

CTA, pCT, MRA, MRV

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COMPUTED TOMOGRAPHY ANGIOGRAPHY (CTA)

- has become possible with introduction of **multislice (multidetector) spiral CT machine** - multiple detectors for simultaneous data collection at different locations - rapid dynamic imaging of anatomy of interest after bolus of IV contrast.
- volumetric data set is acquired *during vascular phase of iodinated contrast*, which is injected **intravenously** usually in antecubital vein (75-120 ml contrast medium at rate of 3 ml/s – patient needs at least 18G IV line).
- CTA uses ≈ 21 gm of iodine
GFR has to be > 45 (vs. > 30 for MRA)
- **timing of data acquisition** in relation to contrast administration is critical for maximum arterial opacification:
 - a) **standard delay** (between start of injection and image acquisition): 12 s for EXTRACRANIAL and 15 s for INTRACRANIAL vessels.
 - b) **automating bolus detection system** (available on most machines) - adjusts for individual variations in circulation time.
- submillimeter axial images are obtained and then reformatted into 2D sagittal and coronal image data sets at 1- to 2-mm intervals.
- 3D reconstruction images are usually obtained, but interpretation of study is based primarily on original *axial* data set and **2D sagittal and coronal** reformatted images.

Indications for CTA:

- 1) carotid artery stenosis / dissection
- 2) intracranial vascular occlusion / aneurysms (≥ 3 mm) / AVM*
*subject to ongoing research.
- 3) dural sinus thrombosis (CT venography).

At present, CTA is mostly employed as **screening tool for aneurysms**:

- a) to rapidly show aneurysms in symptomatic patients
- b) to screen asymptomatic patients at risk for cerebral aneurysms.

CTA advantages over MRA:

- 1) less motion-sensitive
- 2) no flow-related effects (e.g. can easily visualize slow flow or turbulent flow in aneurysms)
- 3) fast (< 32 seconds)
- 4) can be used in *claustrophobic* patients
- 5) no MRI compatibility problems (e.g. intubated patients, aneurysm clips, cardiac pacemakers, etc).

CTA disadvantages over MRA:

- 1) intravenous iodinated **contrast!!!** – side effects and **only one opportunity** to perform study (MRA does not require any contrast - can be repeated immediately!)
- 2) exposure to **radiation**
- 3) vessels **at skull base** may be obscured by enhancement in cavernous sinus or bone.
- 4) in **SAH**, high density of blood can obscure bleeding aneurysm
- 5) aneurysm **clips** produce artifacts (MRA has similar problems)
- 6) **calcifications** can produce artifacts

PERFUSION COMPUTED TOMOGRAPHY (pCT)

– provides **PHYSIOLOGIC + ANATOMIC information**.

- performed with latest-generation multidetector CT scanners, which allow very rapid CT imaging.
- bolus IV injection of contrast (4-5 mL/sec) → rapid serial CT images of chosen volume obtained in multiple phases over approximately 1-minute period.
- at end of this acquisition, multiphase time-density curves corresponding to each voxel are generated within 2D image of multilevel image data set → data further postprocessed and displayed in **color maps** of the following perfusion parameters:
 - 1) **cerebral blood flow (CBF)** in mL/100 g/min
 - 2) **cerebral blood volume (CBV)** in mL/100 g
 - 3) **mean transit time (MTT)** in seconds
- pCT technology has been validated against other proven in vivo techniques (Xe-enhanced CT and PET).
- not good (but still rather useful) for **posterior fossa** – bone artefacts.

INDICATIONS

1. **Acute stroke** – most common use of pCT – to determine presence of salvageable ischemic penumbra during first few hours after stroke. see p. Vas3 >>
2. **SAH-related vasospasm**. see p. Vas25 >>
3. **CNS neoplasms**

Magnetic Resonance Angiography (MRA), Magnetic Resonance Venography (MRV)

- **images of flowing blood*** *without administration of exogenous contrast*** - relying on:

- a) inflow of unsaturated spin (**time-of-flight (TOF) MRA**) - technique used most frequently; relies on suppression of nonmoving tissue to provide background for high signal intensity of flowing blood; areas of turbulent or slow flow may remain undetected (due to intravoxel dephasing).
- b) accumulation of phase shifts proportional to flow velocity (**phase contrast (PC) MRA**) - captures only truly patent vessels:
 - 1) reveals **velocity** and **direction** of blood flow (i.e. more sensitive for detection of slow flow); vs. TOF – mainly anatomic information.
 - 2) excellent suppression of background signal.

- 3) can differentiate between *flow* and *thrombus* (in TOF images, both *thrombus* containing methemoglobin [has T1 effect] and *flow* can be bright whereas only *flow* will have signal on PC images).

