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.

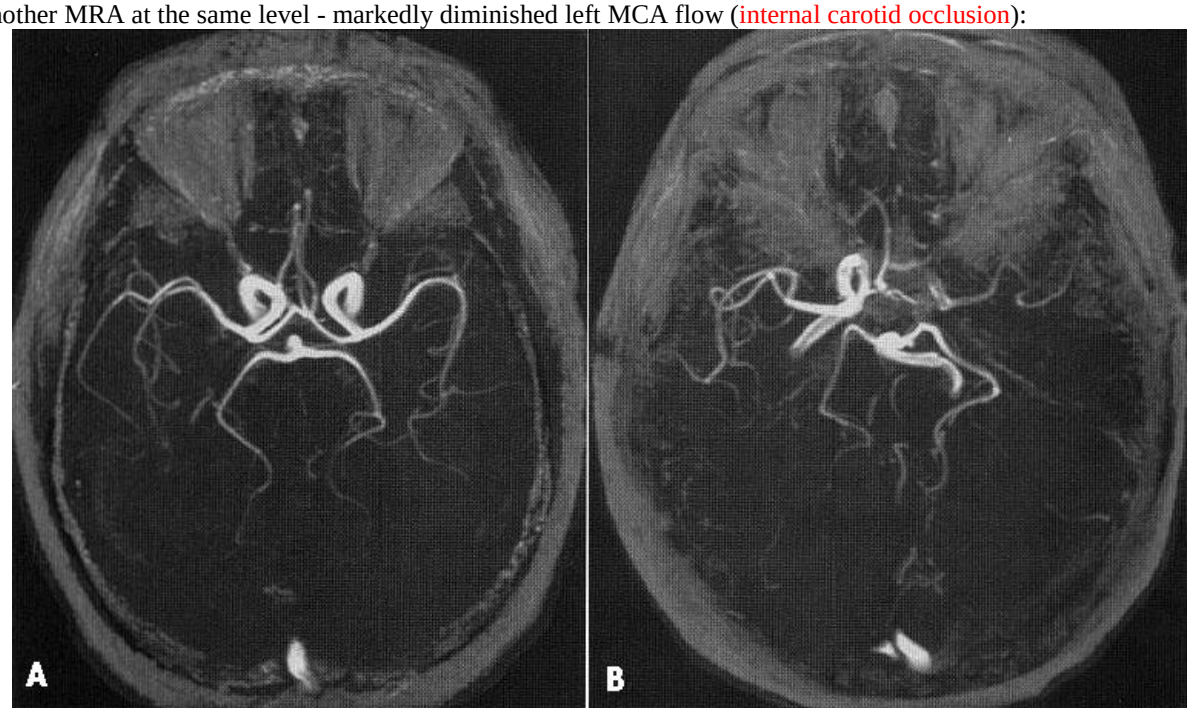
Primary uses of MRA:

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)

