Carotid / Vertebral Imaging

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"Four Trees"

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Disclosures: None

NOTE:

Full Syllabus Chapter on CD

PDF of Lectures available at:
stanford.edu/~hallett/SIR2010

Outline

- Modalities for Carotid / Vertebral Imaging
- Measurement of Stenosis
- Utility of CTA/MRA
- Case Examples with Imaging Tips

Imaging Options for Cervical Arteries

- Ultrasound (US)
- MR Angiography (MRA)
- CT Angiography (CTA)
- Catheter Angiography (DSA)

Doppler Ultrasound

- Inexpensive, readily available
- Flow-related info available
- Operator Dependent
- Diameter measurements have only fair correlation to DSA
- Sensitive but not specific *
- False negatives seen w/ distal stenosis, ostial stenosis, or tandem lesions

* Jahromi AS, et al. J Vasc Surg 2005;41:962-972

DSA

- Highest spatial / temporal resolution
- “Gold Standard”
- Expensive
- Planar images can over- / under-estimate stenosis
- Highest Procedural Risks
  - Stroke 1-4%
  - Mortality 0.1%

MRA

- Can be done without contrast (TOF, black blood)
- Artifacts:
  - Saturation effects
    - spurious signal loss (TOF)
      - Dephasing Artifacts
  - Can overestimate stenosis
    - CE-MRA > TOF
  - May be limited for subtotal occlusions

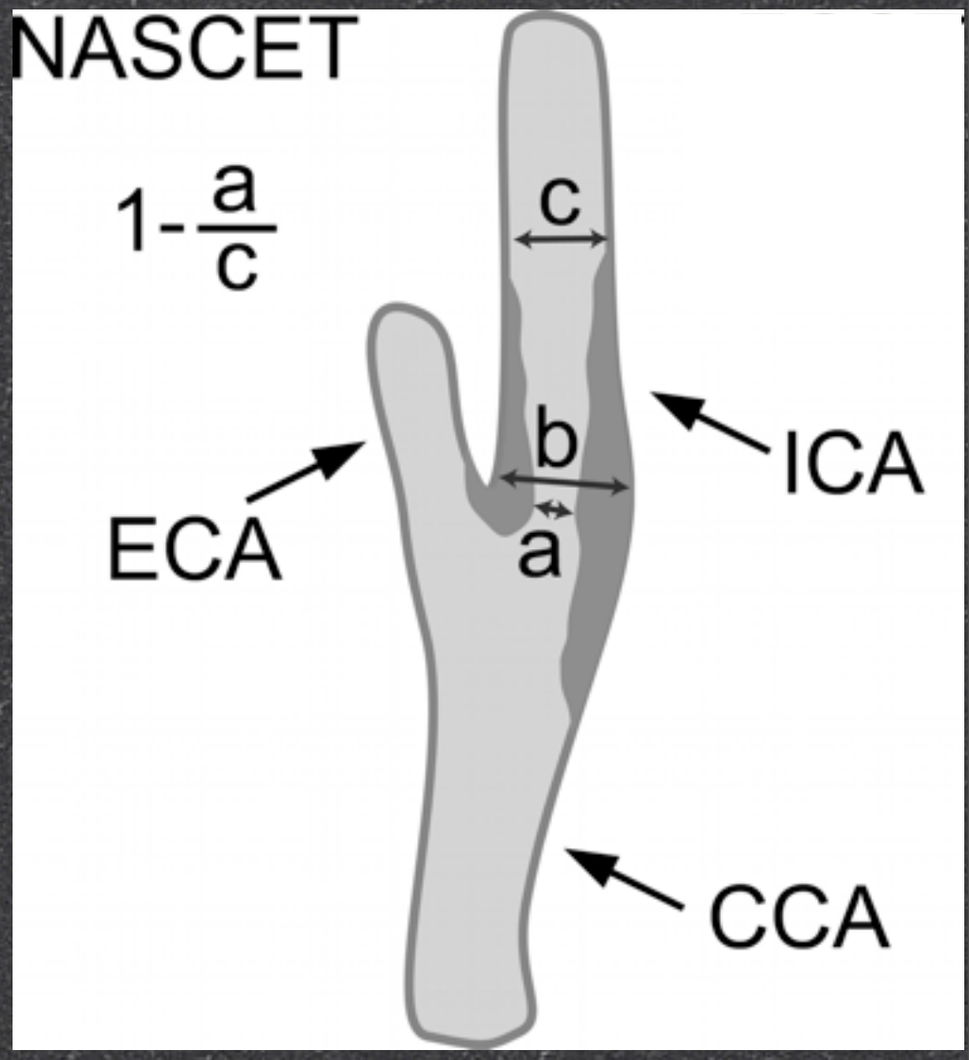
CTA

- Good correlation to DSA and MRA *
- Contrast Allergy
- Contrast Nephropathy
- Limited w/ Dense Calcifications or Metal

* Long, et al. Eur J Endovasc Surg 2002;24:43-52

Detection of Stenoses

- Use NASCET Criteria
- CTA - no systematic tendency to over/ under-estimate
- MRA: depends on technique



Case 1: 47 M with TIA

INITIAL CTA

2 MONTHS LATER

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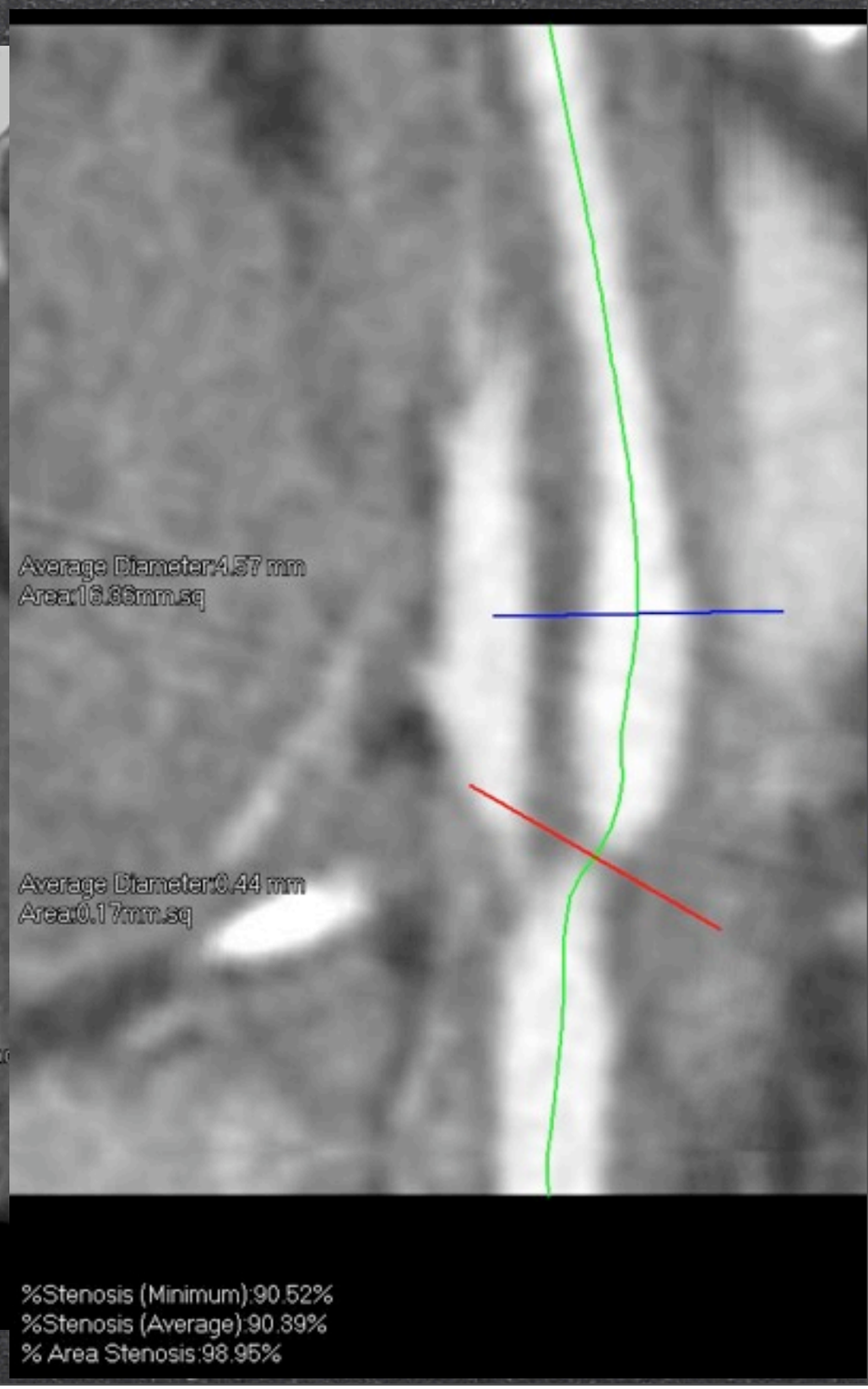
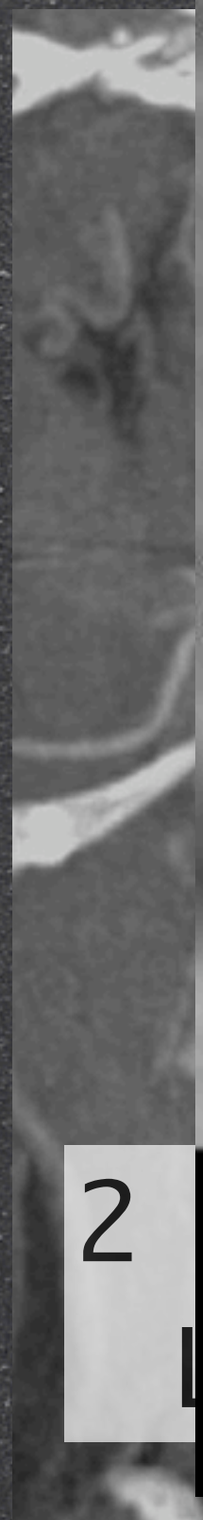


