

# 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](mailto:tadeusz.stadnik@uzbrussel.be)**

- *Ischemic vascular stroke?*  
*with onset of symptoms  $\leq$  6 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:**

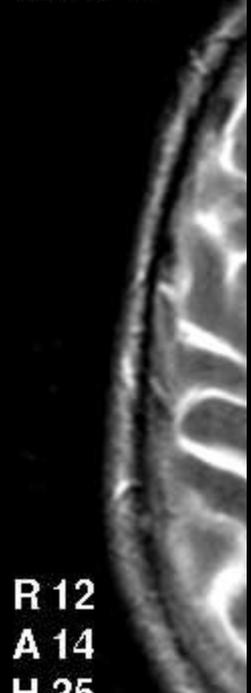
**MRI (T2, Flair, Diff, Perfusion, Angio MRI)  
or CT scan without injection followed by Perf CT and CT  
angiography**

**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*

Sc2/16  
TSE / M

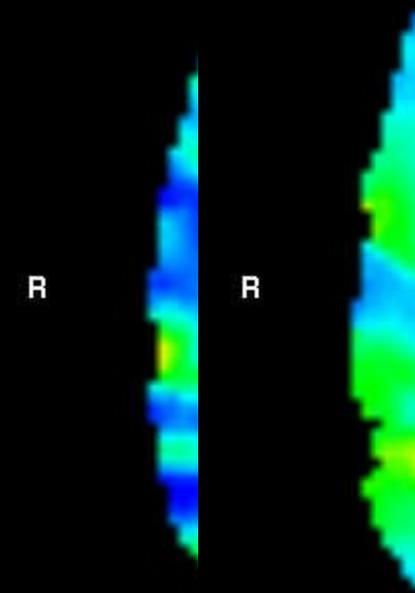


R 12  
A 14  
H 35  
Angle AP 2°  
Angle RL -7  
Angle FH -4

Sc4/16  
DwiSE / I  
b 1000 I



R 12  
A 14  
H 35  
Angle AP  
Angle RL  
Angle FH



Sc7/15  
FEEPI / M  
Dt 000 ms

Sc7/13  
FEEPI / M  
Dt 000 ms

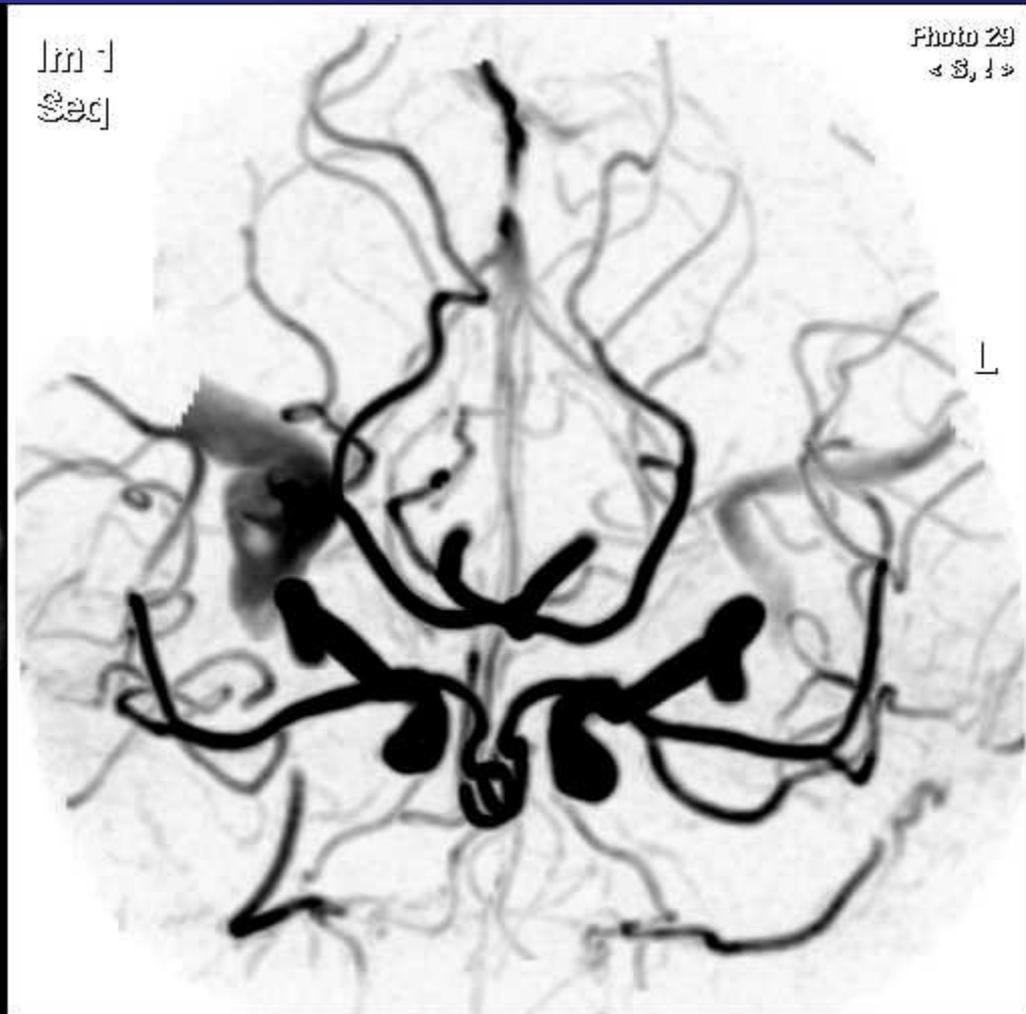
Im 18  
Seq



Photo 18  
< 3, 1 >

# *Ischemic vascular stroke? with onset of symptoms <6 h*

## *Patient after thrombolysis*



# *Ischemic vascular stroke? with onset of symptoms <6 h*

## *Poor candidate thrombolysis*

Sc2/13  
TSE / M

Sc3/13  
DwiSE / M  
b 1000 I

Sc4/5  
T1FFE / M

Photo 19  
◀ ▶

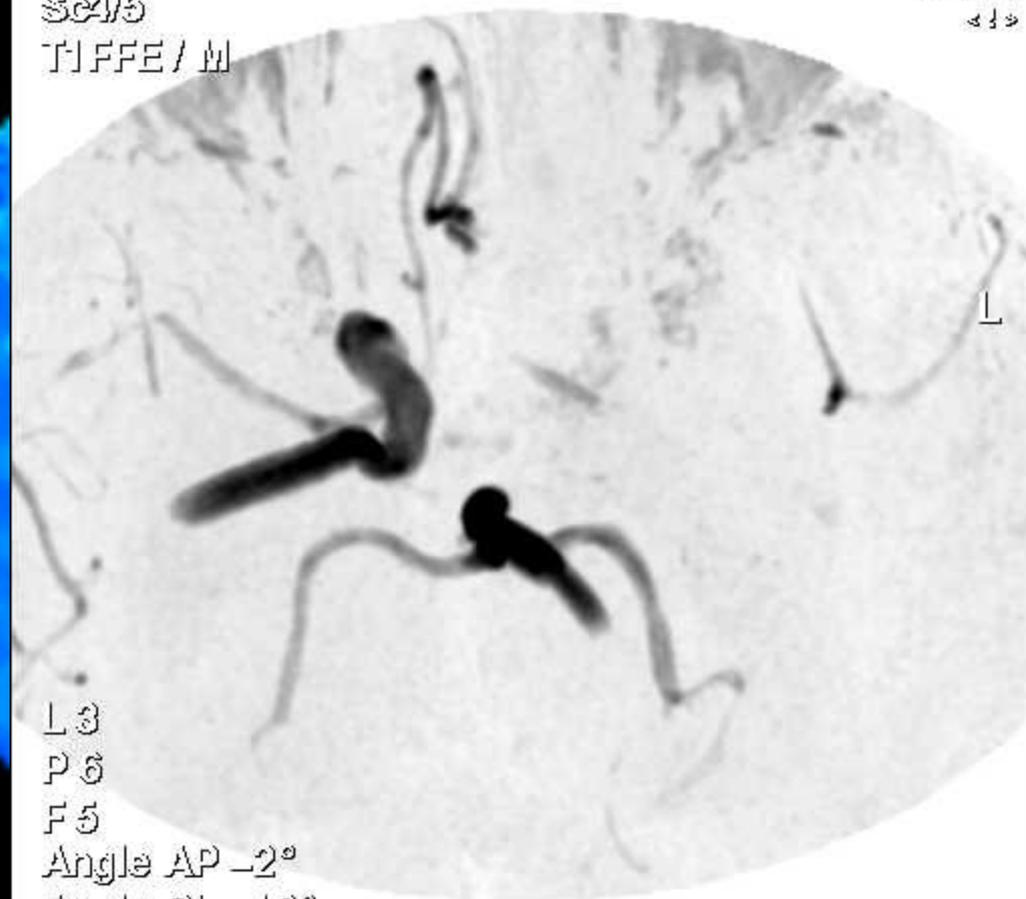
L 3  
P 2  
H 21  
Angle AP  $-2^{\circ}$   
Angle RL  $-16^{\circ}$   
Angle FH  $2^{\circ}$

L 3  
P 2  
H 21  
Angle AP  $-2^{\circ}$   
Angle RL  $-16^{\circ}$   
Angle FH  $2^{\circ}$