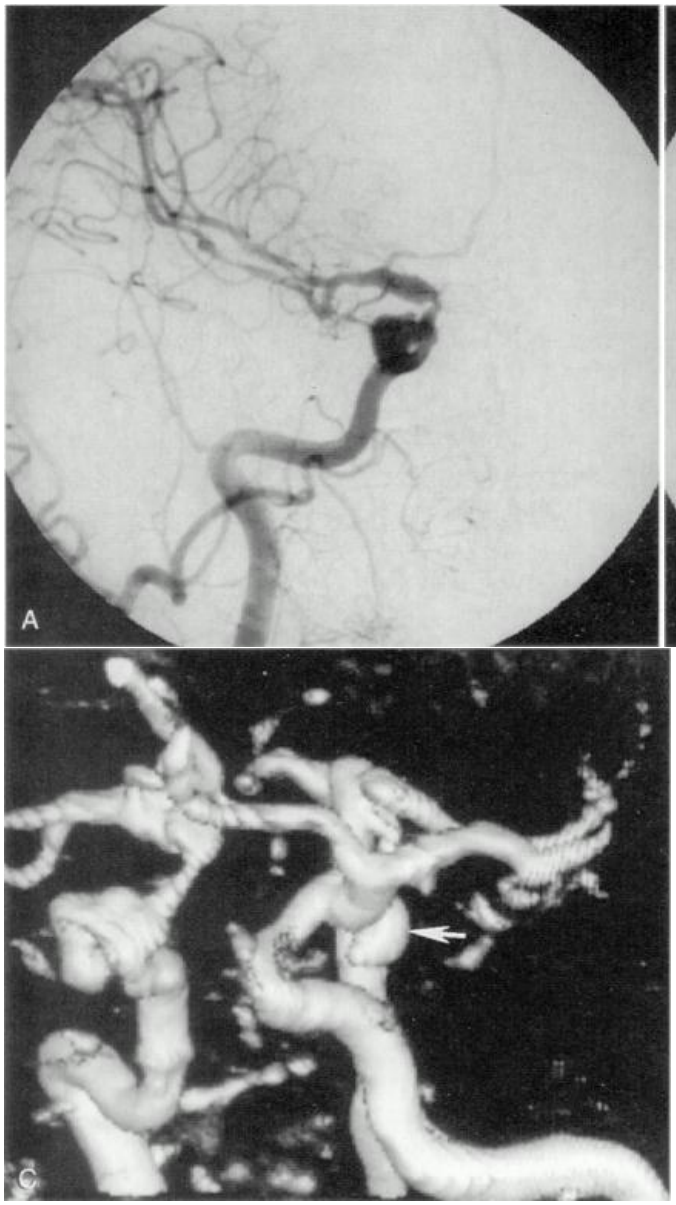
- MRA of *small distal vessels* are often difficult to interpret (CTA has better resolution!).

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

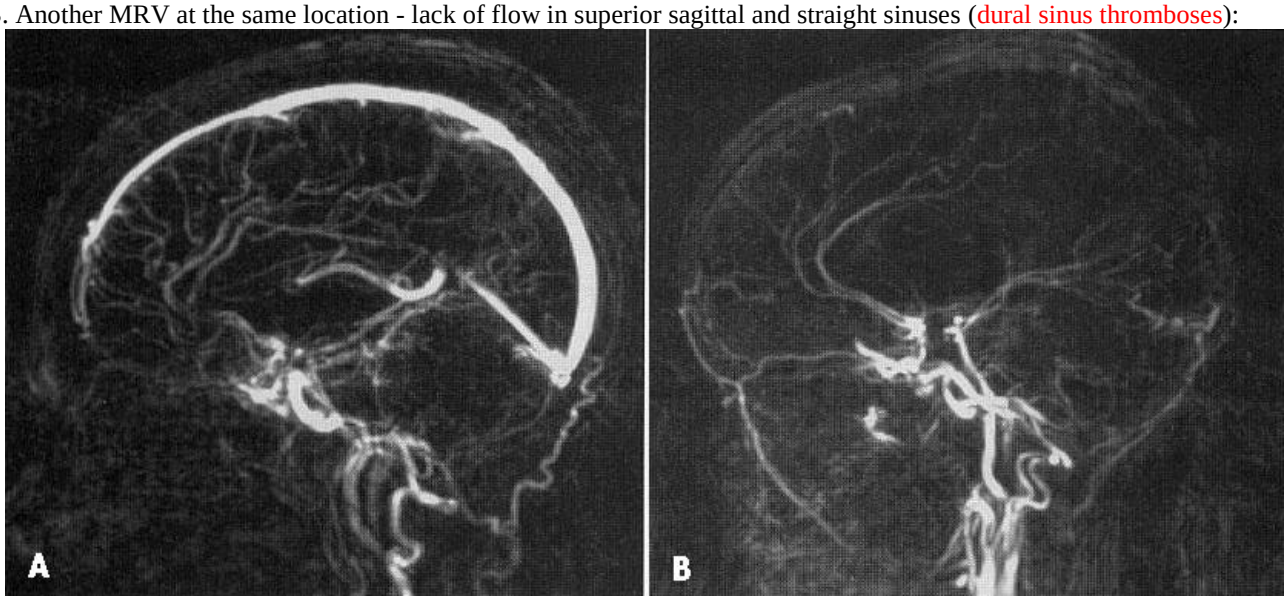
A. Normal MRA (2D TOF), axial slab, through circle of Willis.
B. Another MRA at the same level - markedly diminished left MCA flow (internal carotid occlusion):



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 >>