Case 1: A

INITIAL CTA



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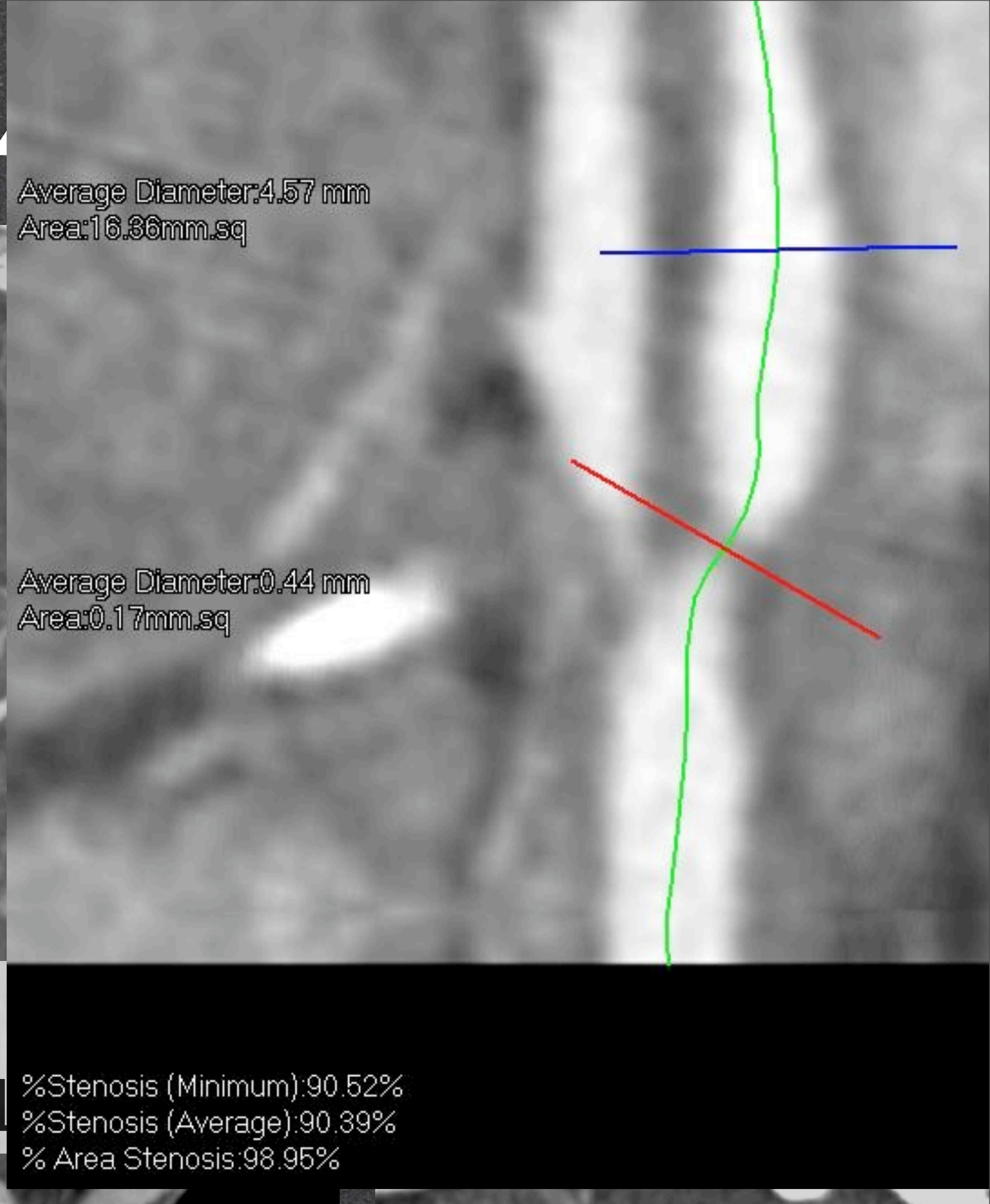


Surgical Path:

- Atherosclerosis
- No inflammatory vasculitis

TIPS

- When high grade stenosis (lumen <1 mm) - vessel distal to stenosis is constricted = “CT ANGIO STRING SIGN”
- DDX diffuse mural thickening: vasculitis, DSX
- Always consider atherosclerosis as an etiology!!

Carotid CTA: Stenosis Measurement

- Direct mm measurement of stenosis linearly related to derived (NASCET-type) % stenosis
- Has been correlated to area reduction measurement also

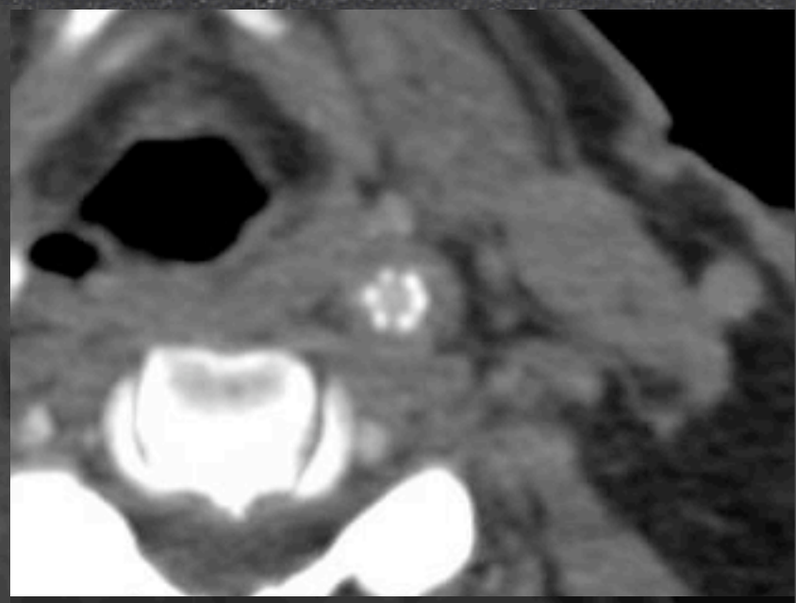
SENS 88%
SPEC 92%
NPV 98%

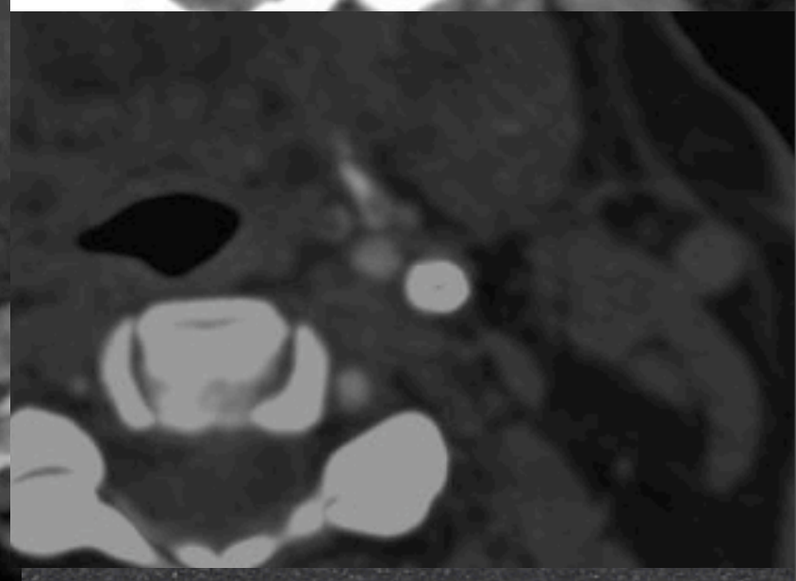
mm Stenosis	% Stenosis (95% PI)
2.2	**50–55**
2.1	52–57
2.0	54–59
1.9	57–62
1.8	59–64
1.7	61–66
1.6	64–68
1.5	66–70
1.4	68–72
1.3	**70–74**
1.2	73–76
1.1	75–78
1.0	77–80
0.9	80–82
0.8	82–84
0.7	84–86
0.6	86–88
0.5	89–90
0.4	91–92
0.3	93–94
0.2	95–96

Note:— Percent stenosis is expressed as a range with 95% prediction intervals (PI).

Bartlett ES AJNR (2006) 27:13-19

Case 2 - 68yo F s/p LICA stenting





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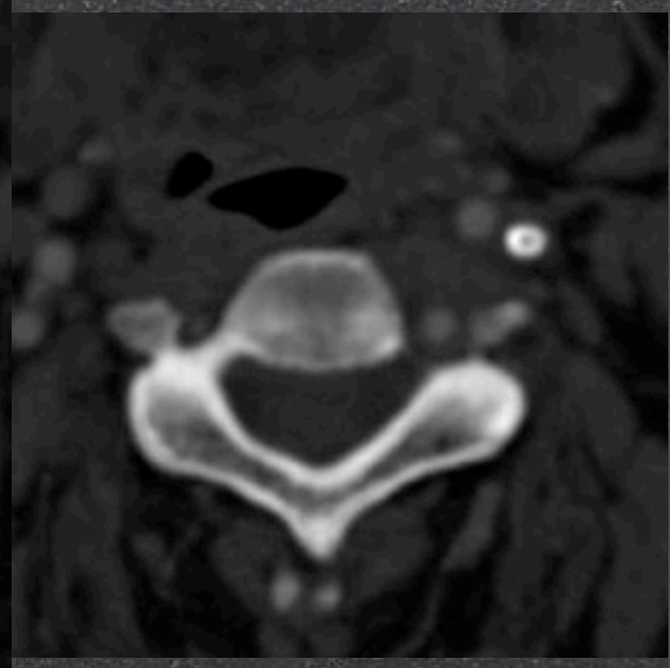
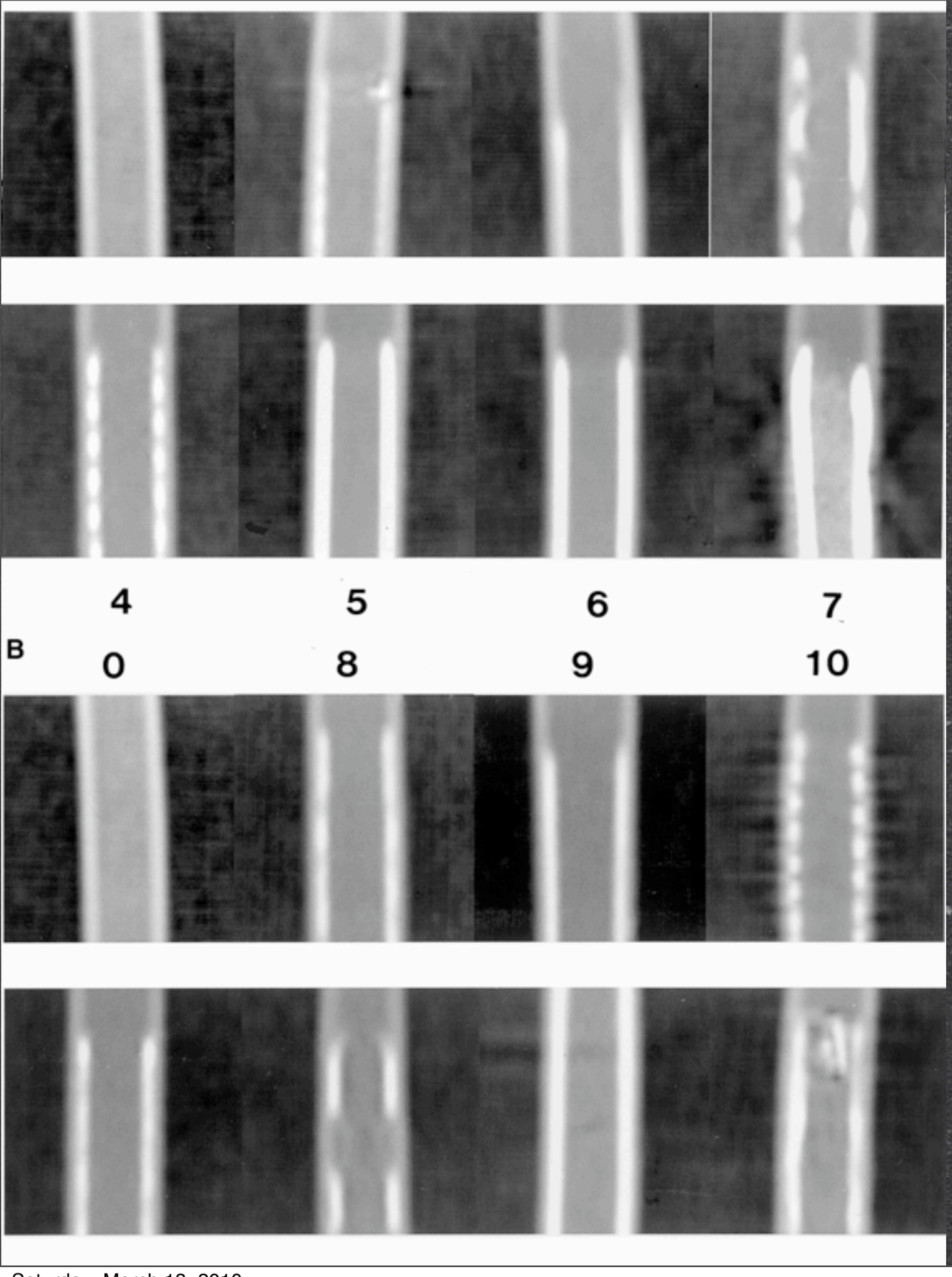