Sc6/11  
FEEPI / M

Dt 000 ms

L 3  
P 5  
F 5  
Angle AP  $-2^{\circ}$   
Angle RL  $-16^{\circ}$



*Ischemic vascular stroke?  
with onset of symptoms >6 h*

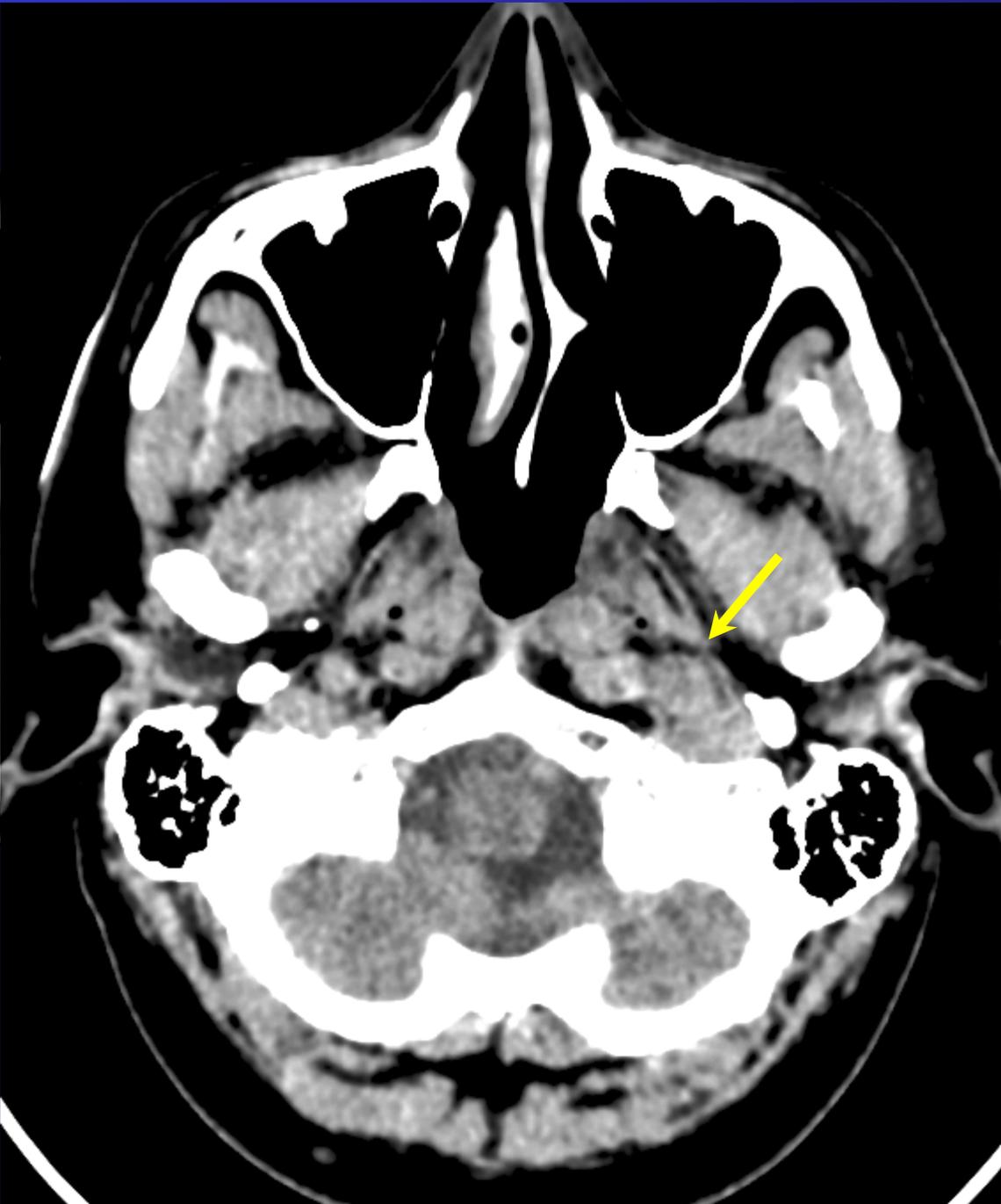
**Deadline: 24 hours**

**Exams: Scanner without injection  
or non enhanced CT followed by angioCT  
or MRI with angio sequences.**

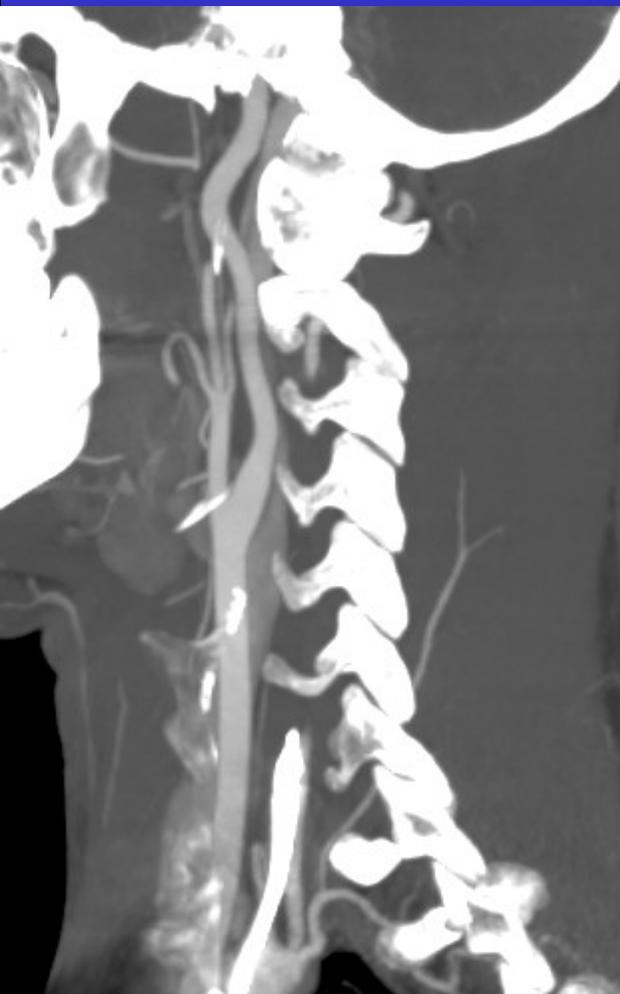
*Ischemic vascular stroke?  
with onset of symptoms >6 h*

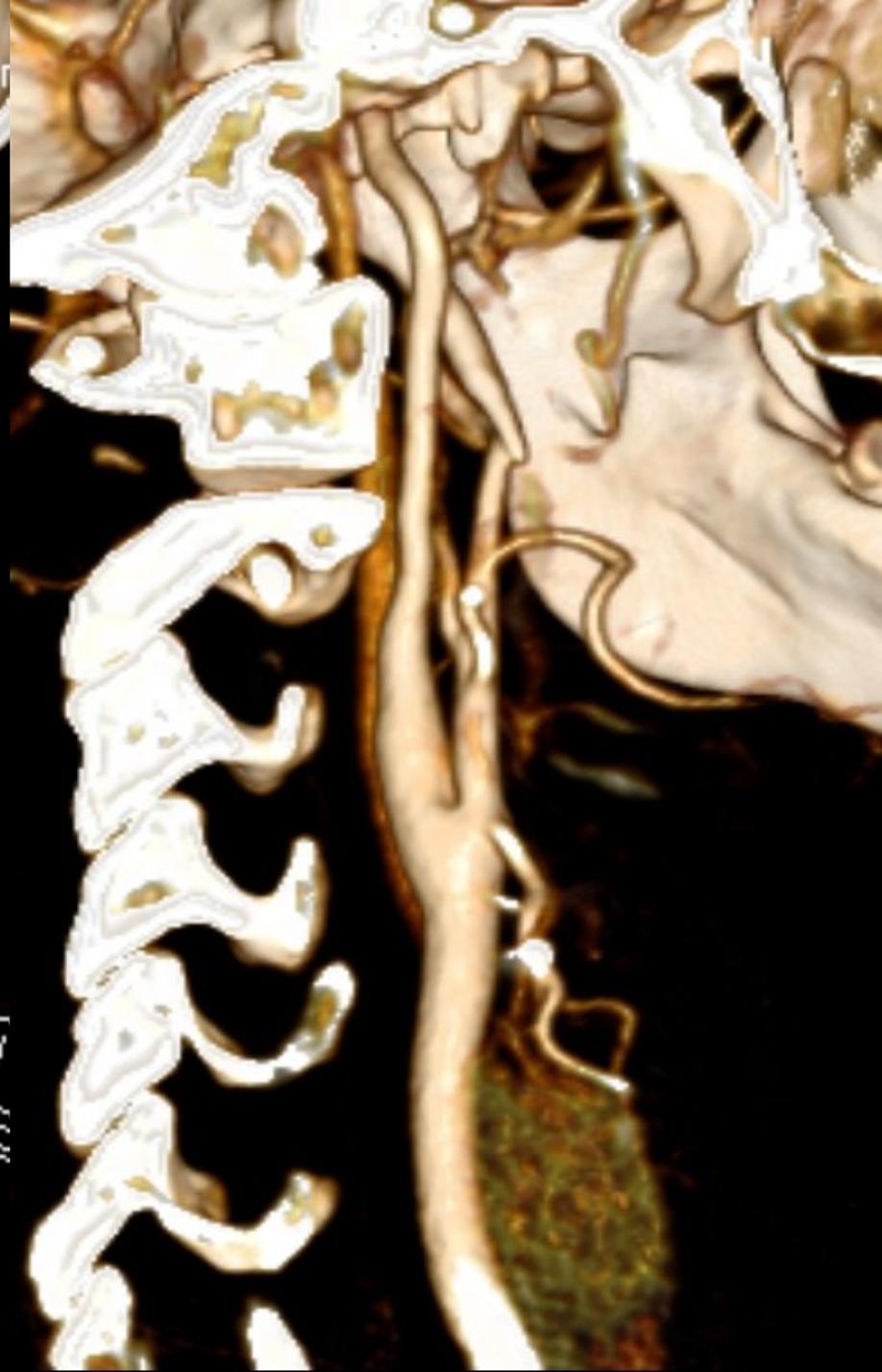
A691124DR00W

**41 year old man with acute paresis  
right hand, dysarthria  
Known hyperlipidemia, smoking,  
recent history of a traumatic fracture  
of a rib**



