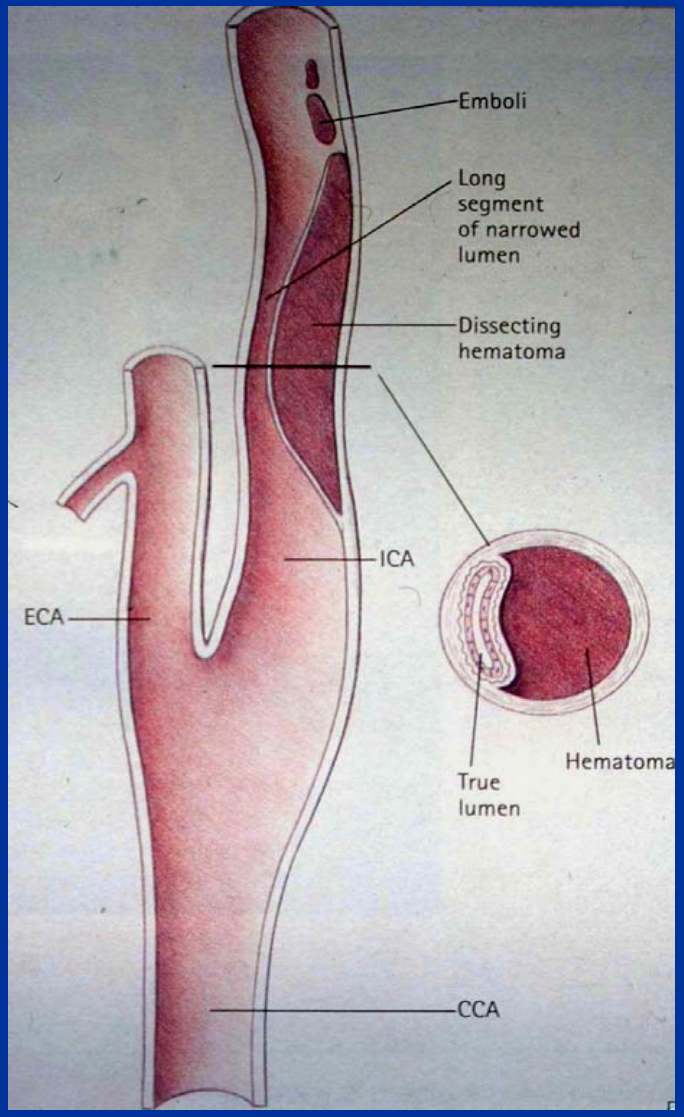


Image courtesy of Dr. Caplan

Facts about ICA Dissection

- Most common form of cervical arterial dissection (annual incidence = 5/100,000)

- Occurs more commonly in patients with connective tissue disorders

- Either occurs spontaneously or secondary to trauma
    - “Trauma” has a wide range of meanings

- The ICA typically dissects extracranially, where it is most mobile/distensible.

Facts about ICA Dissection, Continued

- Typical symptoms:
  - Neck, face, head pain
  - Pulsatile tinnitus
  - Horner syndrome
  - Symptoms of cerebral ischemia (ICA territory)

- Many dissections recanalize/heal spontaneously

- Potential complications include thromboembolus and arterial wall defects (e.g. pseudoaneurysms)

Menu of Radiologic Tests

Tests Commonly Used to Diagnose/Follow ICA Dissections

- Color Duplex Ultrasound

- CT Angiography

- MRI/MRA

- Digital Subtraction Angiography

Color Duplex Ultrasound

Allows imaging of proximal wall of ICA and visualization of blood flow velocities.

Appearance in dissection: thickened, hypoechoic vessel wall (intramural hematoma). Flow velocity diminished. Intimal flap visible in < 33%.