Post-Carotid Artery Stenting (CAS)

- Both CTA and MRA have artifacts and limitations
  - CTA overestimates in-stent stenosis
    - Streak / blooming artifacts
    - Stent composition dependent
    - CTA very limited for small (<3 mm) stents

Strotzer: Invest. Radiol 2001:36(11) 652-658

- CT of 14 different stents in vitro
- Tantalum stent (Strecker): INCREASED density in stent, could mask stenosis
- Platinum markers: severe bloom, difficult to evaluate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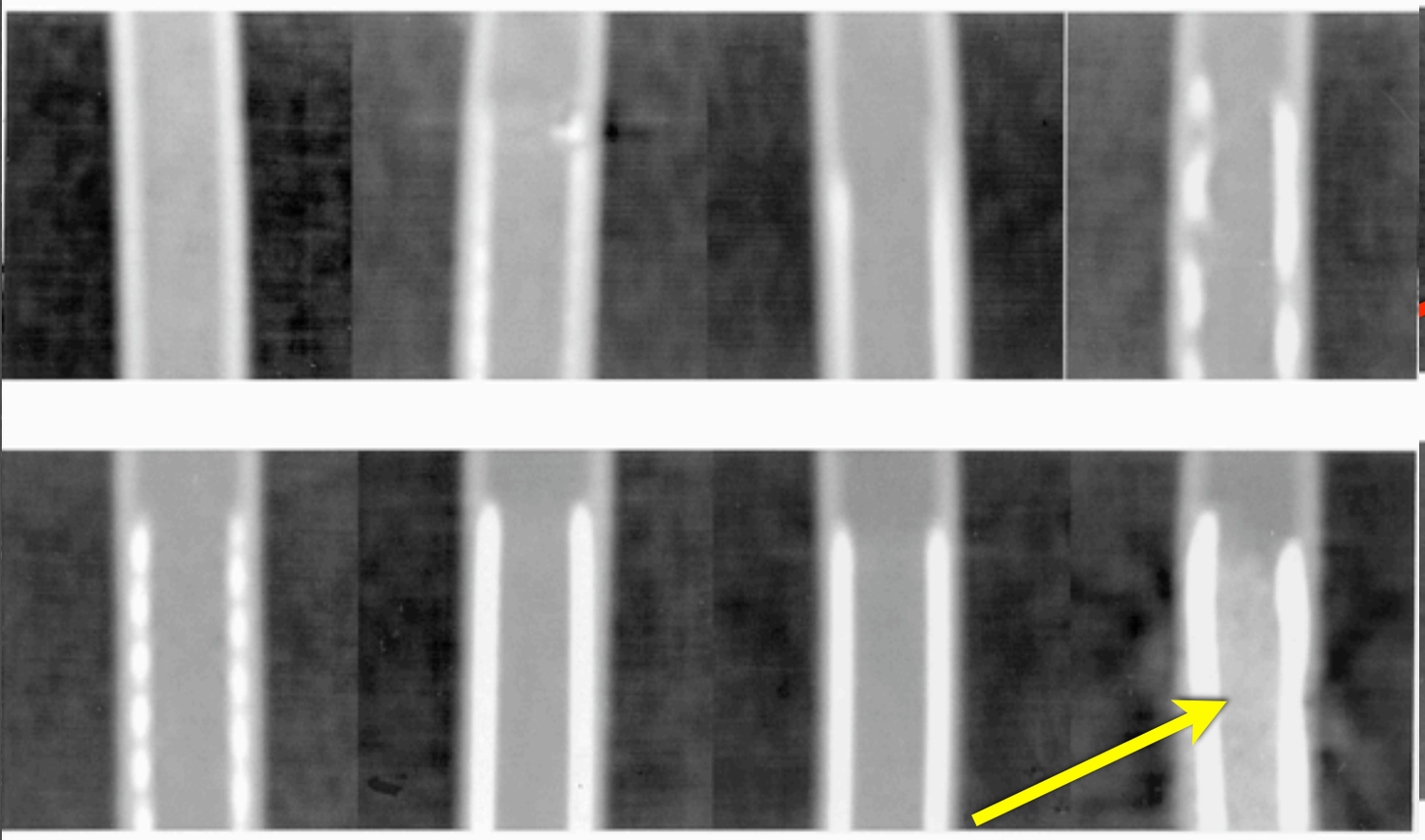
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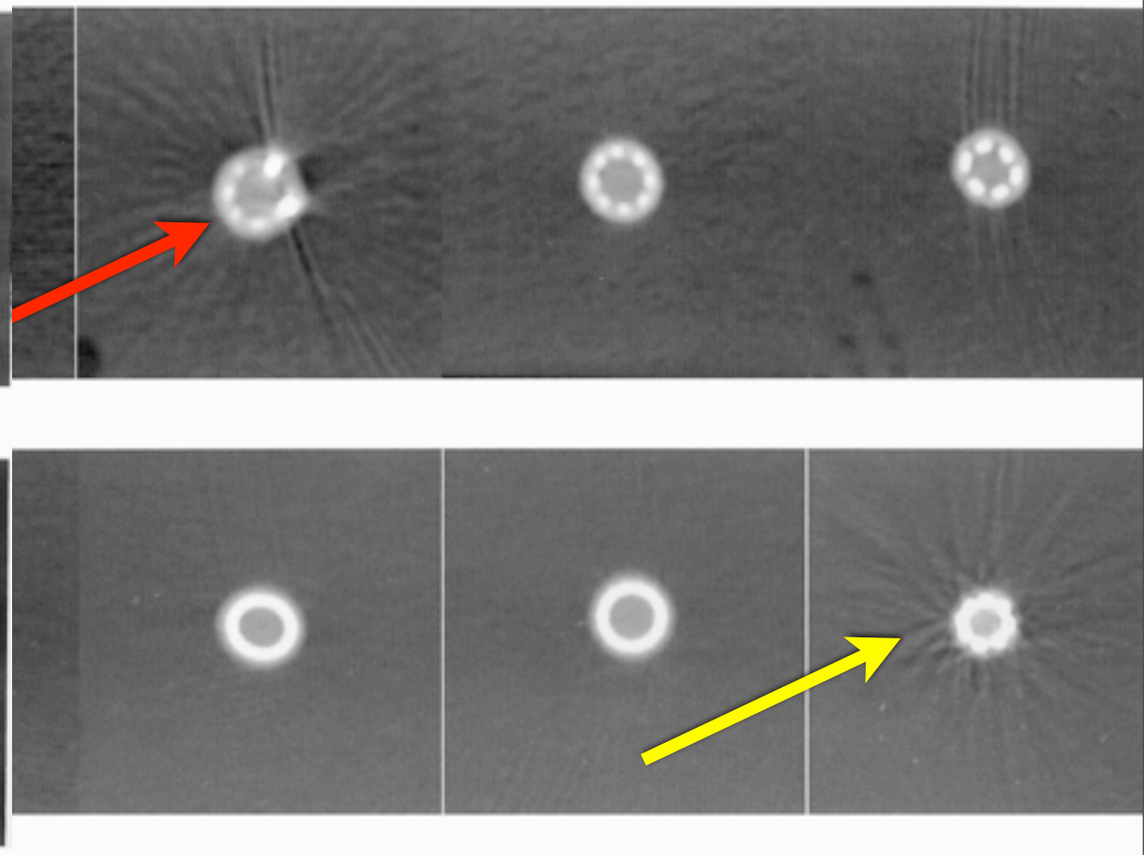
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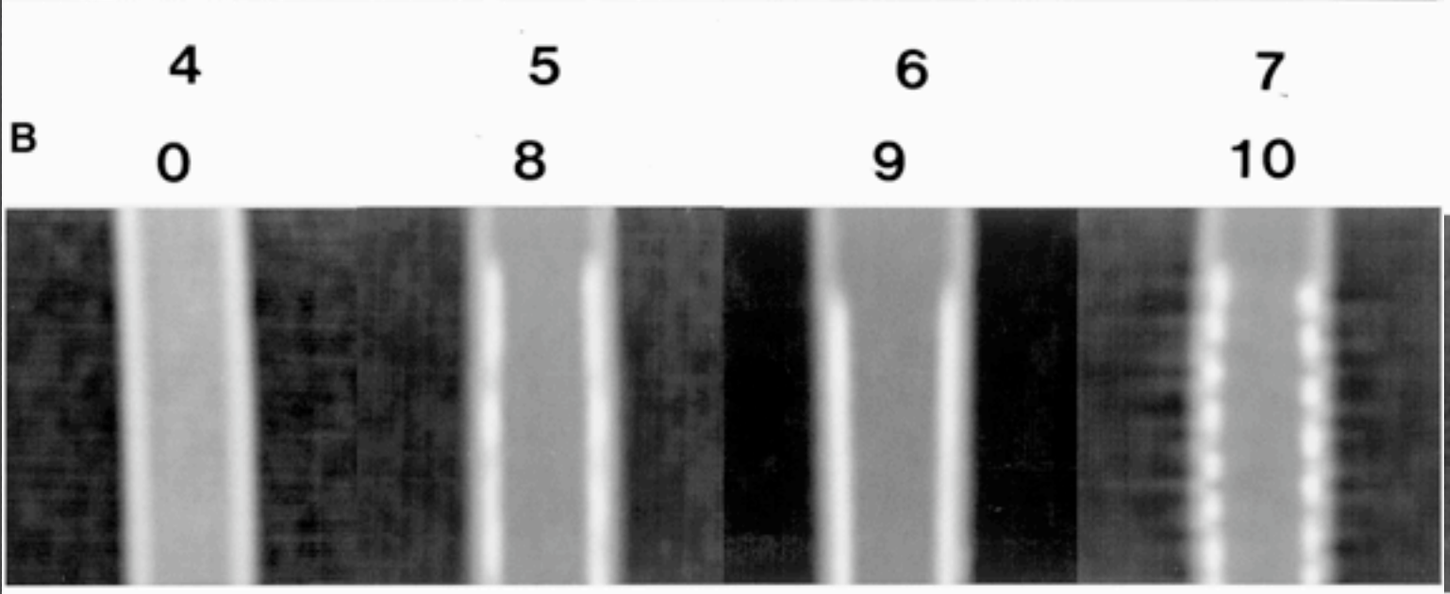
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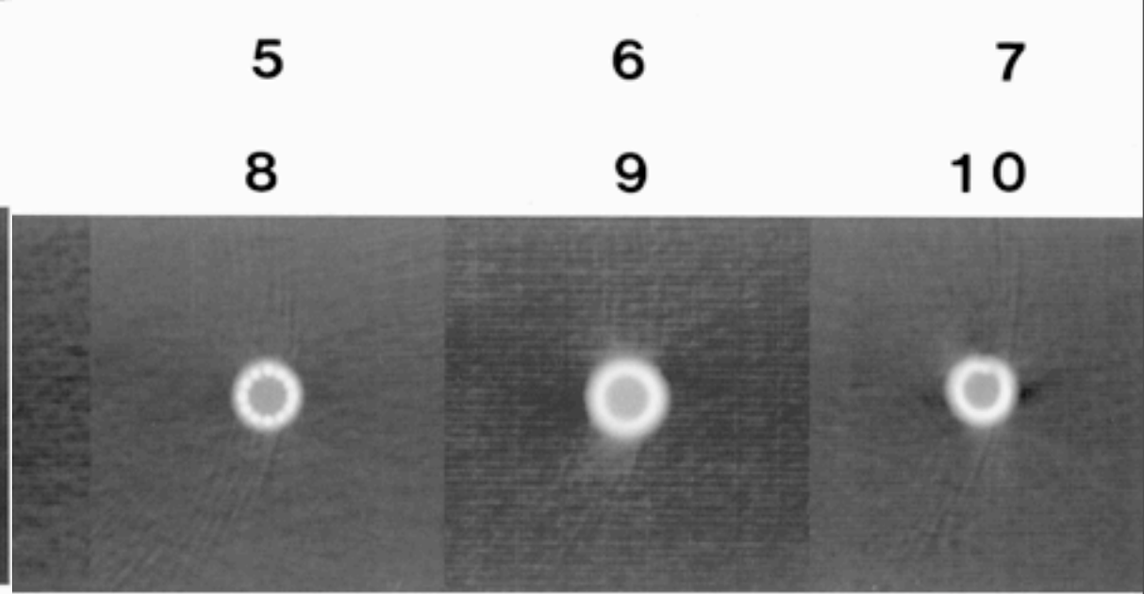
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Lettau, et al: AJNR 2009 (30):1993-1997

