Making the best use of MRI/CT in the emergency setting

Collège Radiologie/Médecine d’urgence
Société Française de Radiologie

The Royal College of Radiologists

Adaptation: TW Stadnik MD,PhD*

Hôpitaux IRIS SUD
Universitair Ziekenhuis UZ Vrije Universiteit Brussel
(*) Radiology Department
Laarbeeklaan 101 1090 BRUSSEL
tel. 32-2-4775319, fax. 32-2-4775362
e-mail tadeusz.stadnik@uzbrussel.be
• Ischemic vascular stroke? with onset of symptoms \(\leq 6 \text{ h}\)
• Acute disorders of behavior, consciousness or delirium?
• Cerebral venous thrombosis?
• Carotid dissection?
• Rapidly progressive neurological deficit with immunosuppression or fever
• Head and spine trauma
• Take Home Points
Ischemic vascular stroke? with onset of symptoms <6 h

1h deadline or less if IV thrombolysis possible

Examinations:

MRI (T2, Flair, Diff, Perfusion, Angio MRI) or CT scan without injection followed by Perf CT and CT angiography

MRI is superior to CT imaging (diffusion weighted imaging)

CT is clearly superior to MRI if the patient is agitated
Ischemic vascular stroke?
with onset of symptoms <6 h
Good candidate for thrombolysis
Ischemic vascular stroke? with onset of symptoms <6 h

Patient after thrombolysis
Ischemic vascular stroke? with onset of symptoms <6 h

Poor candidate thrombolysis
Ischemic vascular stroke? with onset of symptoms >6 h

Deadline: 24 hours

Exams: Scanner without injection or non enhanced CT followed by angioCT or MRI with angio sequences.
Ischemic vascular stroke? with onset of symptoms >6 h

A691124DR00W

41 year old man with acute paresis right hand, dysarthria
Known hyperlipidemia, smoking, recent history of a traumatic fracture of a rib
1. assessment of brain parenchyma

Deadlines: 24h - 72h

Exam: MRI (T2, FLAIR, Diff, Angio PCA),

MRI-the most sensitive examination.
If MRI not available ->, scanner but frequent false negative for ischemic injury.

2. search for the cause

Deadlines: 24h – 72h

Exam: Echo-Doppler carotid.

NB: If significant stenosis or unreliable, perform angio-CT or dynamique angio-MRI
Acute disorders of behavior, consciousness or delirium?

Deadline: 4h
Unless known toxic metabolic or endocrine cause.

Sought Pathology: subdural hematoma, hydrocephalus, brain tumor

Exams: CT or MRI
Acute disorders of behavior, consciousness or delirium?

B800401MA00G

26 Nov 2009
had sex this morning,
subsequently headache, half
hours later generalized seizure,
loss of urine, stool and
immediately coma

CT performed 3h later
Acute disorders of behavior, consciousness or delirium?
Acute disorders of behavior, consciousness or delirium?
Acute disorders of behavior, consciousness or delirium?
Acute disorders of behavior, consciousness or delirium?

Diagnosis?
-aggressive brain tumor?
-pseudotumoral venous thrombosis versus cerebritis complicated by venous thrombosis?
After a full recovery, she left the hospital Dec. 31, 2009
Subarachnoid hemorrhage? (Sudden acute headache)

Deadline: 4h

Exams: Scanner without injection and if possible angioCT

- The sensitivity of this test decreases with time, a normal examination can not exclude a subarachnoid hemorrhage

MRI not unless:

- clinical signs dating back several days, normal CT and lumbar puncture inconclusive
Cerebral venous thrombosis?

Deadline: 4h or less if possible

Exams: MRI and PC Angiografie

Key sequences: PC Angiografie, if non-diagnostic GRE T1 + Gd

Or

CT without injection + CT angiography (As reliable as MRI and more accessible)
### MR Angiography:

<table>
<thead>
<tr>
<th>Angiography</th>
<th>Phase Contrast Angiography</th>
<th>Time Of Flight</th>
<th>Gd enhanced (dynamic) Angiography</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principle</strong></td>
<td>Shift of protons phase</td>
<td>Inflow of fresh protons</td>
<td>T1 effect of Gadolinium</td>
</tr>
<tr>
<td><strong>Artifacts</strong></td>
<td>+++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td><strong>Draw-backs</strong></td>
<td>Acquisition time</td>
<td>Limited Field of View</td>
<td>Require Gd injection</td>
</tr>
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Clinical presentation:

<table>
<thead>
<tr>
<th>Clinical symptom</th>
<th>Arterial dissection</th>
<th>Venous sinus thrombosis</th>
<th>Pituitary apoplexy</th>
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<tr>
<td>Headache</td>
<td>++++(75%) (+ neck ache)</td>
<td>++++ (70-90%)</td>
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<td>Seizures</td>
<td>+</td>
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<td>Papilledema</td>
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Dural sinus thrombosis

Diagnostic considerations

- Can be confused on clinical grounds with migraine headache and pseudotumor cerebri.