**A691124DR00W**





# *Transient ischemic attack?*

## **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?

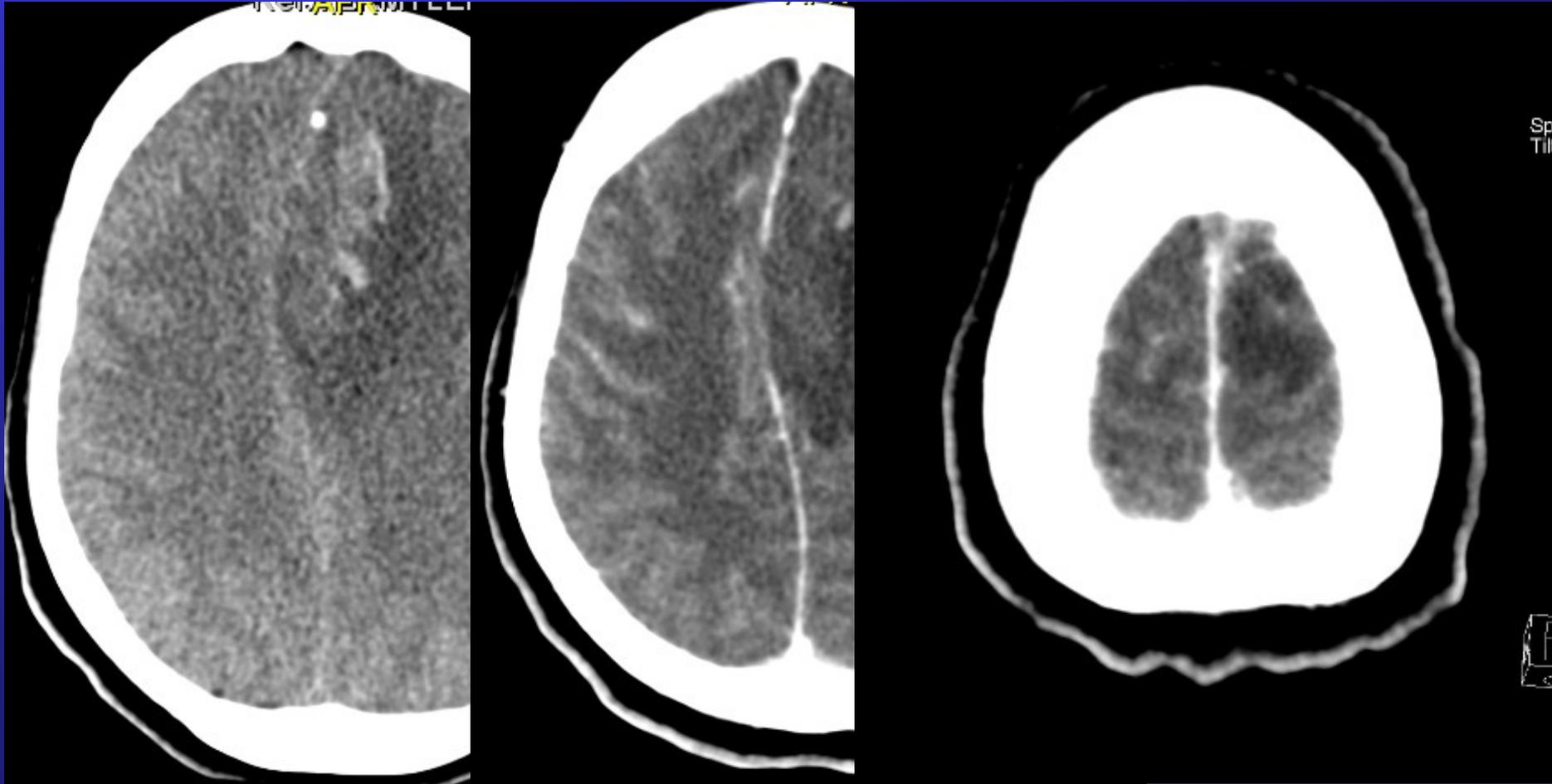
B800401MA00G

26 Nov 2009

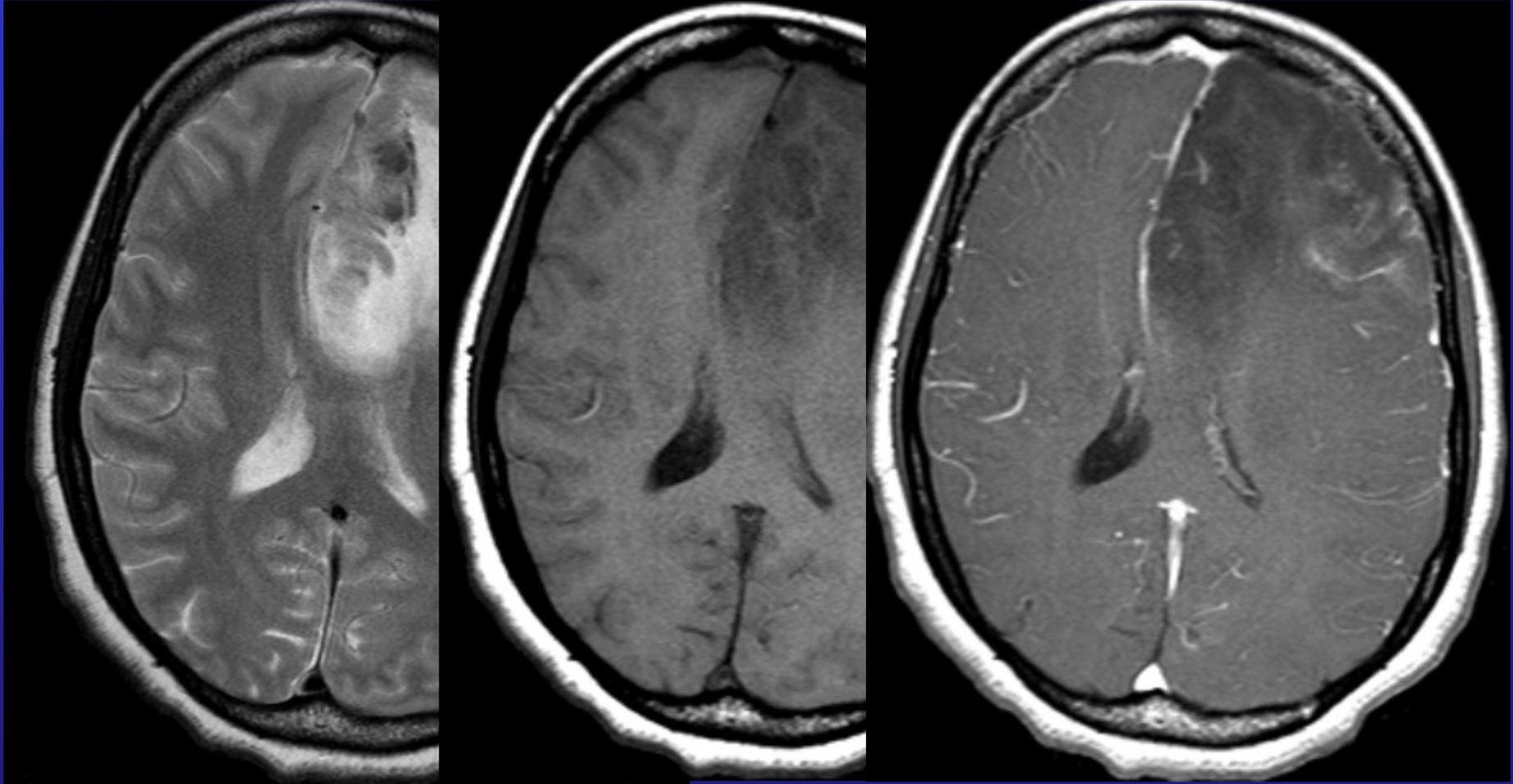
had sex this morning,  
subsequently headache, half  
hours later generalized seizure,  
loss of urine, stool and  
immediately coma

CT performed 3h later

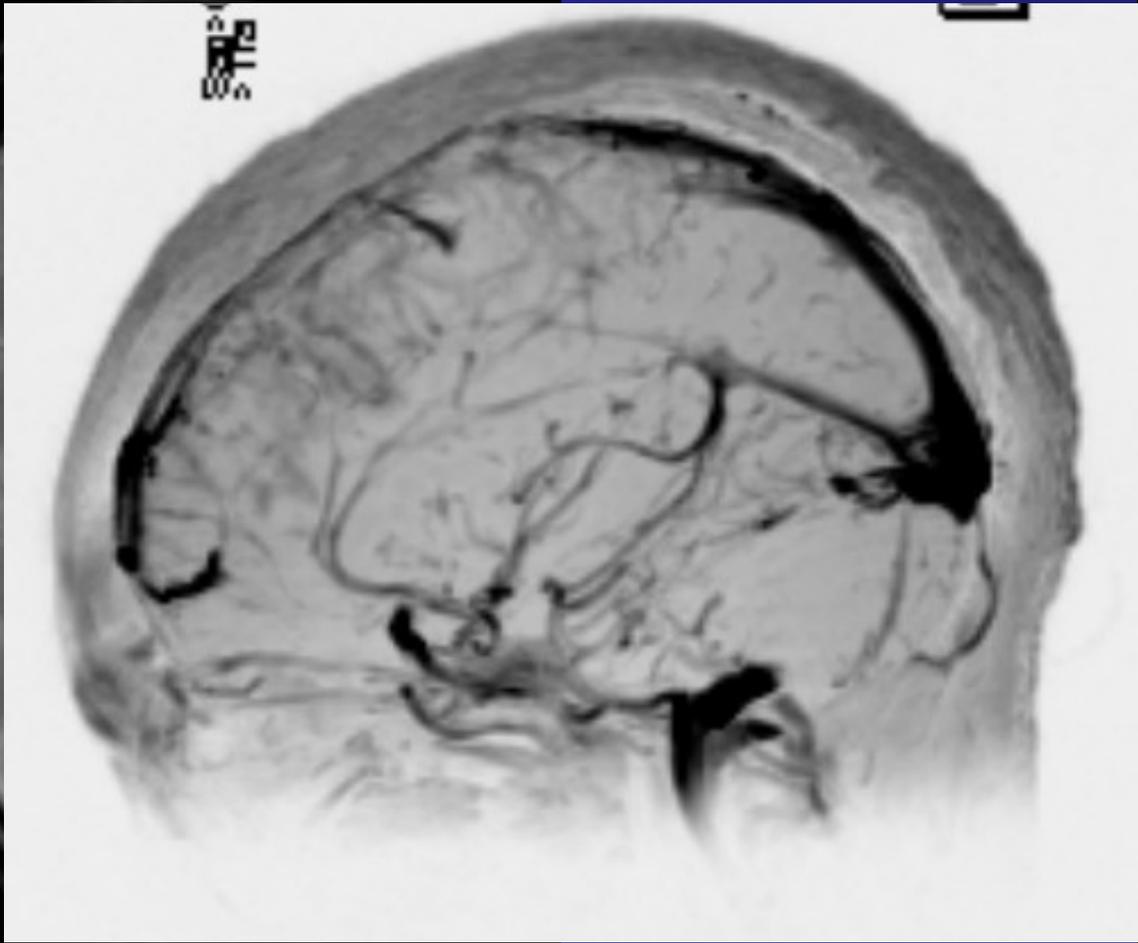
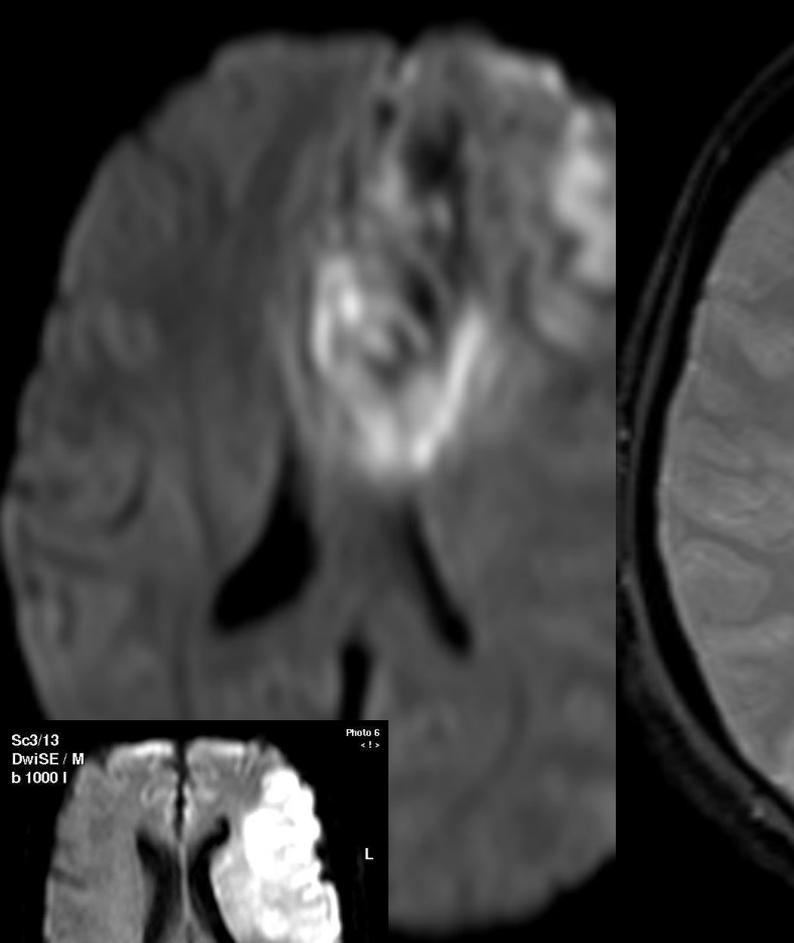
# Acute disorders of behavior, consciousness or delirium?



# Acute disorders of behavior, consciousness or delirium?



# Acute disorders of behavior, consciousness or delirium?



# Acute disorders of behavior, consciousness or delirium?

B800401MA00G

## Diagnosis?

-aggressive brain tumor?

-pseudotumoral venous thrombosis

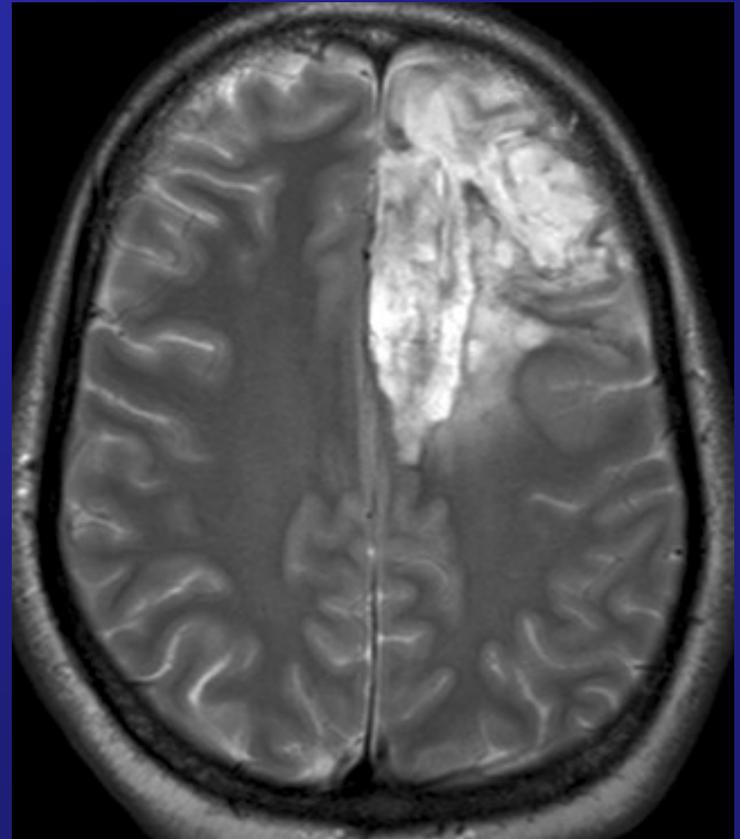
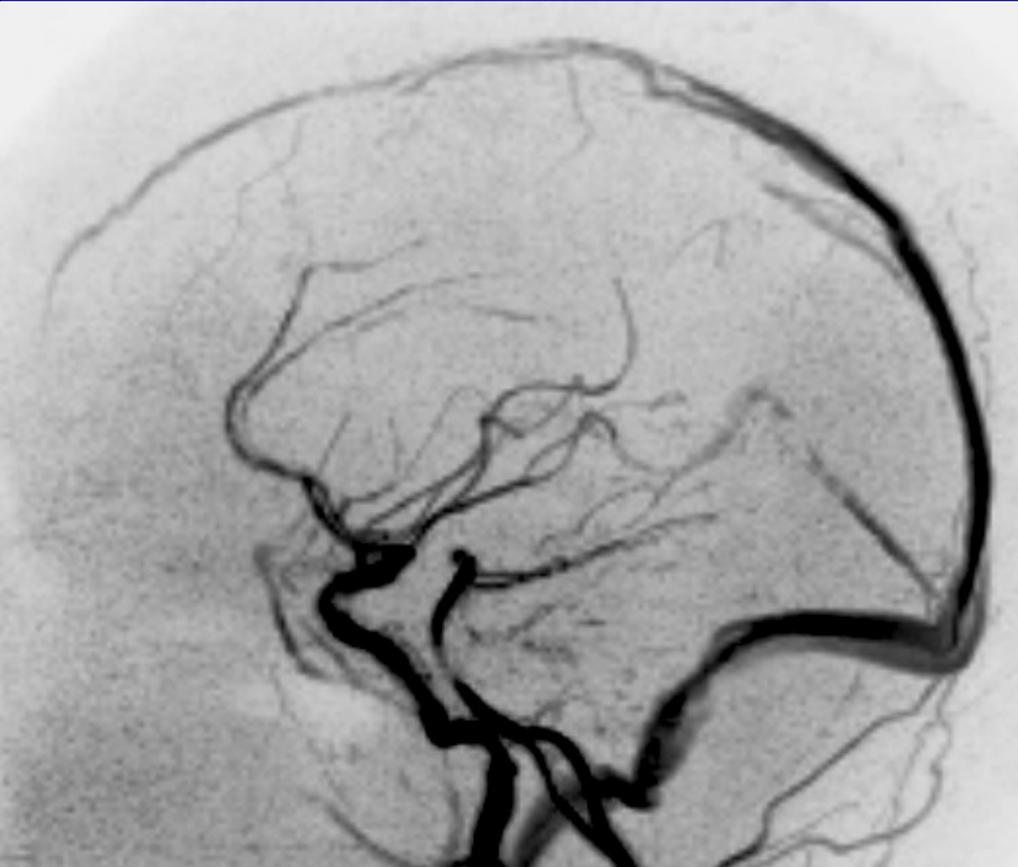
versus

cerebritis complicated by venous

thrombosis?