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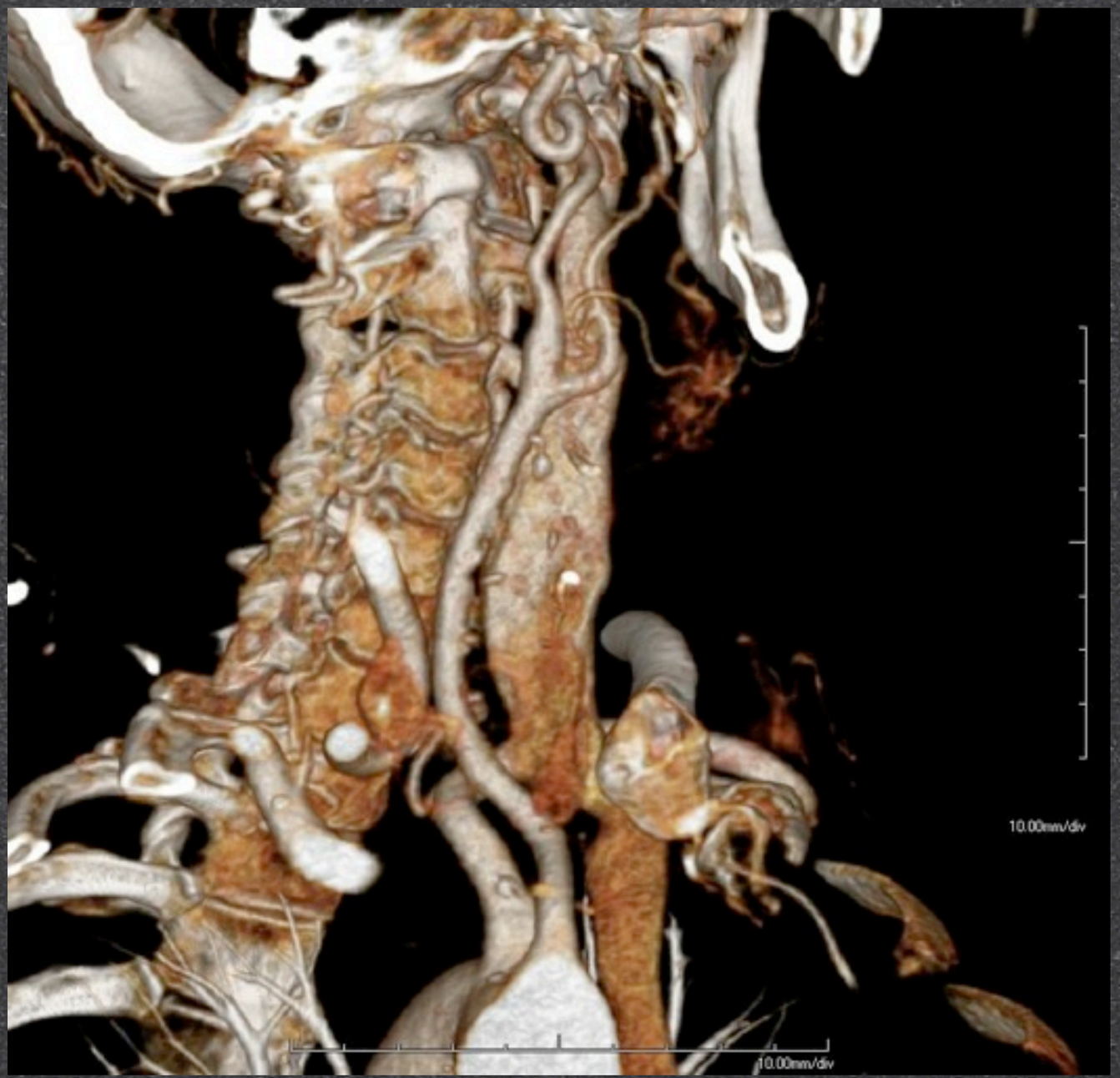
  - MRA: Nitinol better than stainless or cobalt alloys
    - 3T better than 1.5T
- CTA: less ALN (14-42%) than MRA except Nitinol stents imaged at 3T

Wang, et al: Mag Reson Med (2003) 49:972-976

- Stents cause susceptibility and RF shielding effects
- Susceptibility: near 100% from stainless steel, others negligible
- RF Shielding: Variable, worst for cobalt
  - Large platinum stents best for post-IR imaging
- Increase flip angle for CE-MRA to decrease ALN

Case 3: 78 F: abnormal carotid doppler - ? Stenosis



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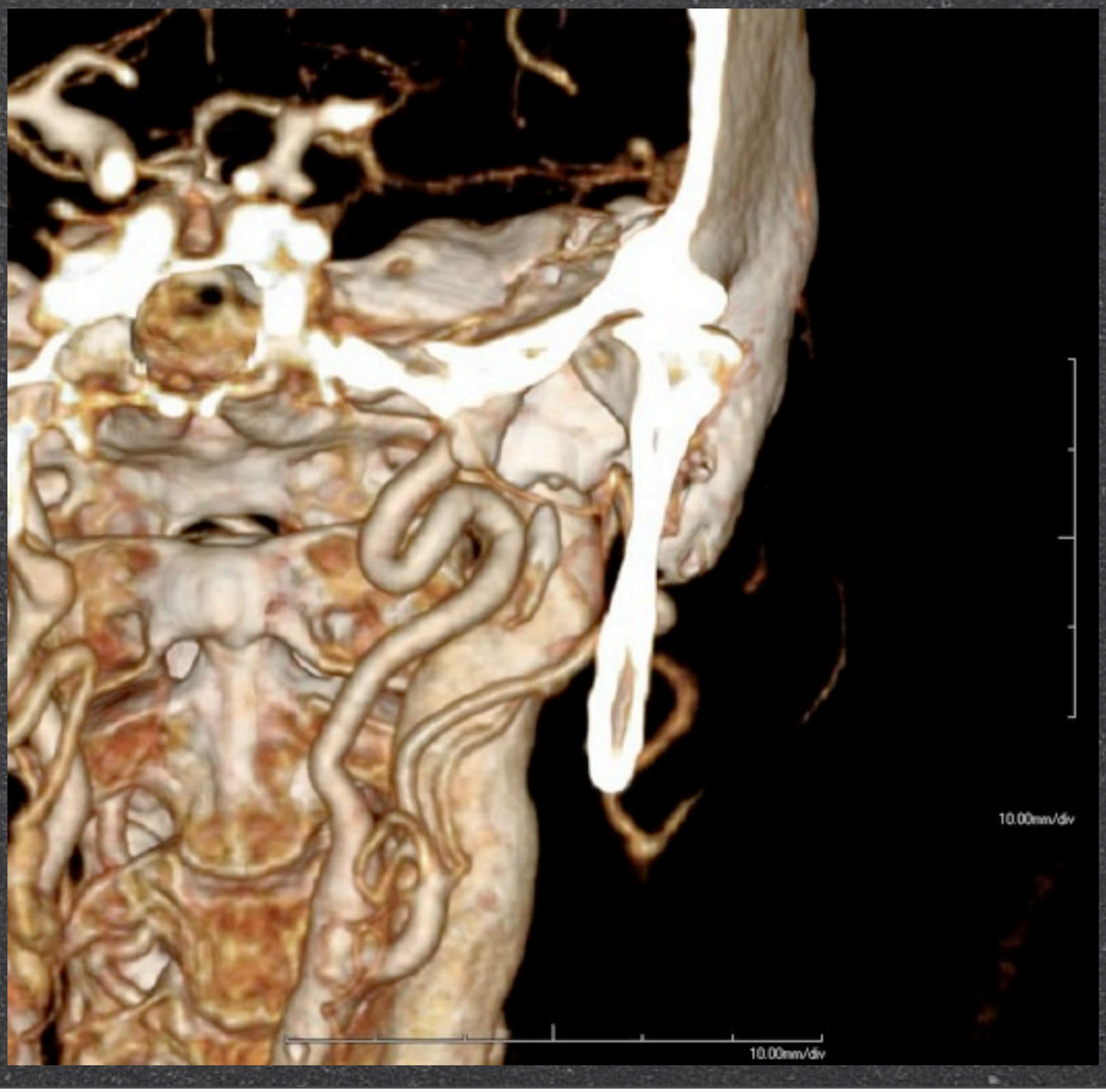