PROS:

- Noninvasive, quick, no contrast required

- 95-96% sensitivity in high-grade stenosis (e.g. patients with cerebral ischemia)*

- Offers a dynamic view of the vessel, similar to angiography

CONS:

- Mandible frequently impedes visualization

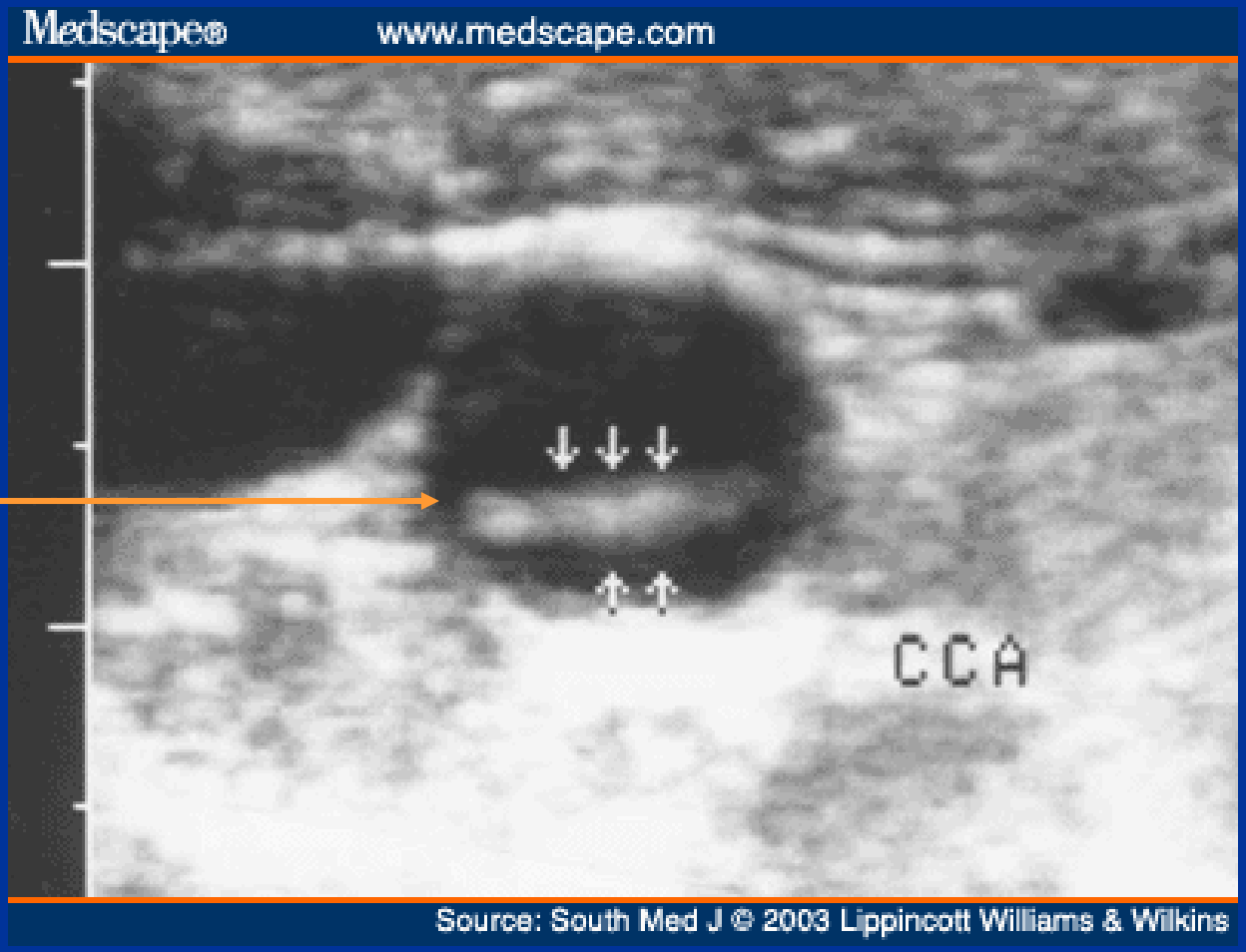
- Decreased sensitivity in cases of low-grade stenosis (71%)*

- Flow velocity measurements may be confounded by comorbid conditions (e.g. AVM, vasospasm)

*Rodallec MH et al. (2008)

Companion Patient #1: Common Carotid Dissection with True and False Lumina on Ultrasound

Intimal flap



http://www.medscape.com

CT Angiography

High-resolution, high-contrast images. Often combined with non-contrast CT to evaluate for intracranial hemorrhage.