B800401MA00G

**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:

<b>Angiography</b>	<b>Phase Contrast Angiography</b>	<b>Time Of Flight</b>	<b>Gd enhanced (dynamic) Angiography</b>
<b>Principle</b>	<b>Shift of protons phase</b>	<b>Inflow of fresh protons</b>	<b>T1 effect of Gadolinium</b>
<b>Artifacts</b>	<b>+++</b>	<b>++</b>	<b>+</b>
<b>Draw-backs</b>	<b>Acquisition time</b>	<b>Limited Field of View</b>	<b>Require Gd injection</b>

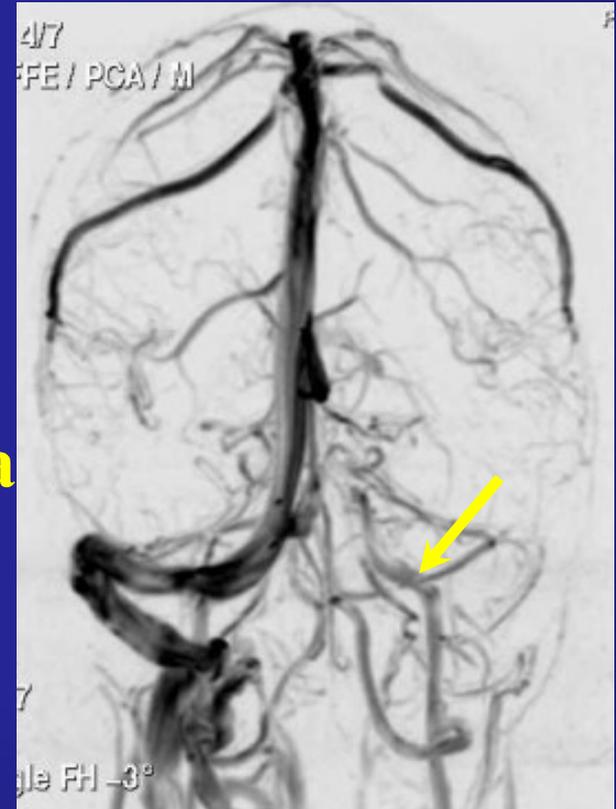
# Clinical presentation:

<b>Clinical symptom</b>	<b>Arterial dissection</b>	<b>Venous sinus thrombosis</b>	<b>Pituitary apoplexy</b>
<b>Headache</b>	+++++(75%) (+ neck ache)	+++++ (70-90%)	+++++
<b>Seizures</b>	+	++ (10-60%)	++
<b>Neurologic deficit</b>	+++ (Horner 15%)	+++ (30-80%)	+++ (3d nerve)
<b>Papilledema</b>		+++ (30-80%)	++

# 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**

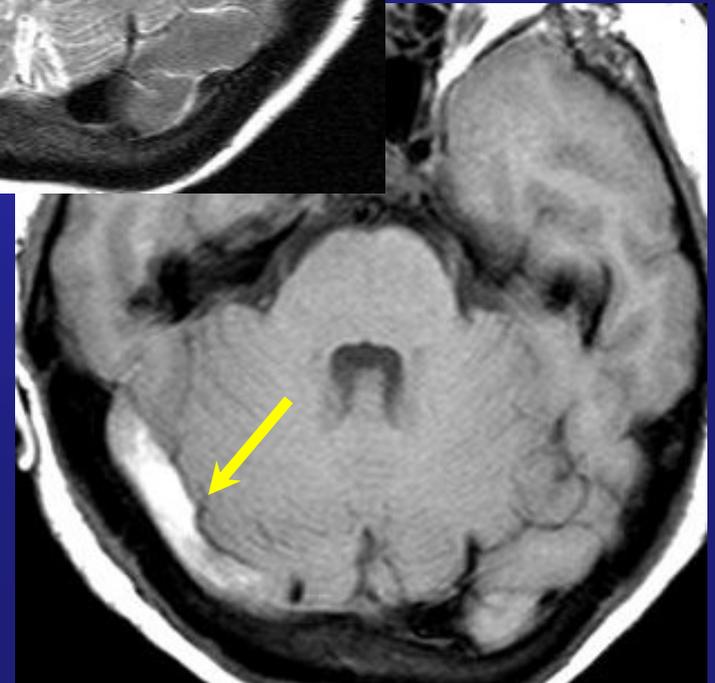
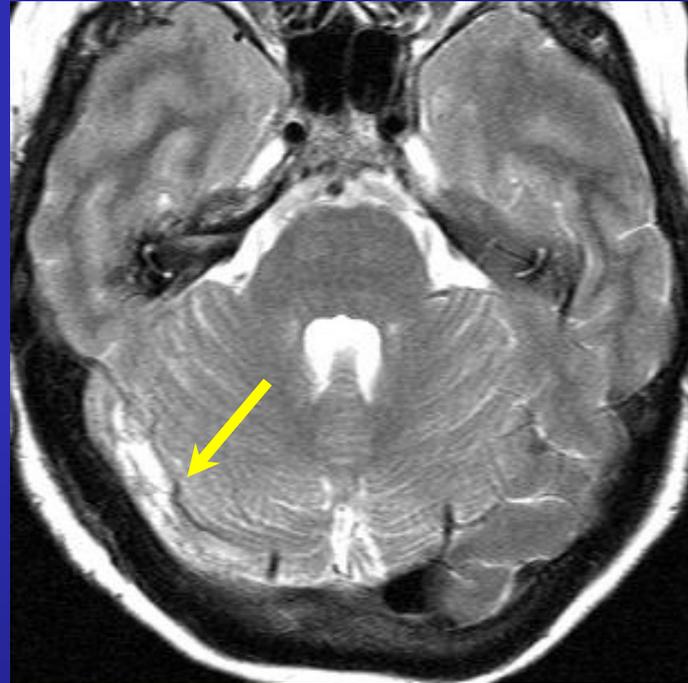


# Dural Sinus Thrombosis

## Diagnostic considerations – MR imaging

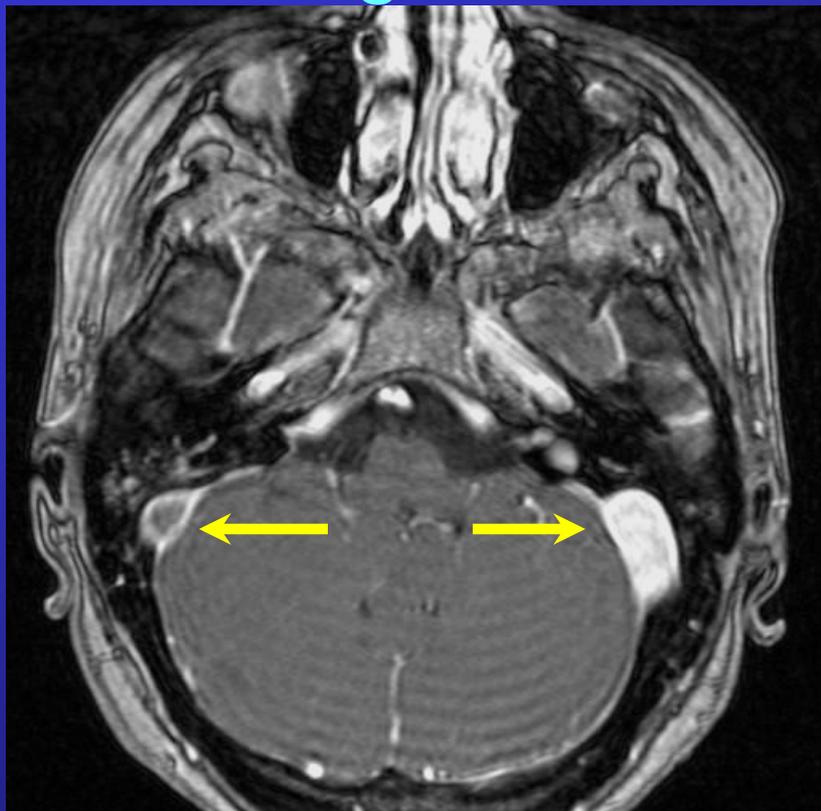
• On unenhanced T2, T1-weighted images  
the replacement of the flow void by increased signal is highly diagnostic

However, this sign is visible only a week after the onset of thrombosis

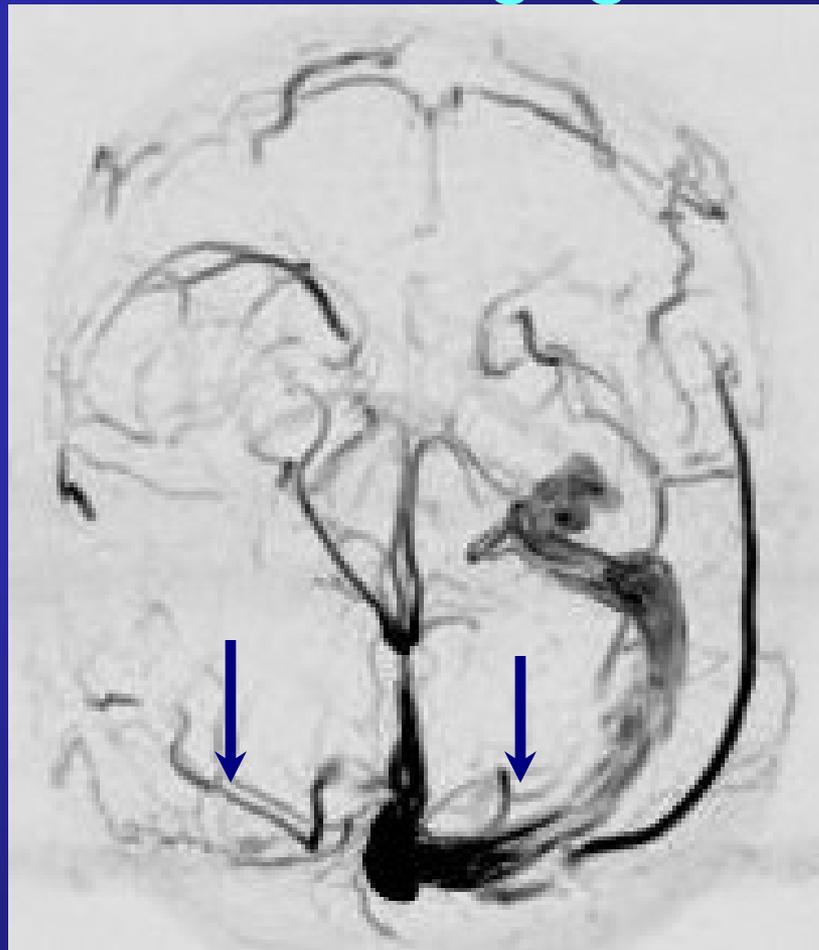


# Dural Sinus Thrombosis

## Diagnostic considerations – MR imaging



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 CTscanner  
without injection +  
CT angiography**