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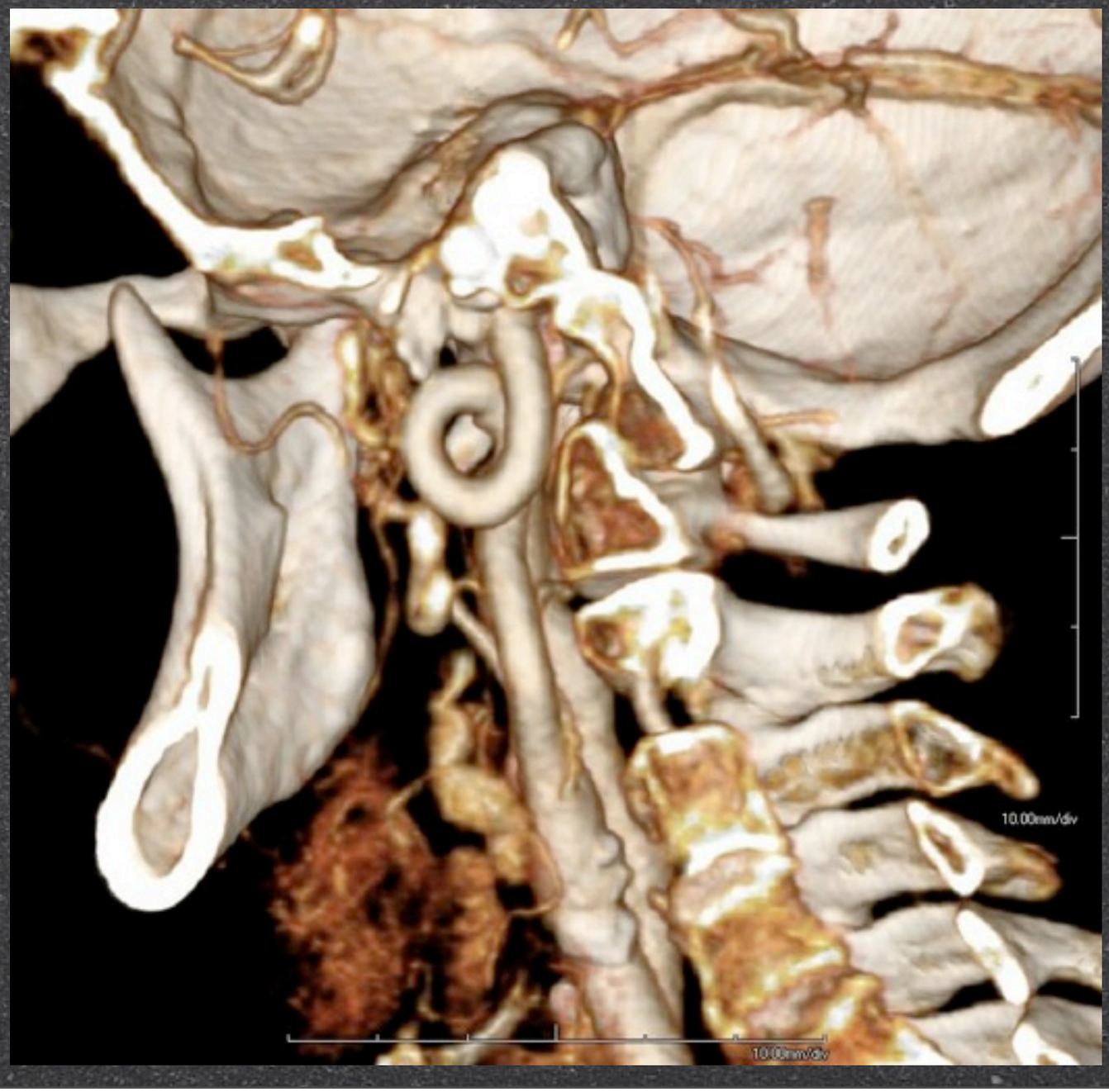

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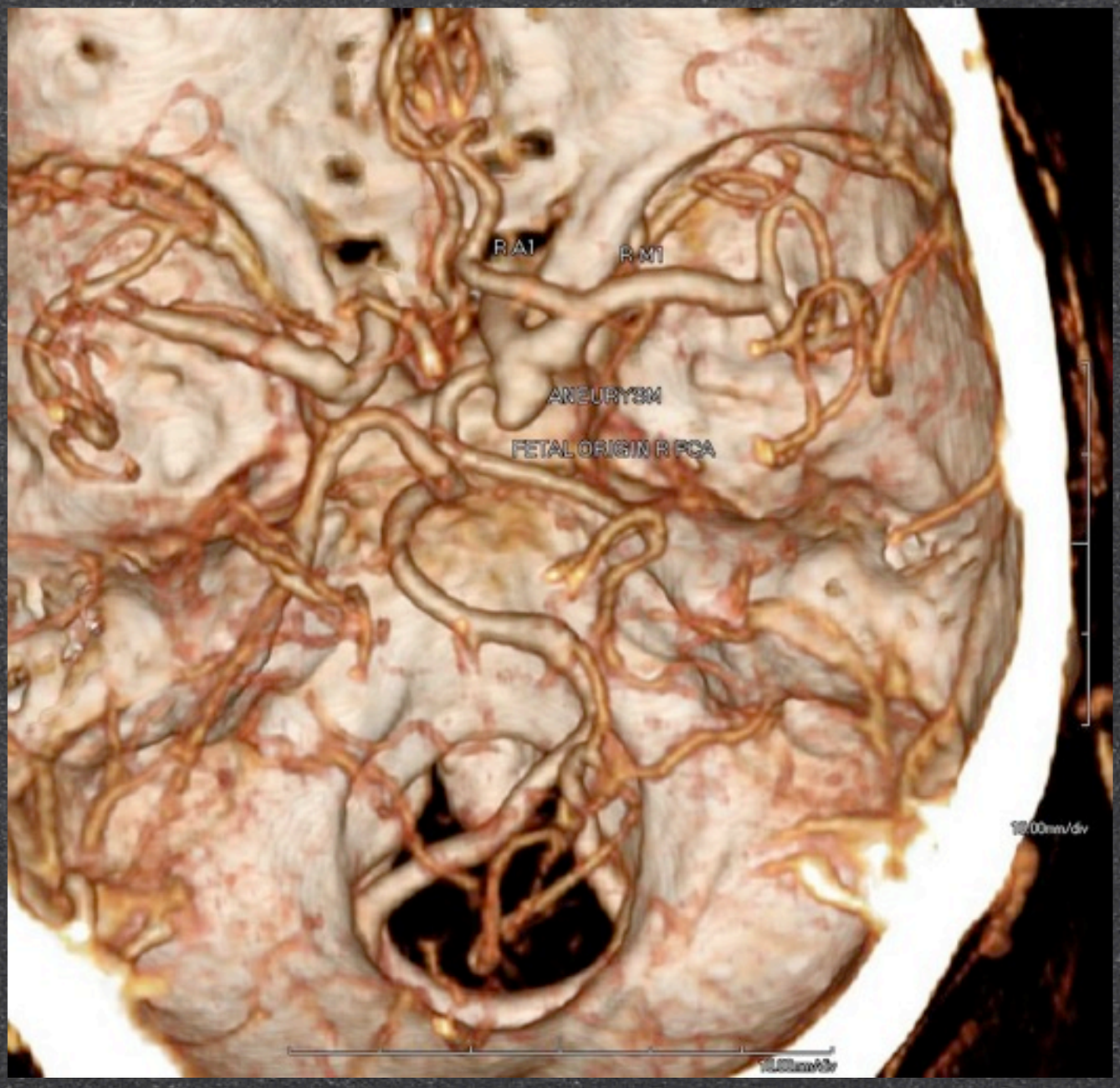

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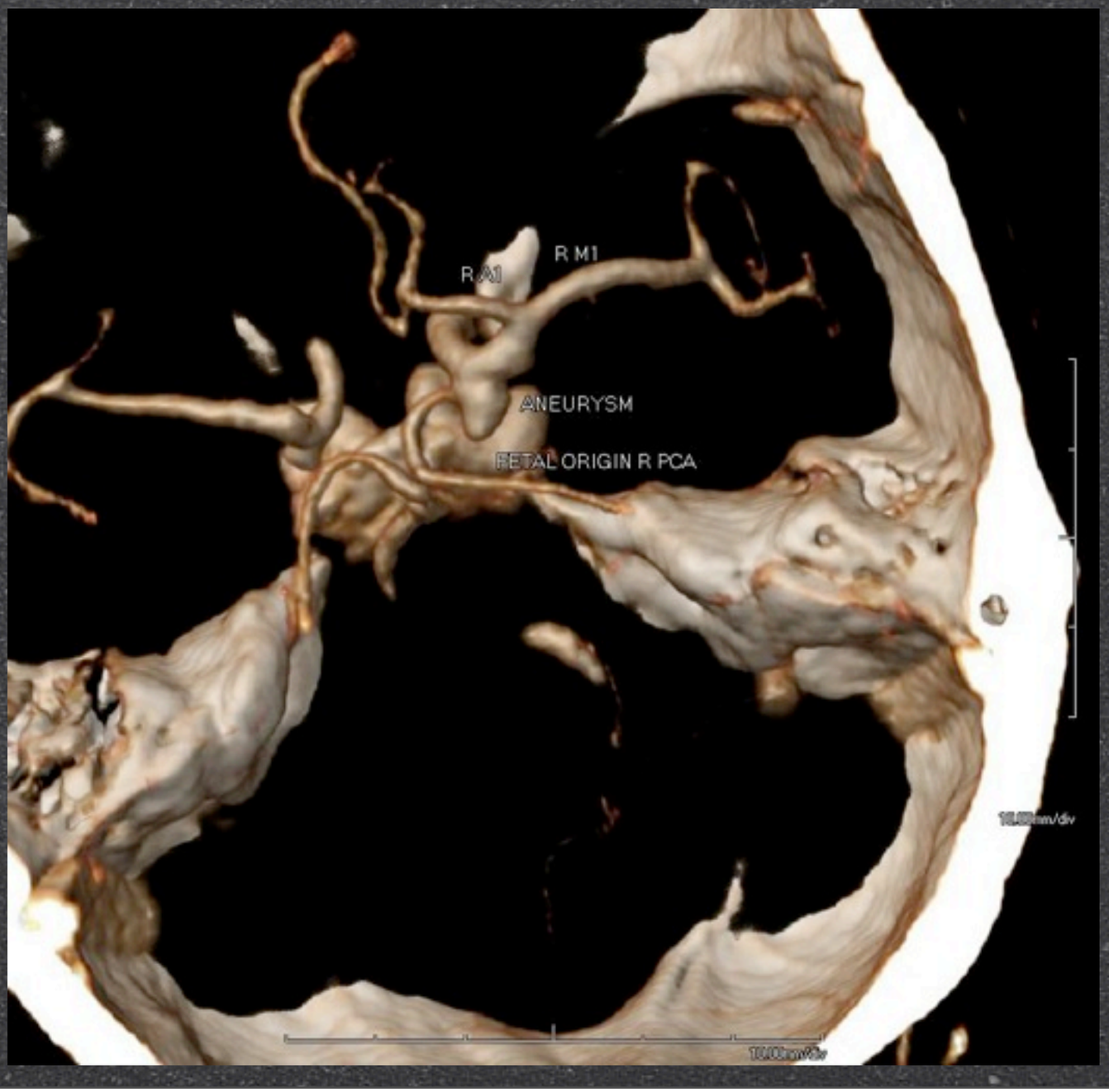