Appearance in dissection: Intramural thrombus/hematoma appears as low attenuation crescent; diameter of the ICA usually increased.

May see dissection flap ± double lumen.

PROS:

- Noninvasive
- Images often in close agreement with those of conventional angiography*
- Allows 3D reconstructions for better visualization of dissections.

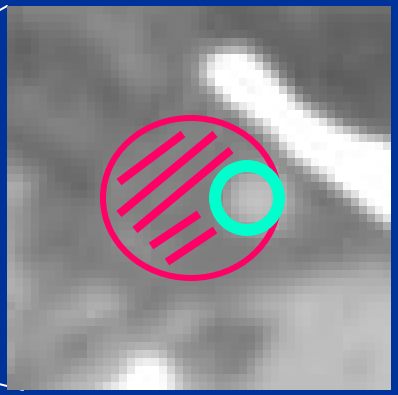
CONS:

- Low attenuation crescent non-specific for intramural hematoma (e.g. can also be seen in atheromatous plaque)
- Less favorable option for patients with renal insufficiency/failure

*Leclerc X et al. (1996)

Companion Patient #2: Bilateral ICA Dissections on CT Angiography

Near-total occlusion of right ICA



Lumen

Low attenuation crescent

Axial Head/Neck CTA

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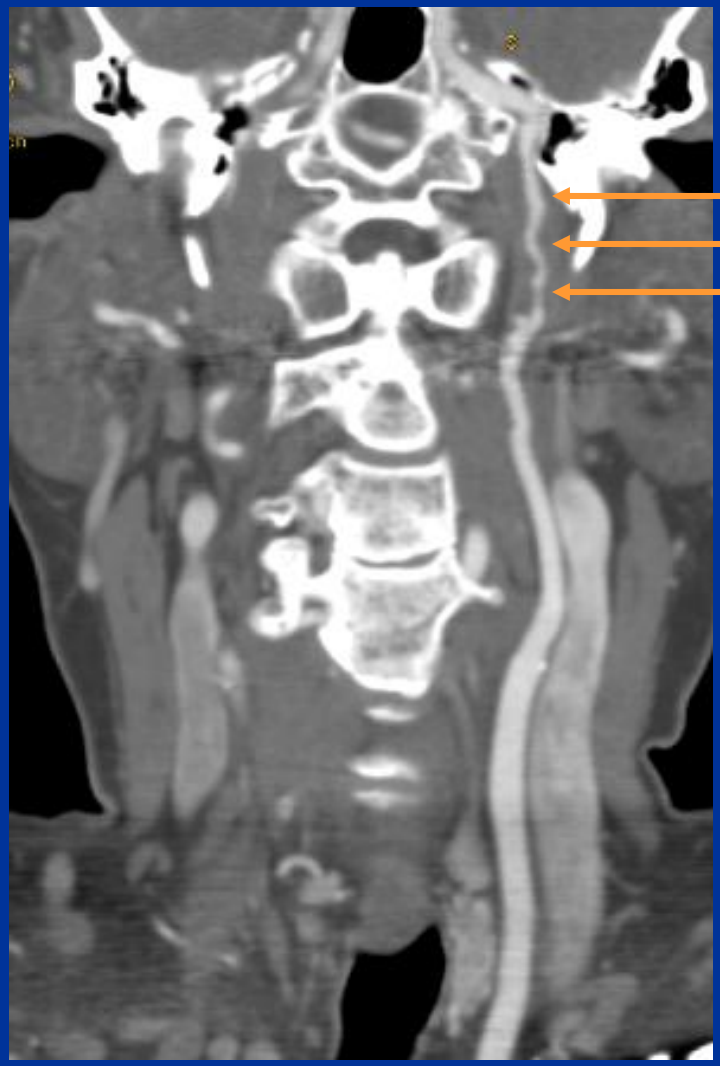
Companion Patient #2: “String Sign”