*vs. **anatomic images of vessels** given by conventional angiography

****contrast-enhanced MRA (cMRA)** is also available (GFR has to be > 30).

N.B. MRA is flow-dependent technology; absence of flow signal does not mean literally complete occlusion but rather that flow is below critical value

- both TOF and PC techniques can be performed with 3D data acquisition (physician can sit at console and manipulate vessels in numerous projections!; vs. conventional angiography).
- if using magnets > 1.5 T, CSF flow can give “flow void” artefacts – can be mistaken for dilated veins.

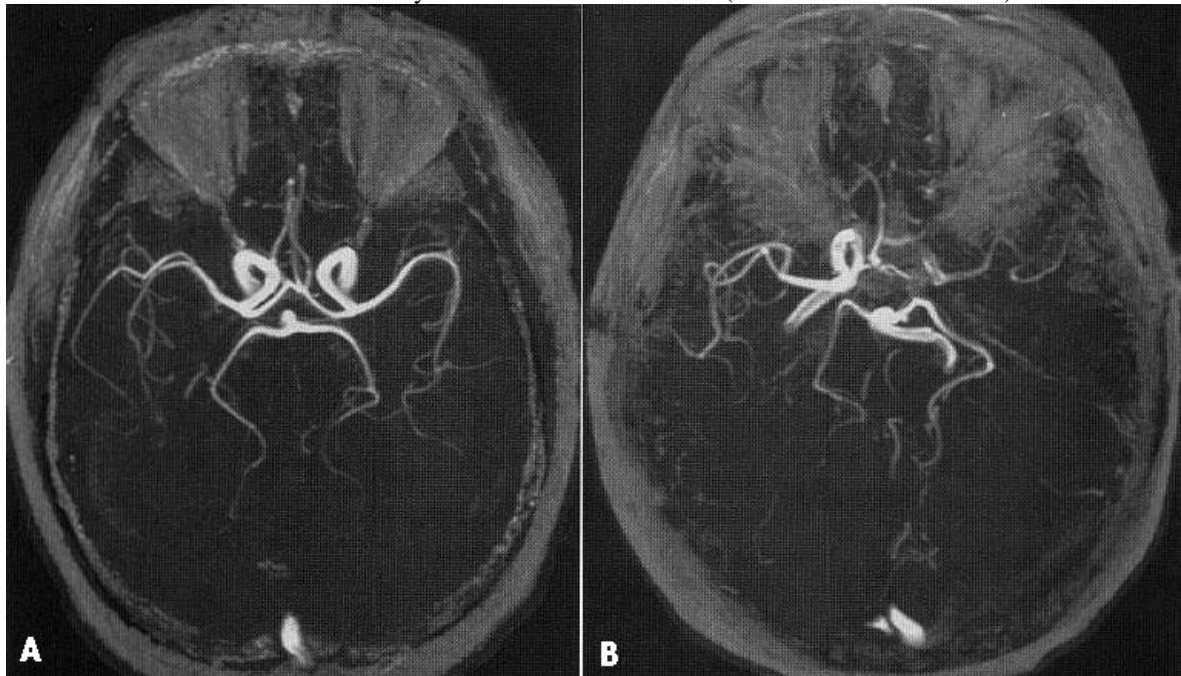
Primary uses of MRA:

- 1) stenotic lesions in *carotid artery bifurcation* (MRA is best noninvasive technique!)
MRA tends to exaggerate severity of arterial narrowing and therefore does not usually miss occlusive disease of large arteries!
 - 2) noninvasive screening for *intracranial aneurysms* (esp. > 3-5 mm) in *patients at risk*.
 - 3) following patients *after coiling* (CTA will have metal artefacts)
- MRA of *small distal vessels* are often difficult to interpret (CTA has better resolution!).