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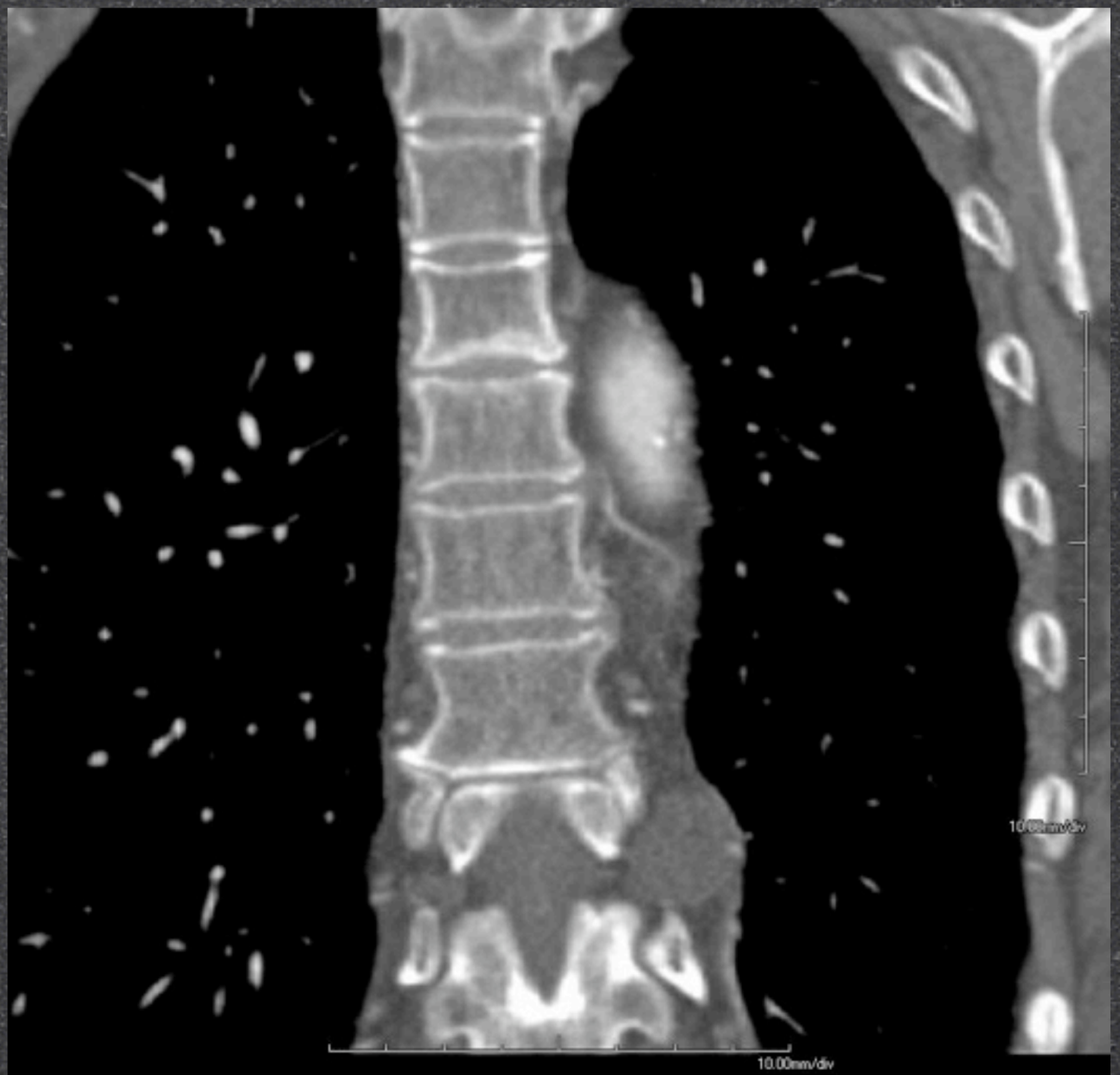

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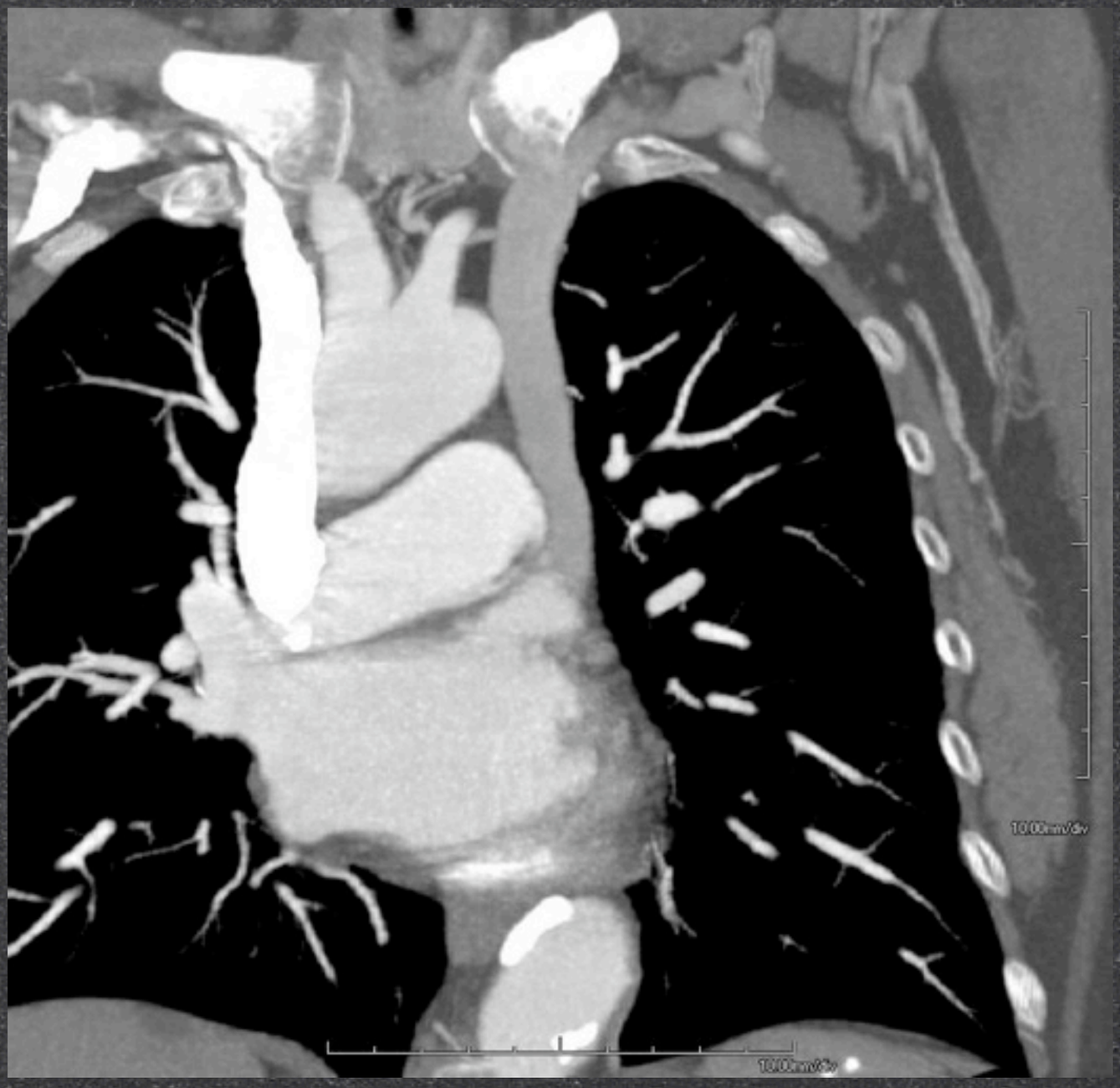

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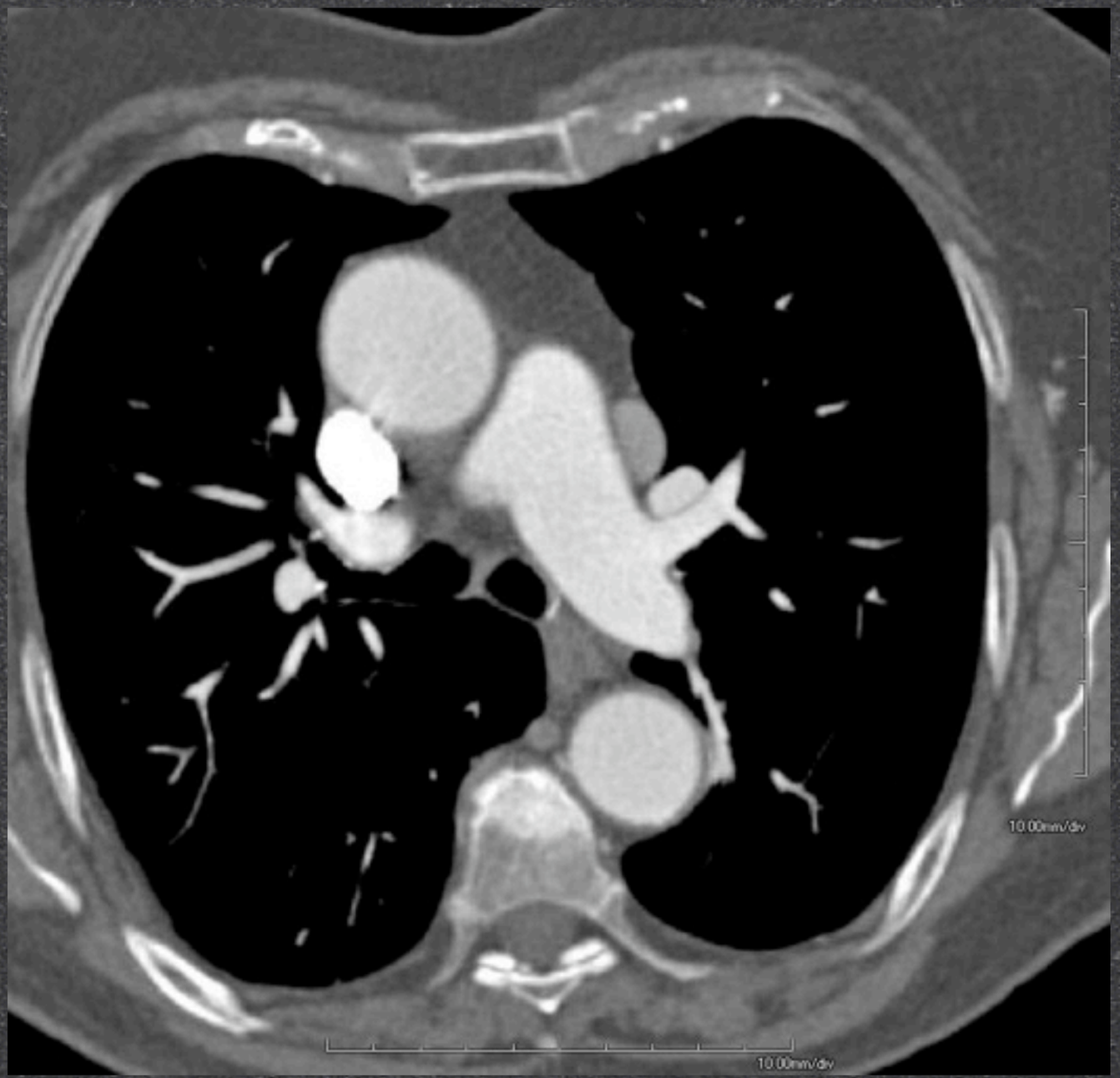