Marked intraluminal narrowing creates a “string-like” appearance in the area of dissection

Coronal Curved Reformat Head/Neck CTA

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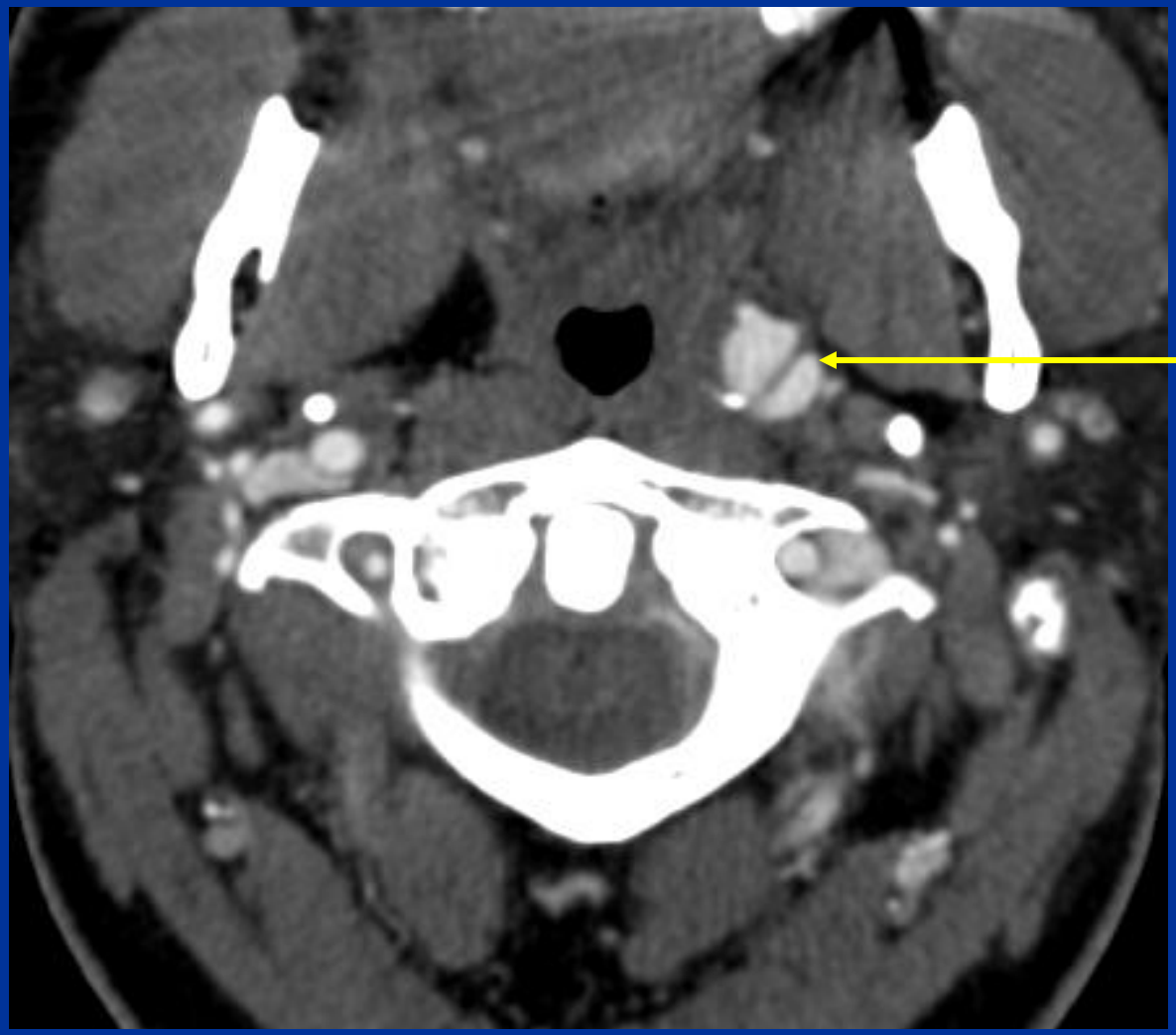
Companion Patient #3: ICA Dissection with True and False Lumina on CTA