**(Less reliable than MRI, but more accessible)**

# Arterial dissection

## Diagnostic considerations

**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.**

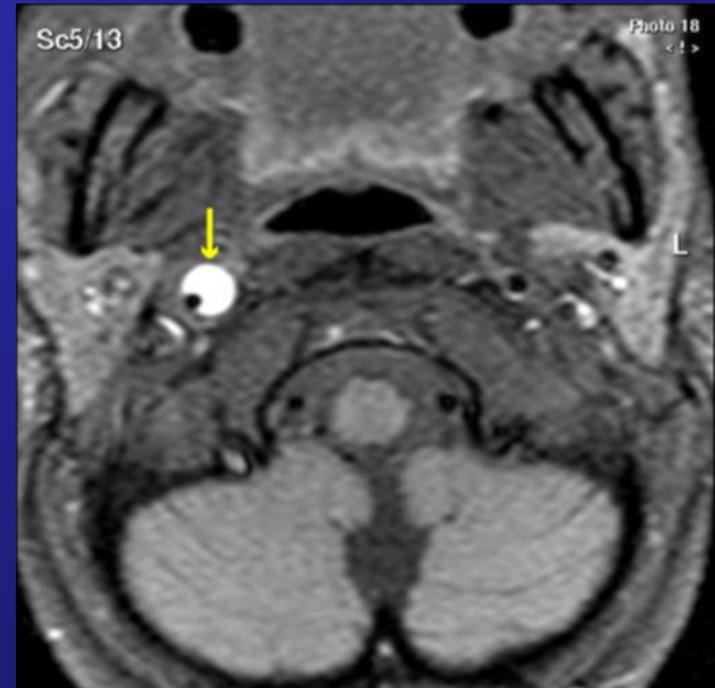


# Arterial dissection

## Diagnostic considerations

- **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!)*



**Fat-suppressed T1-weighted image**

# 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  
*American Journal of Neuroradiology* 25:769-774, May 2004

**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.**

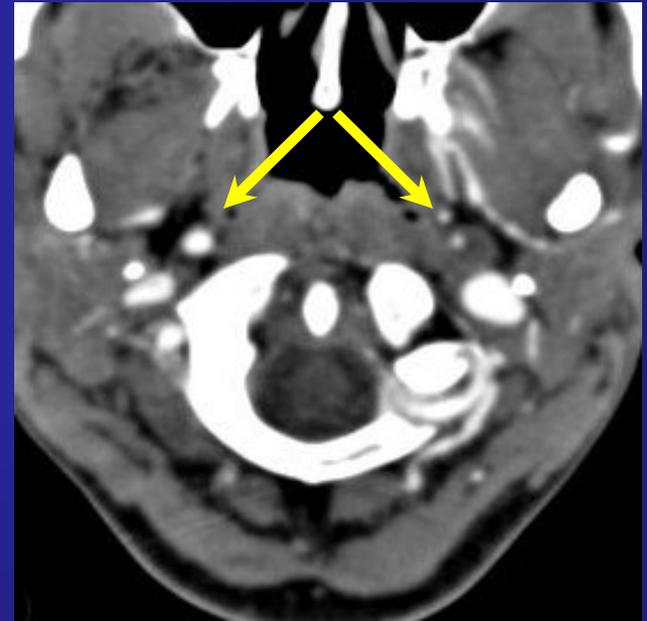
# Arterial dissection

## Diagnostic considerations

### • Findings of arterial dissection on CT angiography

#### On source images:

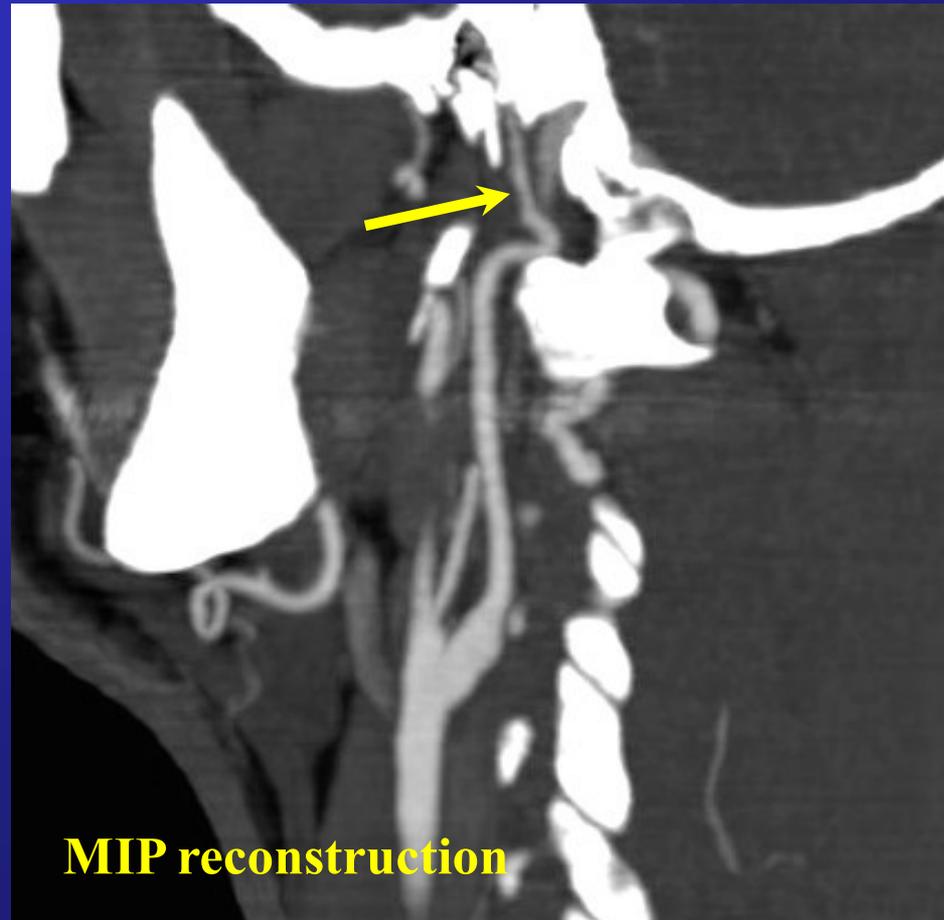
- *narrowing or occlusion of the contrast-filled lumen*
- *may be combined with a contrast-filled pseudoaneurysm*
- *the hematoma appears isodense relative to soft tissue*
- *the residual lumen is generally eccentric in location relative to the hematoma*



# Arterial dissection

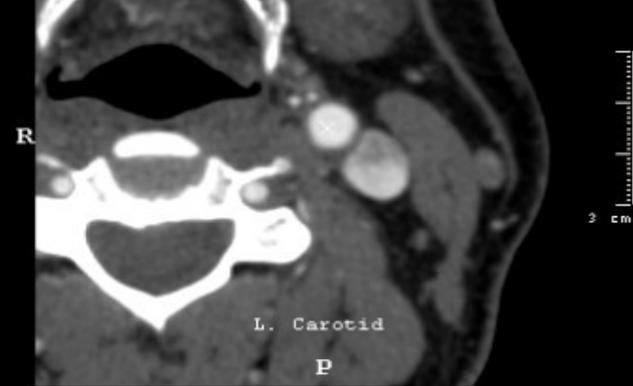
## Diagnostic considerations

- Findings of arterial dissection on CT angiography
- Generally diagnosis obvious on source images



# Arterial dissection

## Diagnostic considerations

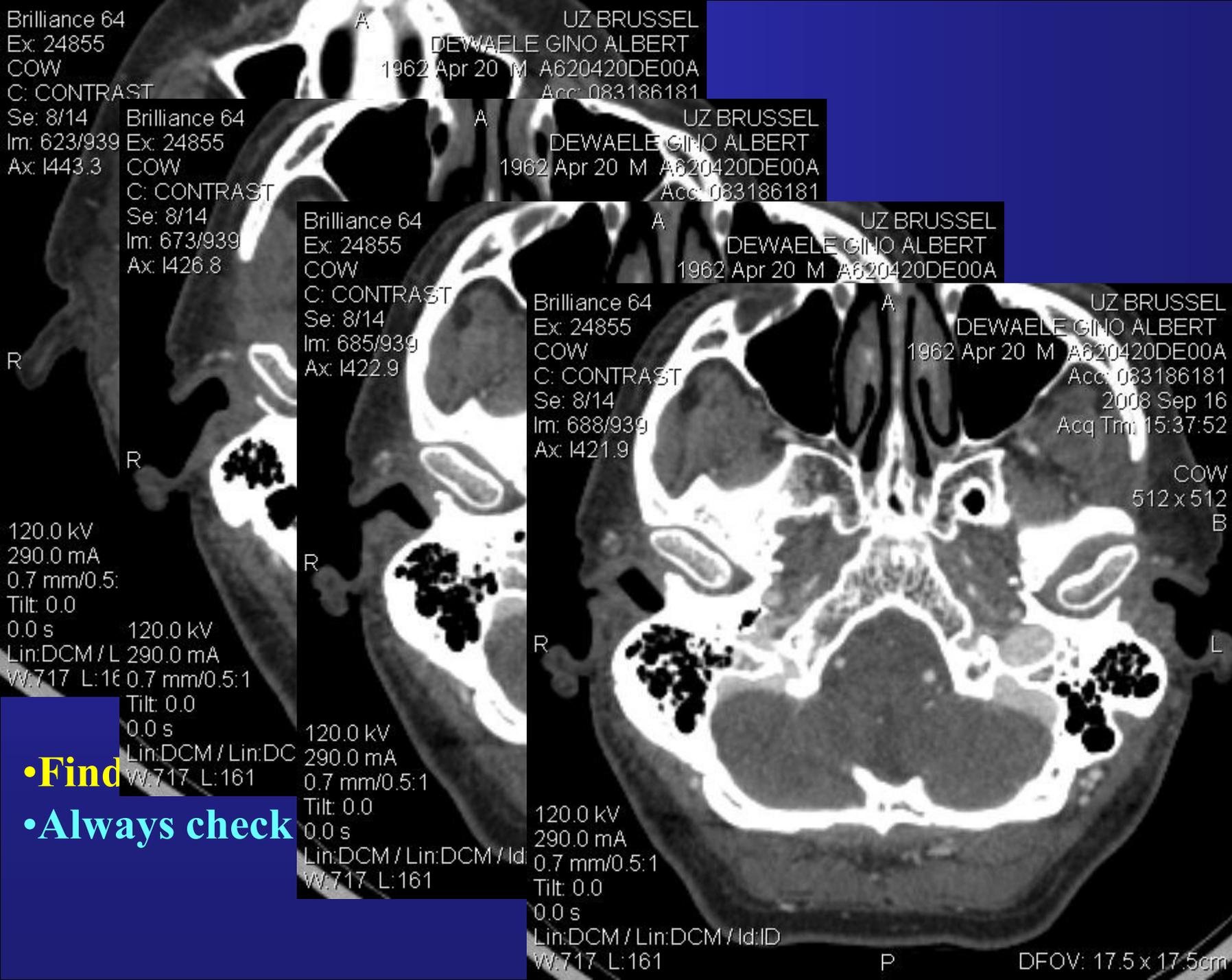


- Findings of arterial dissection on CT angiography
- Reconstructions only may be not diagnostic

W255 / C127  
KV: 120  
ma:290<sup>F</sup>

F

li car emd



Brilliance 64  
Ex: 24855  
COW  
C: CONTRAST  
Se: 8/14  
Im: 623/939  
Ax: 1443.3

UZ BRUSSEL  
DEWAELE GINO ALBERT  
1962 Apr 20 M A620420DE00A  
Acc: 083186181

Brilliance 64  
Ex: 24855  
COW  
C: CONTRAST  
Se: 8/14  
Im: 673/939  
Ax: 1426.8

UZ BRUSSEL  
DEWAELE GINO ALBERT  
1962 Apr 20 M A620420DE00A  
Acc: 083186181

Brilliance 64  
Ex: 24855  
COW  
C: CONTRAST  
Se: 8/14  
Im: 685/939  
Ax: 1422.9

UZ BRUSSEL  
DEWAELE GINO ALBERT  
1962 Apr 20 M A620420DE00A  
Acc: 083186181

UZ BRUSSEL  
DEWAELE GINO ALBERT  
1962 Apr 20 M A620420DE00A  
Acc: 083186181  
2008 Sep 16  
Acq Tm: 15:37:52  
COW  
512 x 512  
B

120.0 kV  
290.0 mA  
0.7 mm/0.5:  
Tilt: 0.0  
0.0 s  
120.0 kV  
290.0 mA  
Lin:DCM / L  
W:717 L:161  
0.7 mm/0.5:1  
Tilt: 0.0  
0.0 s  
Lin:DCM / Lin:DC

120.0 kV  
290.0 mA  
0.7 mm/0.5:1  
Tilt: 0.0  
0.0 s  
Lin:DCM / Lin:DCM / Id  
W:717 L:161