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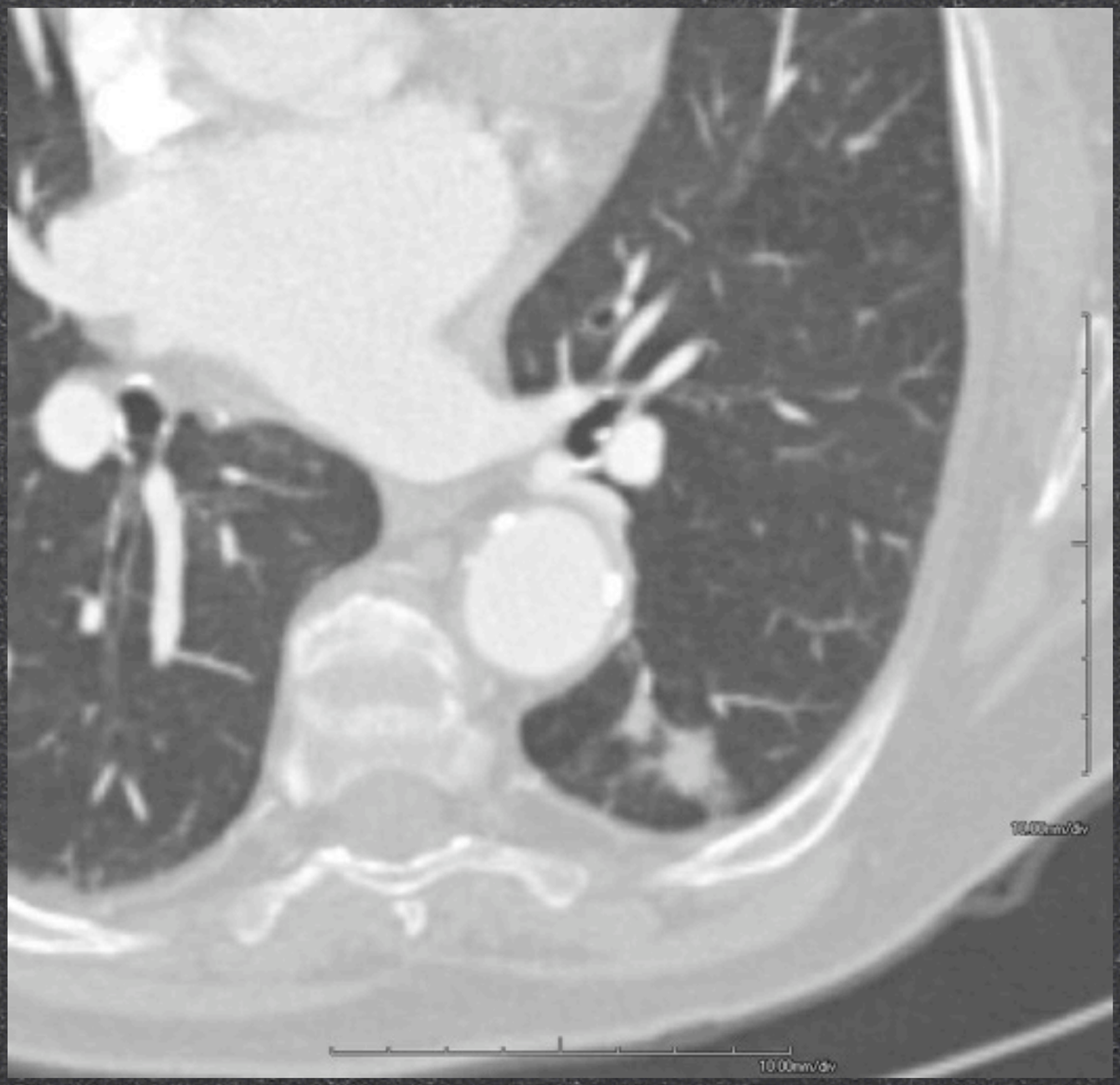
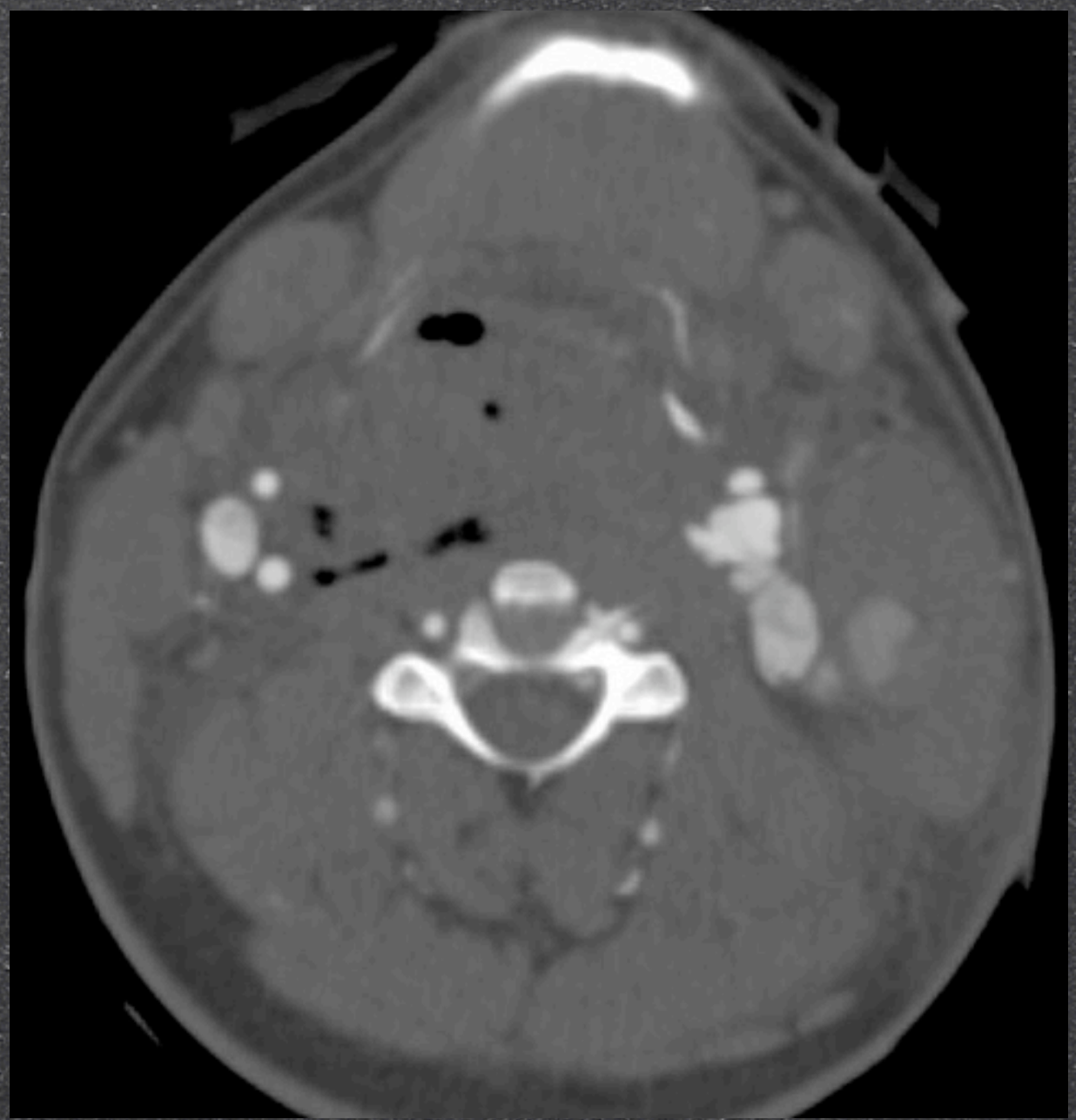


TIP

- Look at all the data, including axial source images
- Expect non-vascular pathology

Case 4: 31 yo Male S/P GSW to neck



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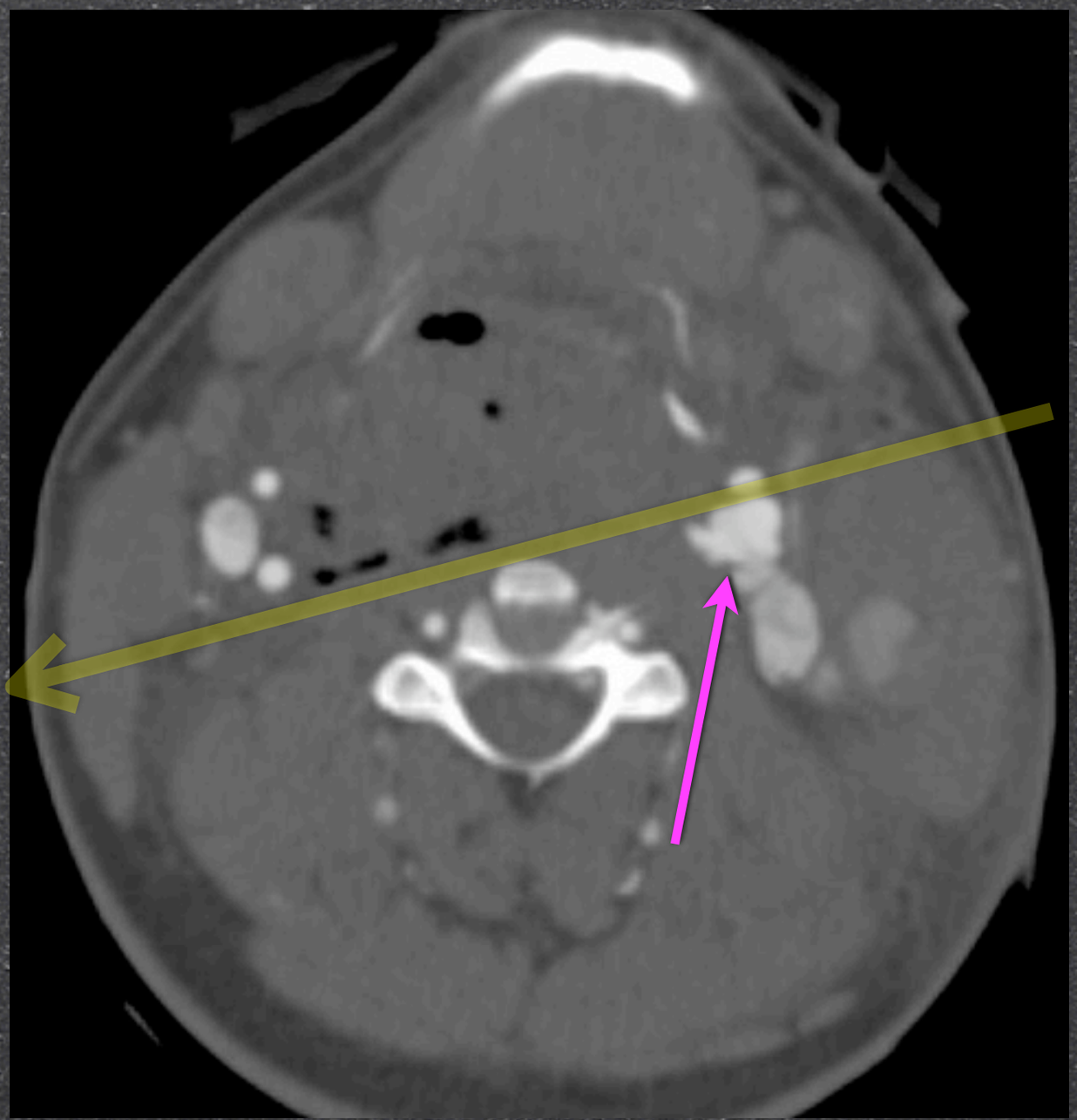
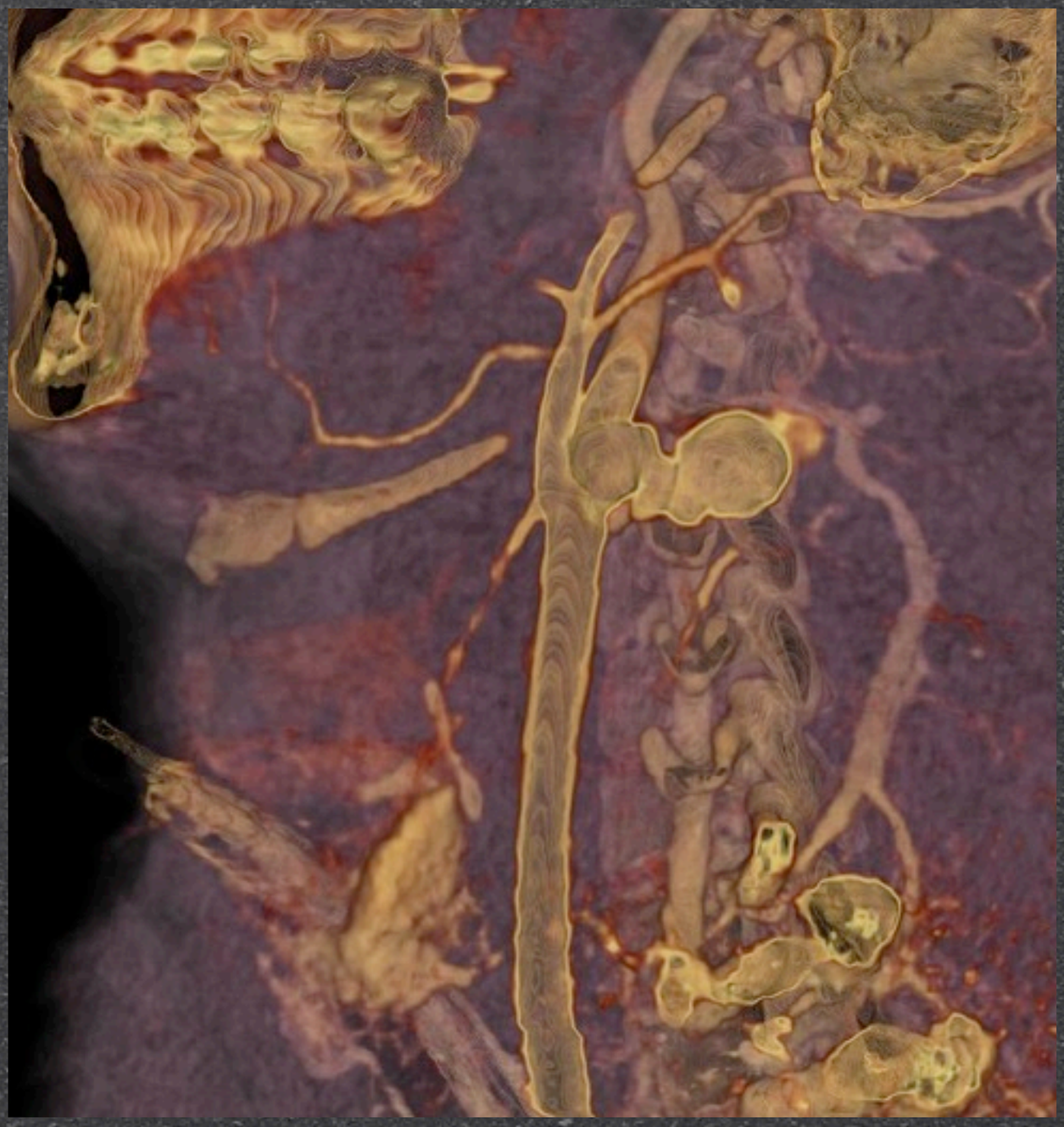