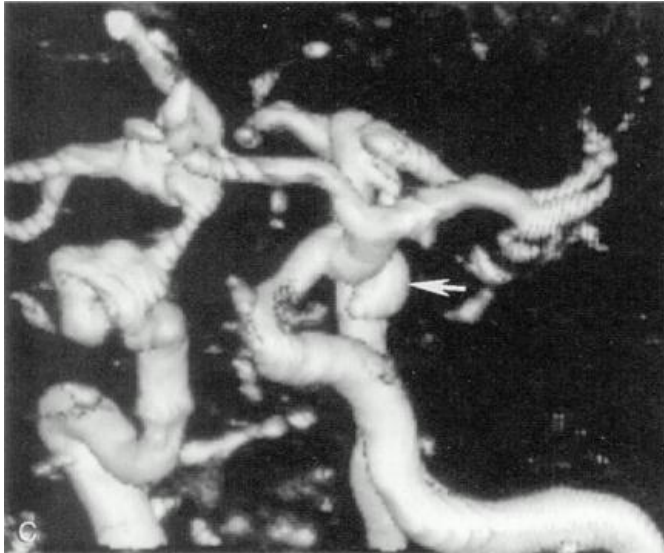
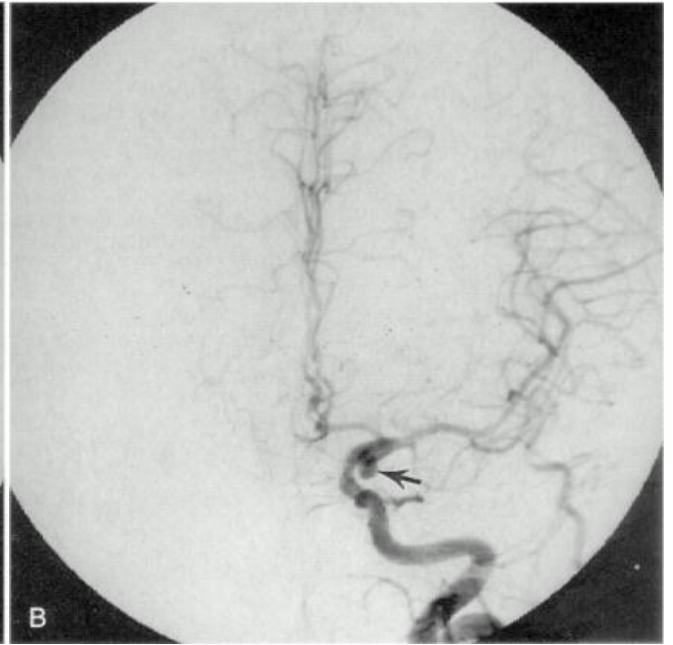
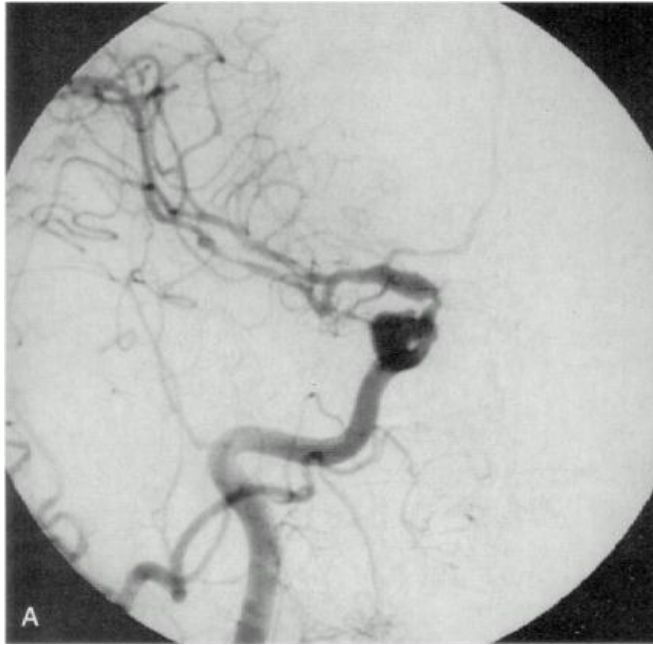
Primary uses of MRV – thrombosis of *superior sagittal sinus or transverse sinuses* - diagnosis & follow-up (monitoring thrombus resolution and guiding duration of anticoagulation).

A. **Normal** MRA (2D TOF), axial slab, through circle of Willis.

B. Another MRA at the same level - markedly diminished left MCA flow (**internal carotid occlusion**):

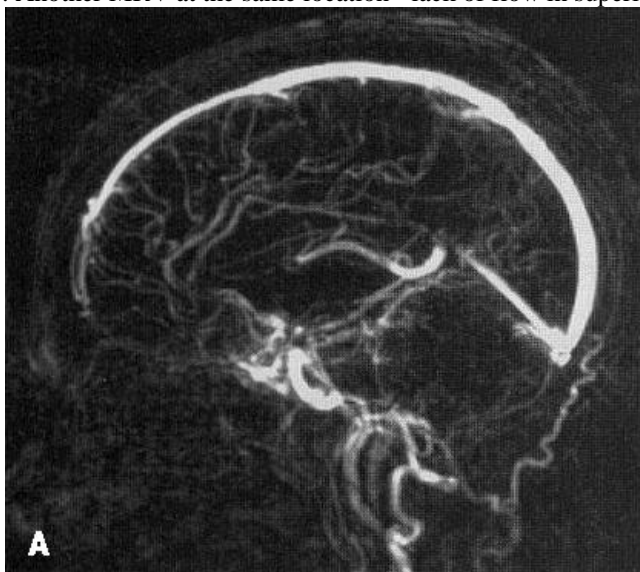


Aneurysmal dilatation of cavernous and supraclinoid portions of right ICA and aneurysm (arrow) at supraclinoid portion of left ICA: right (A) and left (B) carotid angiograms; 3D surface-rendered MRA (C):



A. Normal MRV (2D PC), median sagittal slab.

B. Another MRV at the same location - lack of flow in superior sagittal and straight sinuses (**dural sinus thromboses**):



BIBLIOGRAPHY for ch. "Neurovascular Examination" → follow this [LINK >>](#)

Viktor's NotesSM for the Neurosurgery Resident
Please visit website at www.NeurosurgeryResident.net