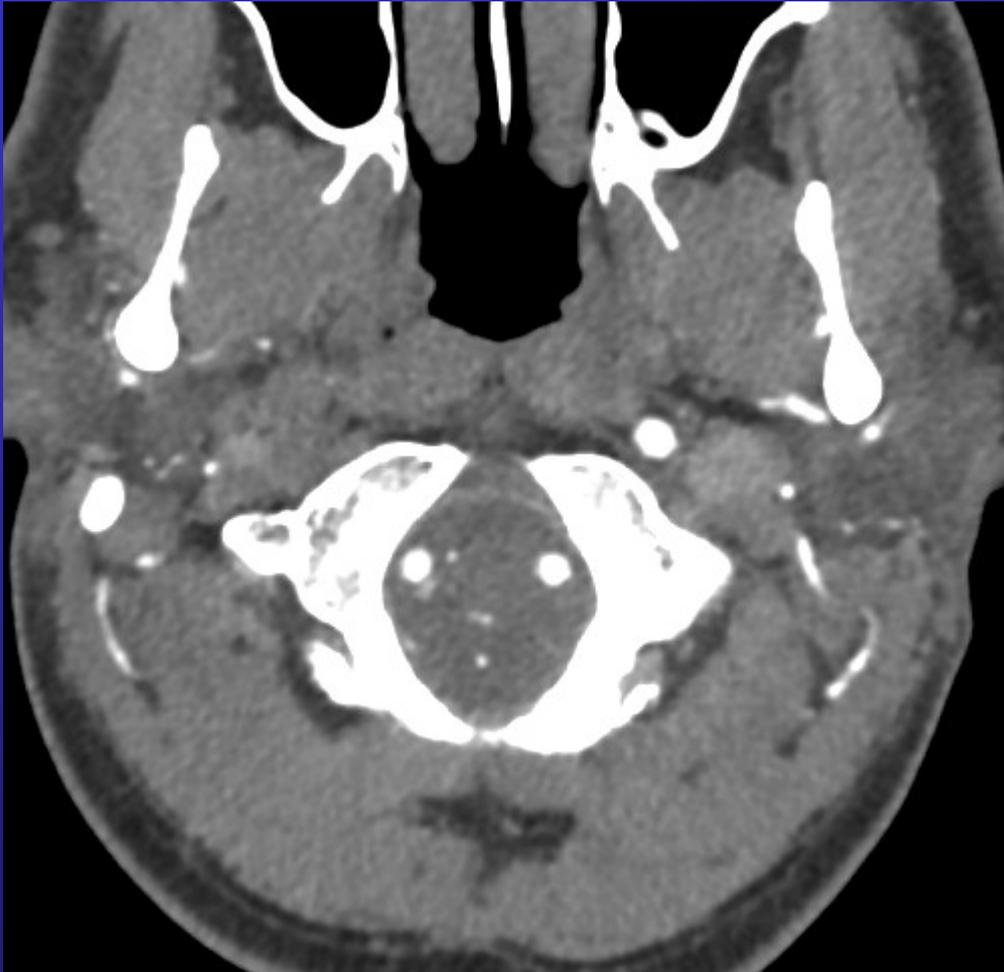
120.0 kV  
290.0 mA  
0.7 mm/0.5:1  
Tilt: 0.0  
0.0 s  
Lin:DCM / Lin:DCM / Id:ID  
W:717 L:161

DFOV: 17.5 x 17.5cm

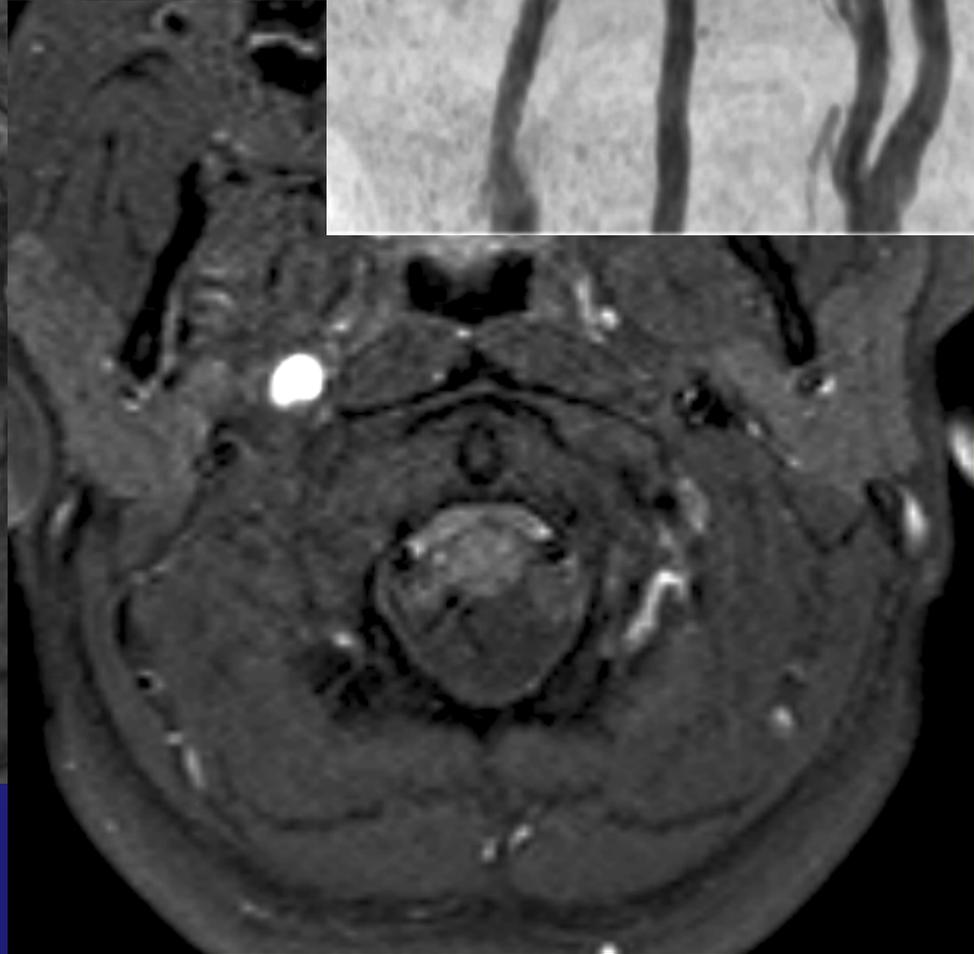
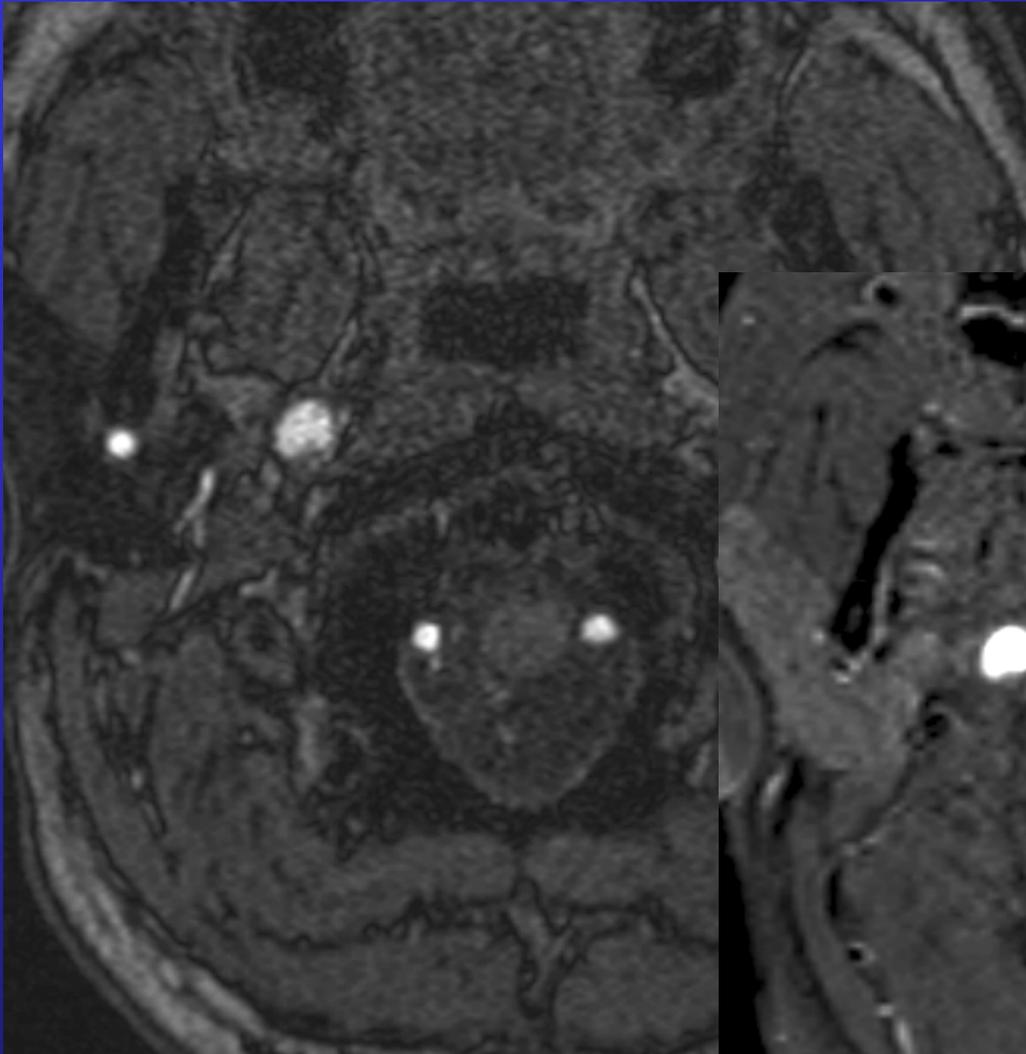
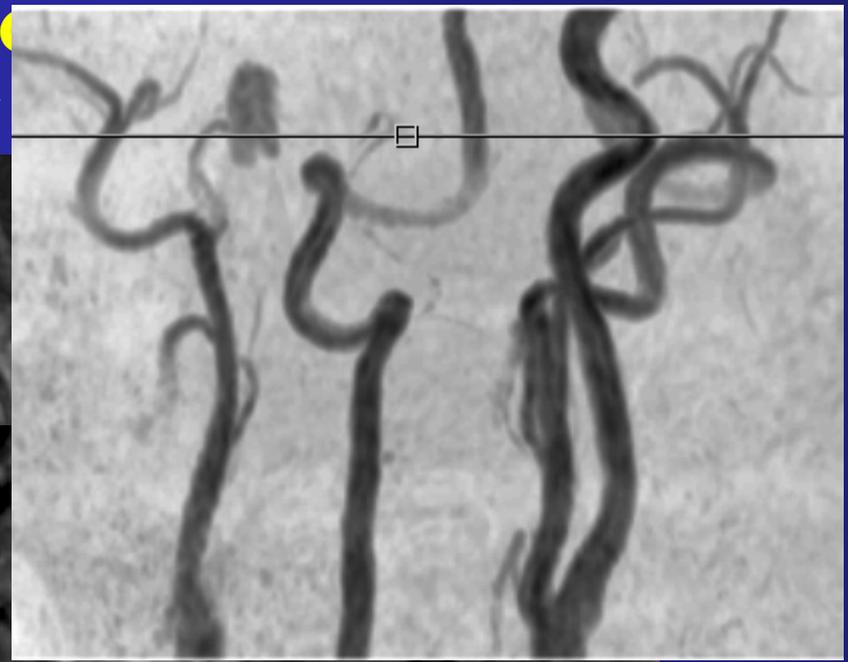
• Find  
• Always check

• Findings of arterial dissection on CT angiography

• In case of thrombosis, superiority of MRI



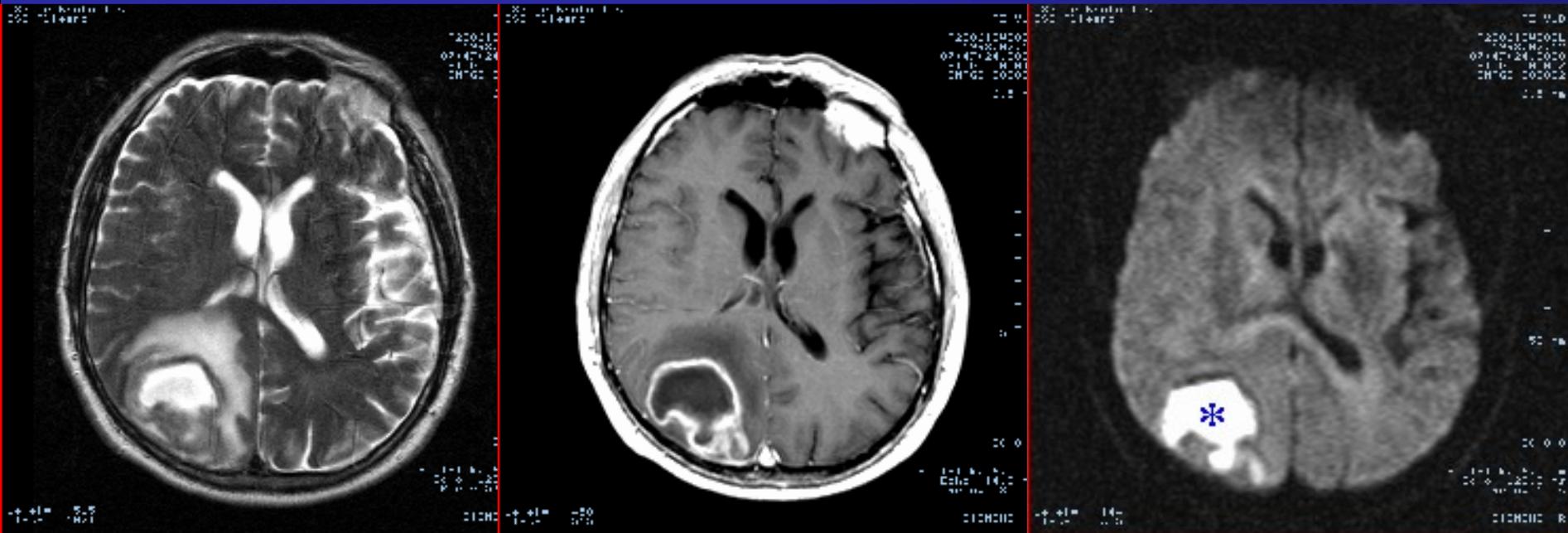
- Findings of arterial dissection on C
- In case of thrombosis, superiority