Dissected ICA with true and false lumina

Axial Head/Neck CTA

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MRI/MRA

Wide variety of MR imaging paradigms allows for multiple views of dissection with differing enhancement.

On T1-weighted imaging, blood appears as hyperintense, due to paramagnetic properties of hemoglobin breakdown products.

PROS:

- Hyperintensity of blood allows distinction from plaque and other soft tissue densities

- Excellent sensitivity (95%) and specificity (99%) for ICA dissection*

CONS:

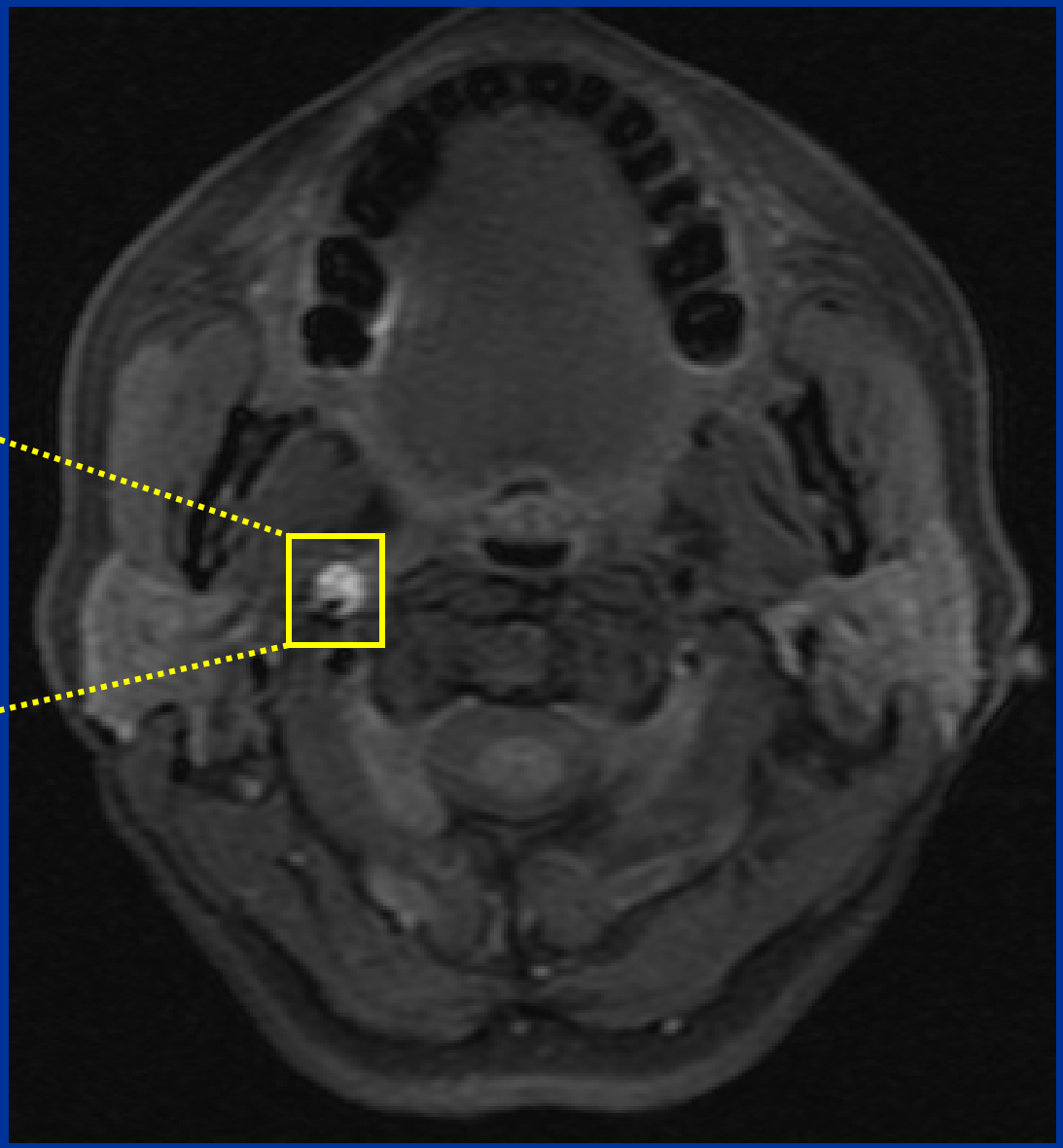
- Not as useful for early diagnosis (blood originally appears isointense, then becomes hyperintense as it breaks down over 2-3 days)