- Venous infarction is one of the feared complications of dural sinus thrombosis.

- Marked increases in intracranial pressure as a result of venous outflow obstruction can lead to coma and death.
Dural Sinus Thrombosis
Diagnostic considerations – MR imaging

- On unenhanced T2, T1-weighted images, the replacement of the flow void by increased signal is highly diagnostic.

However, this sign is visible only a week after the onset of thrombosis.
On enhanced (Gd) T1 GRE (Gradient Echo)(not Spin Echo), the thrombus in the sinus typically fails to enhance. Typical MR venography show absence of signal in the affected dural sinus.
Carotid dissection?

Deadline: 4h or less if possible

Exams: MRI with PCA (T2, Flair, Diff, Angio PCA T1 Fat Sat and / or Angio TOF Fat Sat on the stenosis

Or CT scanner without injection + CT angiography

(Less reliable than MRI, but more accessible)
Dissection of the carotid and vertebral arteries was once considered uncommon.

- Dissection of the cervicocephalic arteries is a neurologic emergency because of the increased risk of cerebral infarction.

- Before development of MR imaging, catheter angiography was considered the study of choice for depiction of carotid and vertebral dissection.
Because of its noninvasive nature, MR imaging has replaced catheter angiography for the diagnosis of arterial dissection at many institutions.

Diagnostic clue: intramural hematoma

(remains isointense compared with muscle on both T1- and T2-weighted images during the first few days after dissection!)
Arterial dissection
Diagnostic considerations

- Multidetector CT angiography
  - rapid thin-section depiction of vessels
  - excellent anatomic detail
  - three-dimensional reconstructed images.

Multisection CT Angiography Compared with Catheter Angiography in Diagnosing Vertebral Artery Dissection
Chi-Jen Chen, Ying-Chi Tseng, Tsong-Hai Lee, Hui-Ling Hsu and Lai-Chu See

The sensitivity, specificity, accuracy, and positive and negative predictive values of multisection CT angiography in diagnosing VA dissection were 100%, 98%, 98.5%, 95%, and 100%, respectively.
Arterial dissection
Diagnostic considerations

• Findings of arterial dissection on CT angiography

On source images:
• narrowing or occlusion of the contrast-filled lumen
• may be combined with a contrast-filled pseudoaneurysm
• the hematoma appears isodense relative to soft tissue
• the residual lumen is generally eccentric in location relative to the hematoma
Arterial dissection
Diagnostic considerations

• Findings of arterial dissection on CT angiography

• Generally diagnosis obvious on source images
• Findings of arterial dissection on CT angiography
• Reconstructions only may be not diagnostic
• Finding arterial dissection on CT angiography
• Always check the native pictures
• Findings of arterial dissection on CT angiography
• In case of thrombosis, superiority of MRI
• Findings of arterial dissection on CT angiography
• In case of thrombosis, superiority
Rapidly progressive neurological deficit with immunosuppression or fever

Deadline: 24h or less if possible
Exams: MRI. If abscess suspected: 4h or less (Diffusion!)
Rapidly progressive neurological deficit with immunosuppression or fever

Deadline: 24h or less if possible

Exams: MRI. If abscess suspected: 4h or less (Diffusion! DD with necrotic tumor)
Head trauma without loss of consciousness

Exams:

RX skull not indicated

Brain scan and cervical spine: not indicated unless (1 hour) neurological signs, vomiting or progressively worsening headache, impaired consciousness, risk of hematoma (anticoagulant therapy, bleeding disorders), neck pain or severe trauma
Head trauma with loss of consciousness

Exams:

RX skull **not indicated**

Brain scan and cervical spine: **4h**

Shortened time to **1h** if neurological signs

NB: attention to the association of a cervical spine injury to install in the scanner

NB: scanner until the cervico-dorsal junction
Spine trauma without neurological signs

NOTE: Inform the patient that he must return to the clinic in case of persistent pain, while the initial radiograph was normal.

Exams:

xr spine? 4h
May be falsely reassuring, frequent false neg
F + P supine; cervico-occipital junction
Favor Scanner 4h
Especially if diagnostic doubt
Spine trauma with neurological signs

Exams:
Scanner: 1h
MRI: 1h

Necessary if no osteo-articular injury on scanner
if discordance between CT and clinical findingss.
After neurosurgical opinion?
Spine trauma with neurological signs (fallen from his horse, paresis fingers right hand). XR the day of trauma.
Spine trauma with neurological signs (fallen from his horse, paresis fingers right hand). MR 2 days after trauma.
Spine trauma with neurological signs (fallen from his horse, paresis fingers right hand). CT 2 days after trauma.
Spine trauma with neurological signs (fallen from his horse, paresis fingers right hand). MR angio 5 days after trauma
Imaging:

Imaging is indicated only in patients with "red flag" conditions or in whom disc surgery is considered. Consensus is that initial treatment is conservative for about 6-8 weeks. ("red flags" – suspicion of infection, malignancy, severe symptoms who fail to respond to conservative care, neurologic deficit, osteoporotic fractures)

IRM>Scanner

BMJ 2007;334(7607):1313 (23 June), doi:10.1136/bmj.39223.428495.BE
"red flags" – suspicion of infection, malignancy, severe symptoms who fail to respond to conservative care, neurologic deficit, osteoporotic fractures

suspicion of infection – discitis
Pituitary apoplexy

• in pituitary tumour
  • hemorrhagic apoplexy
  • acute necrosis

26 nov 99
Clinical symptoms: heavy headache, vomiting and neck stiffness
Clinical diagnosis: subarachnoid haemorrhage or meningitis
09 dec 99; MR 1.5T
Pituitary apoplexy

• **clinical symptoms**
  • headaches often bitemporal
  • fever
  • visual field defects
  • cranial nerve palsies
  • photophobia, stiff-neck, altered consciousness, convulsions!
  ! DD with meningitis/ subarachnoid haemorrhage!

• **in normal pituitary:**
  • Sheehan's syndrome *(postpartum necrosis)* (secondary to hemorrhagic shock)
  • diabetes *(with cerebro-vascular disease)*
  • sickle-cell disease *(rarely)*

• **in pituitary tumour**
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Pituitary apoplexy

• in pituitary tumour
  • hemorrhagic apoplexy
  • acute necrosis

Clinical symptoms: heavy headache, oedema periorbital soft tissues
Clinical diagnosis: cavernous sinus thrombosis or meningitis
22 sep 99; CT Normal
27 sep 99; 1.5 Tesla MRI
Pituitary apoplexy

- in pituitary tumour
- hemorrhagic apoplexy
- acute necrosis

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Pituitary Apoplexy: Early Detection with Diffusion-Weighted MR Imaging

Jeffrey M. Rogg\textsuperscript{a}, Glenn A. Tung\textsuperscript{a}, Gordon Anderson\textsuperscript{b} and Selina Cortez\textsuperscript{c}

Nonenhanced CT scan shows a homogeneous, nonhemorrhagic, hyperattenuated intrasellar mass.

Histological analysis revealed the presence of a necrotic pituitary adenoma with haemorrhage
Practical guidelines for imaging in chronic or recurrent headache

• The emergency neuroimaging is not warranted.
• However, up to 2.1% will have clinically important findings on neuroimaging.
• MRI will be superior to CT.
• If Axial FLAIR (5mm), coronal T2 (3mm) reveal no abnormality, the probability to find any pathological condition by multiplying the sequences is very low.
Headache with neurological signs

22 Nov 2010
Headache since 1 week.
Today, loss of visual acuity and anisocorie
CT and MR performed 22 Nov 2010
Headache with neurological signs

CT performed 22 Nov 2010 13:28
Headache with neurological signs
Headache with neurological signs
Headache with neurological signs

Radiologist report: normal CT and MR
Evolution: progressive blindness, paralysis n. abducens
Diagnosis: idiopathic intracranial hypertension

What you need in such a situation:

• New CT?
• New MR?
• Second opinion?
Headache with neurological signs

Further neurological deterioration
MR performed 23 Nov 2010 11:56

Radiologist report: normal MR
Diagnosis: idiopathic intracranial hypertension, pseudotumor cerebri
Treatment: attempt to place VP shunt

Headache with neurological signs
Headache with neurological signs

B710731DR00Q 23 Nov 2010 20h

Transfert UZ VUB

Teleradiolgy Second opinion: venous sinus thrombosis

Treatment: anticoagulation
Headache with neurological signs

B710731DR00Q  24 nov 2010

neurological deterioration
no response to question or command
difficult endotracheal intubation
induction with Pentothal, high dose required for loss of consciousness

MRI:
Headache with neurological signes

24 nov 2010 20h

Clinical death
Take Home Points

Ischemic vascular stroke? with onset of symptoms <6 h in the context of thrombolysis

MRI is superior to CT imaging (diffusion weighted imaging)

CT is clearly superior to MRI if the patient is agitated
Take Home Points

Ischemic vascular stroke? with onset of symptoms >6 h in the context of headache, young patient

Consider non enhanced CT followed by angioCT or MRI with angio sequences
Carotid dissection?

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Or

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Head trauma with loss of consciousness

Exams:
RX skull not indicated
Brain scan and cervical spine: 4h
Shortened time to 1h if neurological signs

NB: scanner until the cervico-dorsal junction
Take Home Points

If discrepancy between radiological findings and the clinical situation?

feel free to request a second opinion

e-mail stadnik@vub.ac.be