Use of Blood Pool Inversion Volume Rendering



Entrikin DW: JCCT 2008,2:366-371

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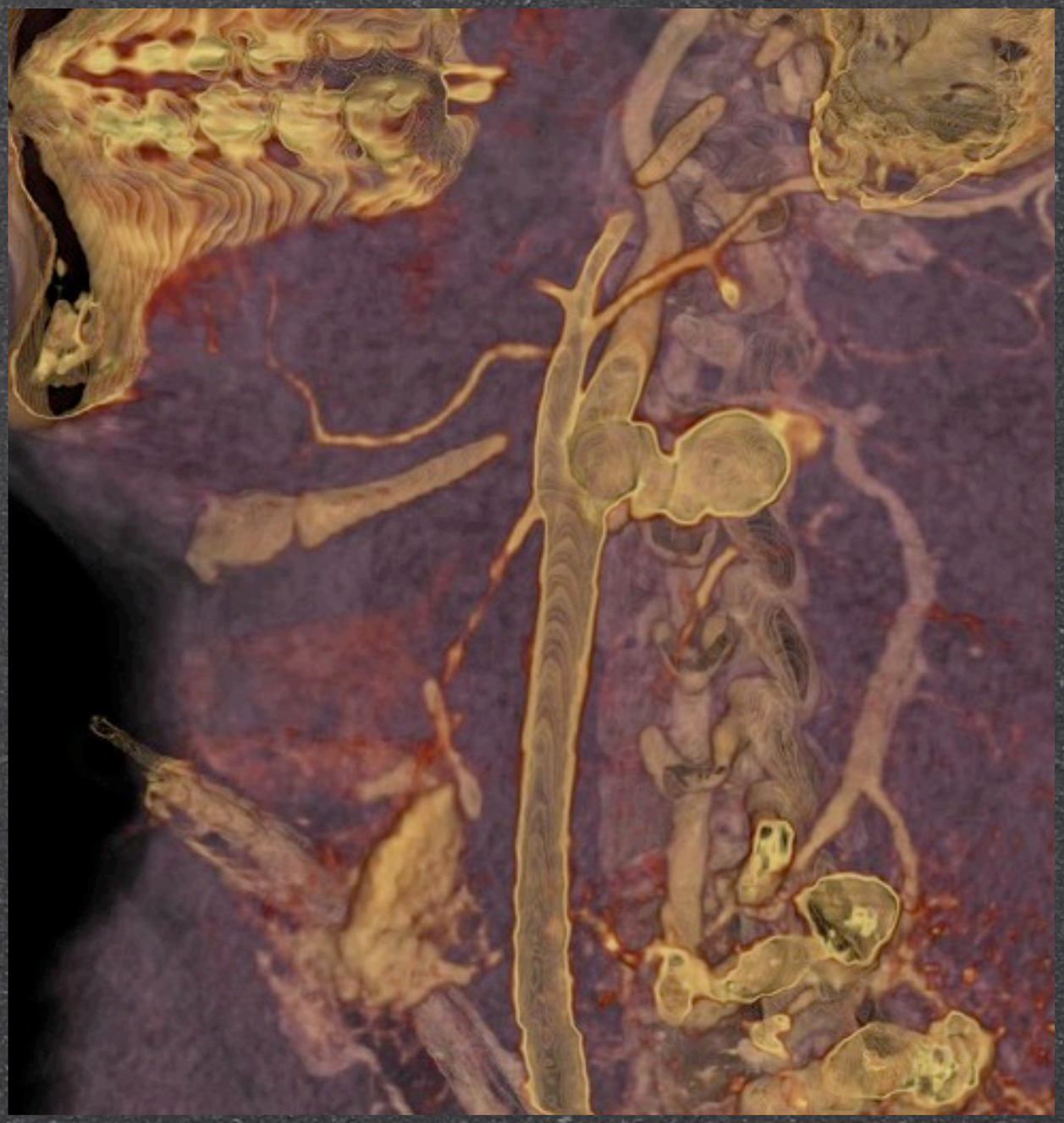

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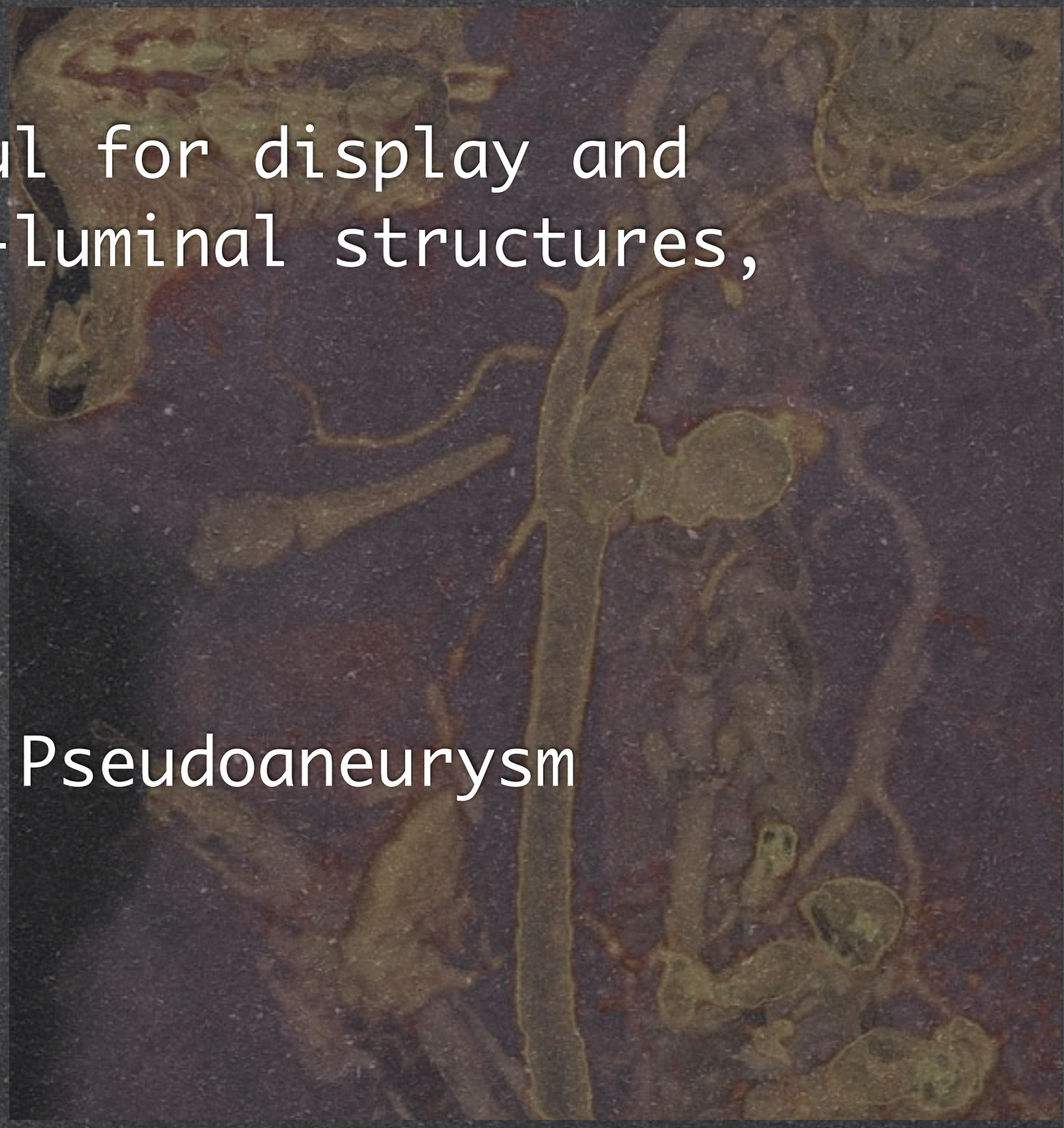
TIP



- BPI -VR is helpful for display and viewing of intra-luminal structures, especially:
  - Valves
  - Clot
  - DSX, aneurysm, Pseudoaneurysm
  - Stenoses

CONCLUSIONS

- CTA and MRA are robust techniques for evaluation of cervical arteries
- Understand strengths, limitations, and artifacts for each modality
- Knowledge of stent / marker composition, size, orientation will dictate the best modality for post-stent imaging followup

Thanks ! !

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