- Scans have lengthy acquisition times, require potentially toxic contrast

*Levy C et al. (1994)

Patient JM: T1-weighted MRI

Hyperintense intramural blood products



Axial T1 Fat Suppression Head MRI

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Digital Subtraction Angiography

Commonly regarded as the “gold standard”

Typical signs of dissection include: “string sign,” “string and pearl sign” (focal narrowing with distal dilatation), “flame sign” (tapered occlusion sparing carotid bulb), occlusion, and/or pseudoaneurysm.

Pathognomonic signs (double lumen, intimal flap) are rarely observed.*

PROS:

- Can observe vessel in real time, obtain information about flow velocity, reconstitution of luminal flow, etc.

- Consistent image quality (MR and CT can be easily degraded by artifact)

CONS:

- Does not provide detailed information about the arterial wall (thickness, presence of hematoma)

- Expensive procedure, lengthy

- Risks associated with procedure: hematoma, perforation, renal failure, etc.

*Rodallec MH et al. (2008)

Companion Patient #3: Chronic ICA Dissection with Pseudoaneurysm on DSA

Sagittal Digital Subtraction Angiography

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Differential Diagnosis

Certain conditions may appear similar to ICA dissection on angiography.

Here, we will review two such conditions.

Companion Patient #4: Atheromatous Plaque

Digital Subtraction Angiography

Distinguishing characteristics:

1) Location of the lesion: plaques are often located at the carotid bifurcation, whereas dissections typically occur more superiorly

2) Size of the lesion: dissections frequently involve long sections of artery, whereas plaques are often more focal/discrete

3) Patient history: cardiovascular risk factors, evidence of plaque burden elsewhere in the circulation, etc.

Companion Patient #5: Fibromuscular dysplasia

Sagittal Head/Neck CTA

Distinguishing characteristics:

1) Classic “Beads on a string” appearance, indicating irregular narrowing of the arterial lumen, (dissection typically appears as a sudden, smooth change in caliber).

2) Signs of fibromuscular dysplasia will likely be present elsewhere in the arterial circulation (e.g. vertebral artery in this patient).

Summary

We have discussed:

- A common presentation of internal carotid artery dissection

- ICA anatomy and the pathogenesis of ICA dissection

- The four most commonly-used imaging modalities in diagnosing and monitoring ICA dissections:
  - Color duplex ultrasound
  - CT angiography
  - MRI/MRA
  - Digital subtraction angiography

- Two conditions that can appear similar to carotid artery dissection and how to distinguish these diagnoses on imaging

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