# *Rapidly progressive neurological deficit with immunosuppression or fever*

**Deadline: 24h or less if possible**

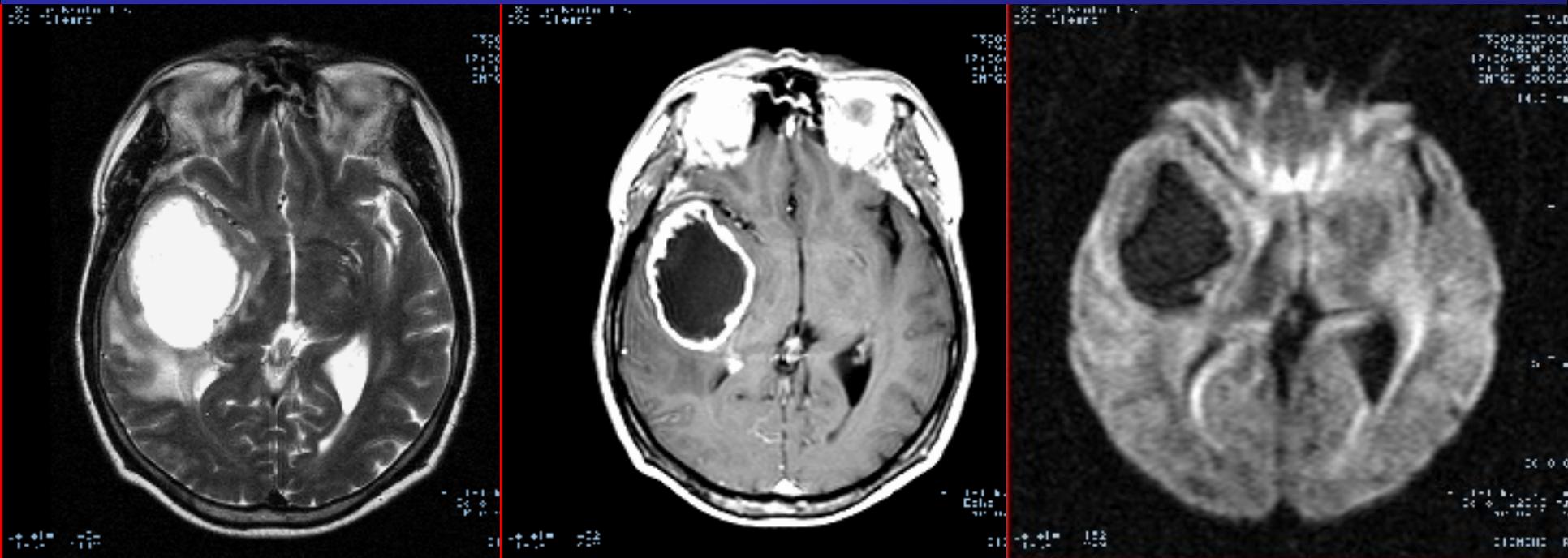
**Exams: MRI. If abscess suspected: 4h  
or less (Diffusion!)**



# *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**

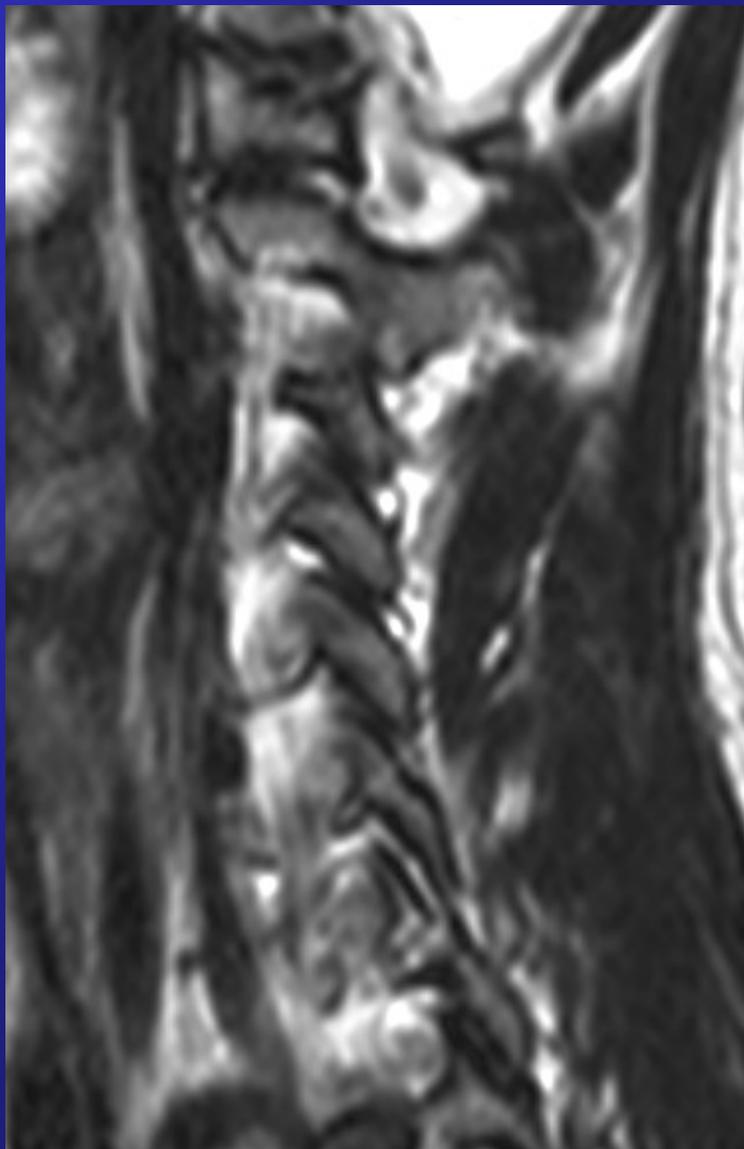
**if discordance between CT and clinical findings.**

**After neurosurgical opinion?**

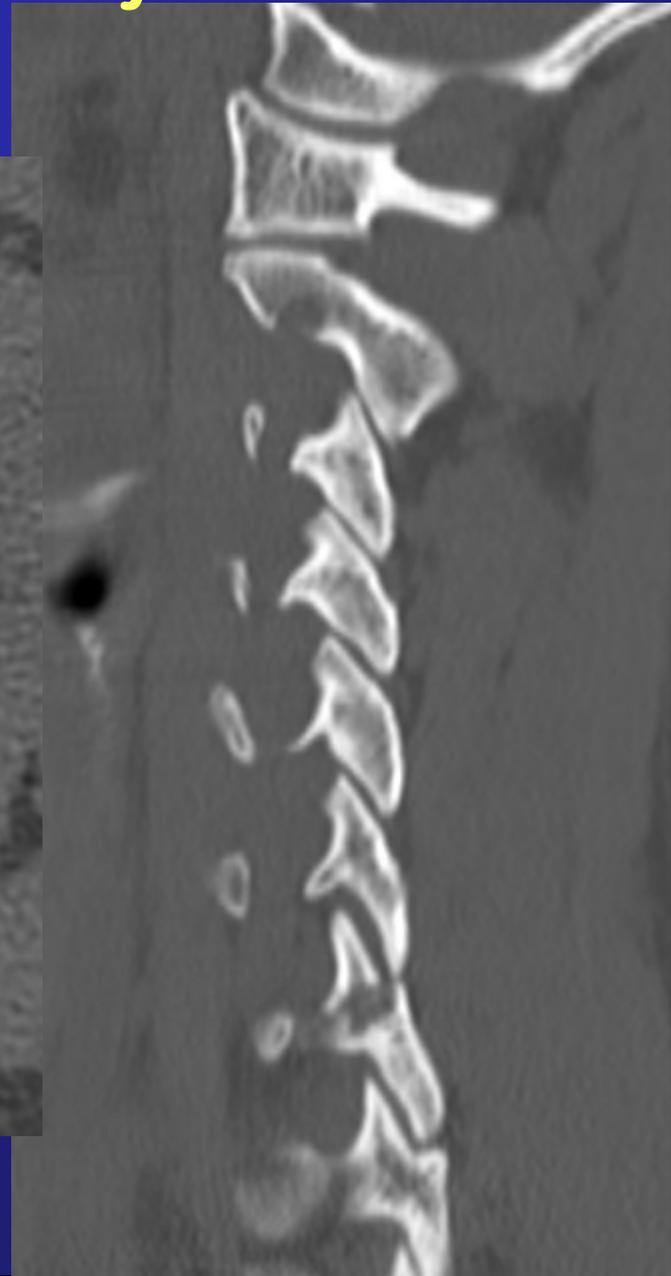
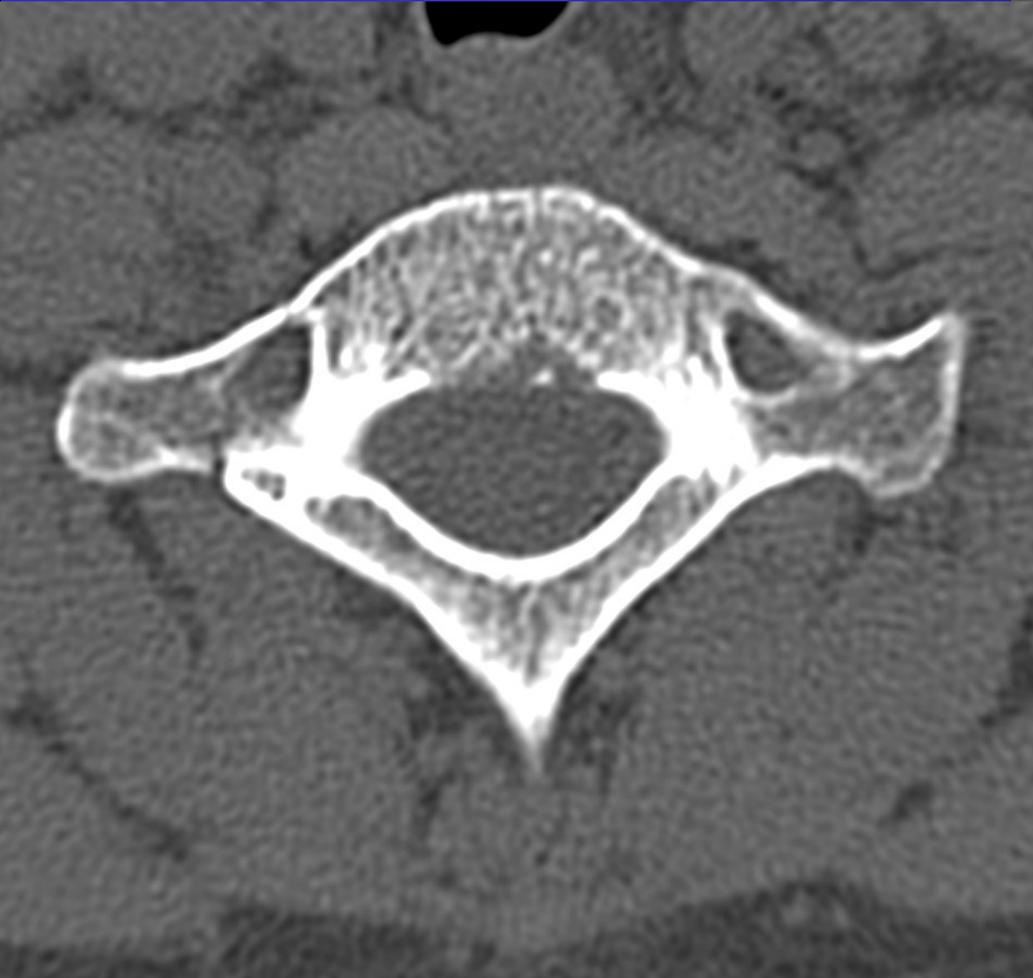
**Spine trauma with neurological signs (fallen from his horse, paresis fingers right hand). XR the day of trauma**



**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**



# *Diagnosis and treatment of low back pain and sciatica*

## **Imaging:**

Imaging is indicated only in patients with "red flag" conditions or in whom disc surgery is considered.

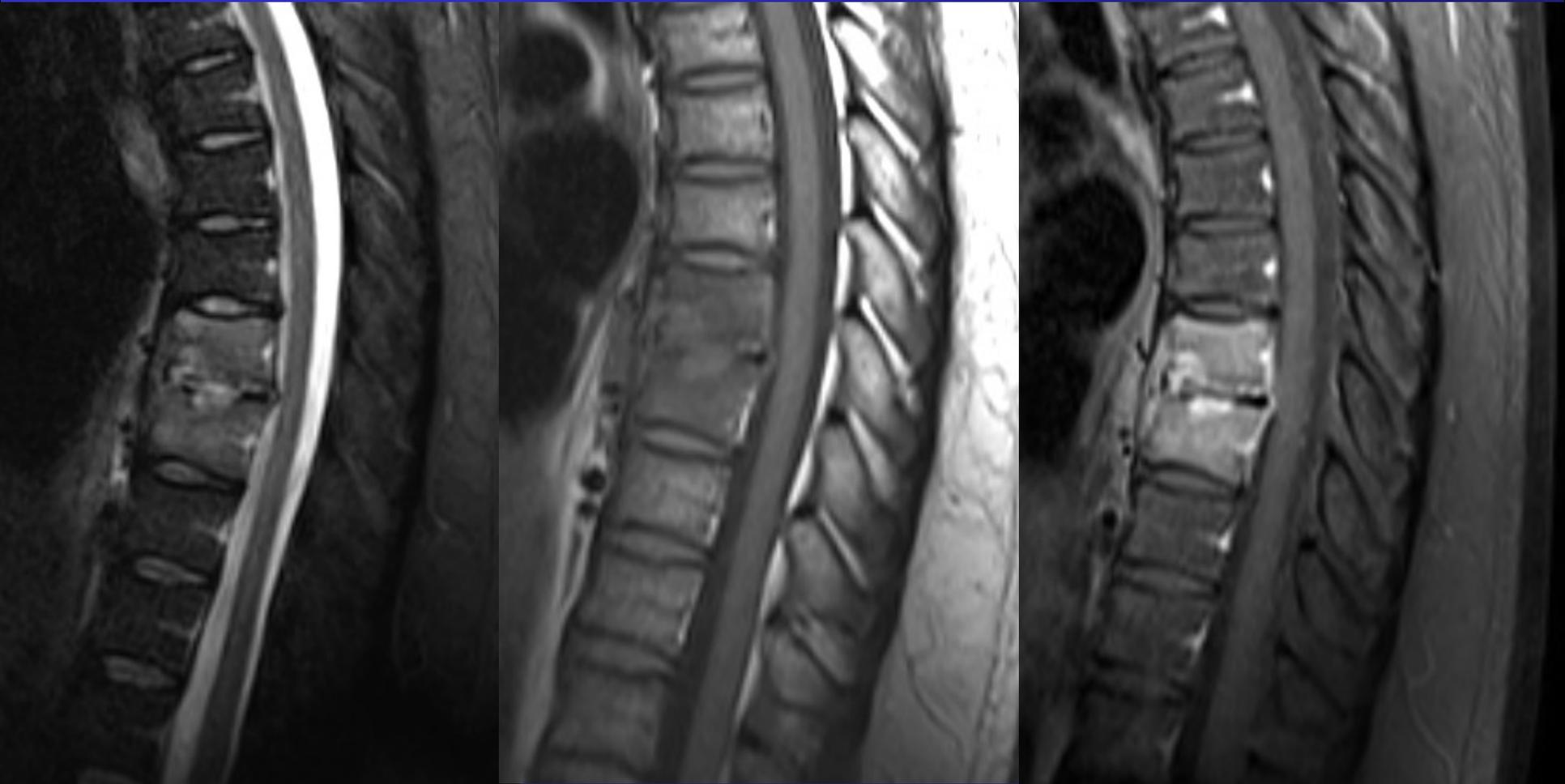
Consensus is that initial treatment is conservative for about 6-8 weeks.

("red flags" – suspicion of infection, malignancy, severe symptoms who fail to respond to conservative care, neurologic deficit, osteoporotic fractures)

**IRM>Scanner**

("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

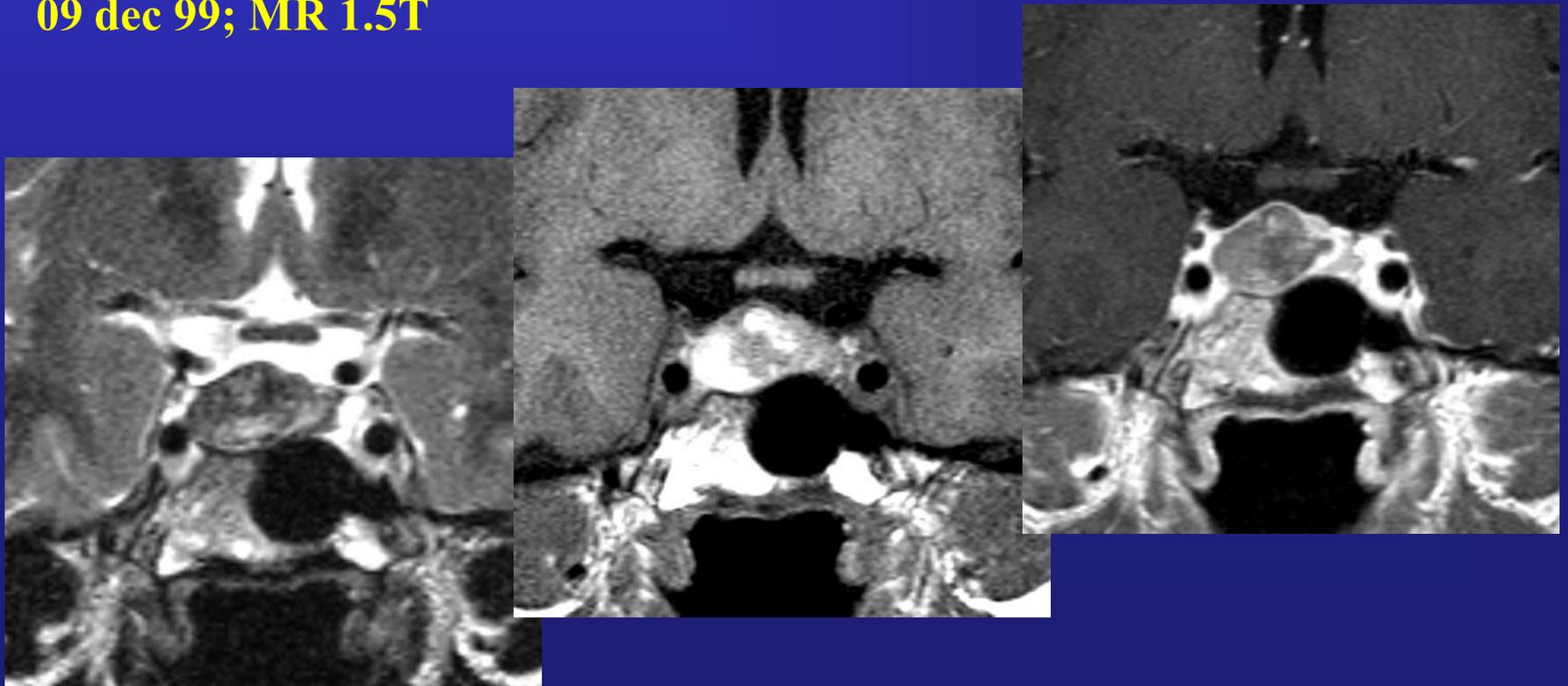
- in pituitary tumour
  - hemorrhagic apoplexy
  - acute necrosis

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

- hemorrhagic apoplexy
- acute necrosis

## Clinical presentation:

<b>Clinical symptom</b>	<b>Arterial dissection</b>	<b>Venous sinus thrombosis</b>	<b>Pituitary apoplexy</b>
<b>Headache</b>	+++++(75%) (+ neck ache)	+++++ (70-90%)	+++++
<b>Seizures</b>	+	++ (10-60%)	++
<b>Neurologic deficit</b>	+++ (Horner 15%)	+++ (30-80%)	+++ (3d nerve)
<b>Papilledema</b>		+++ (30-80%)	++

# Pituitary apoplexy

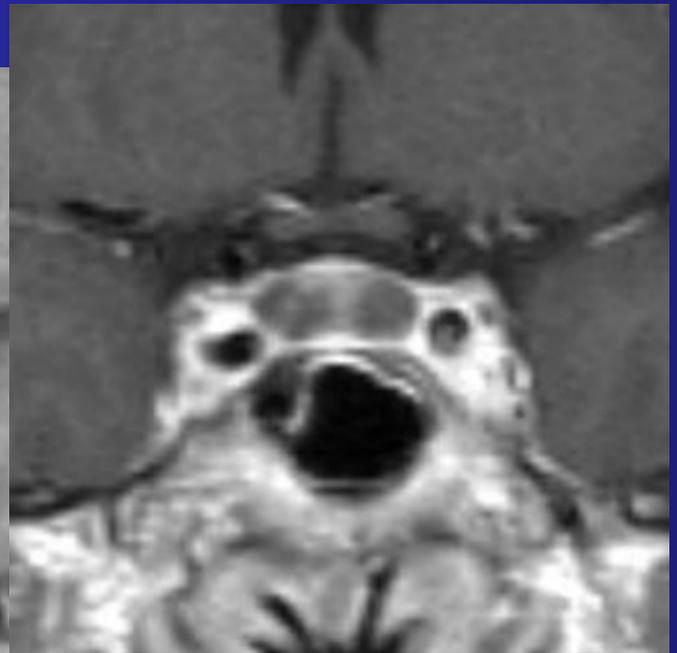
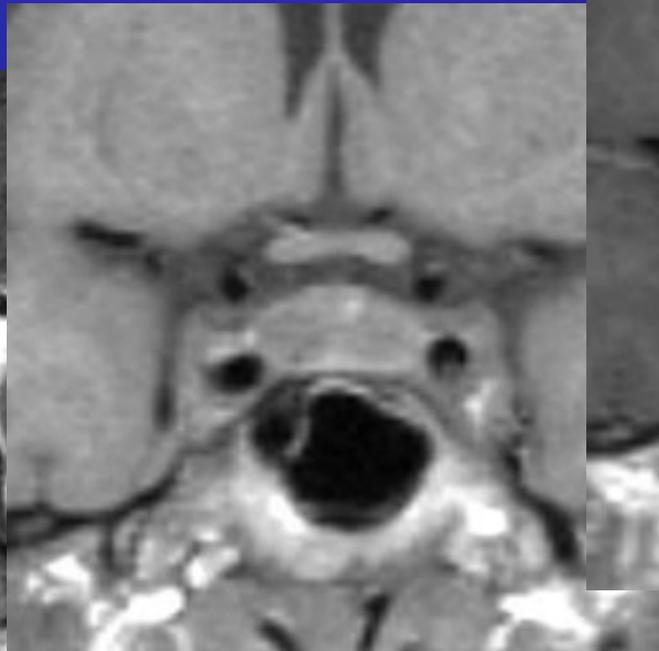
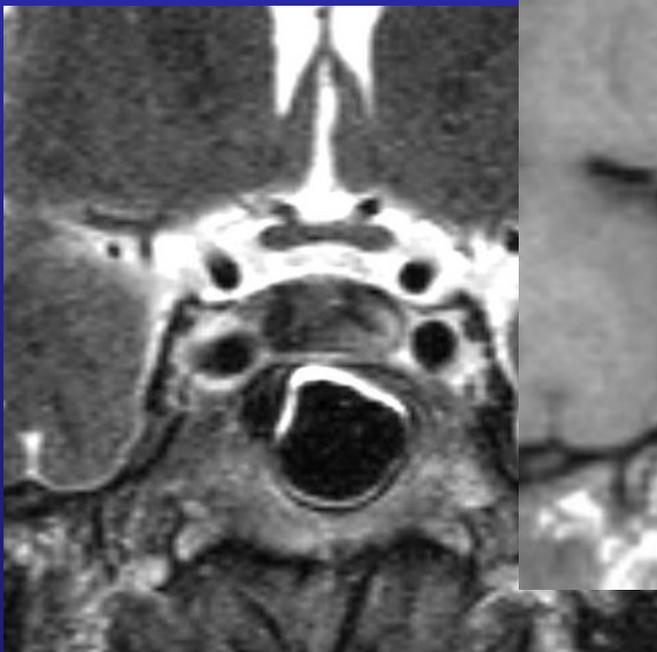
- in pituitary tumour
  - hemorrhagic apoplexy
  - acute necrosis

**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**



# Ppituitary apoplexy

- in pituitary tumour
  - hemorrhagic apoplexy
  - acute necrosis**

*American Journal of Neuroradiology* 23:1240-1245,  
August 2002

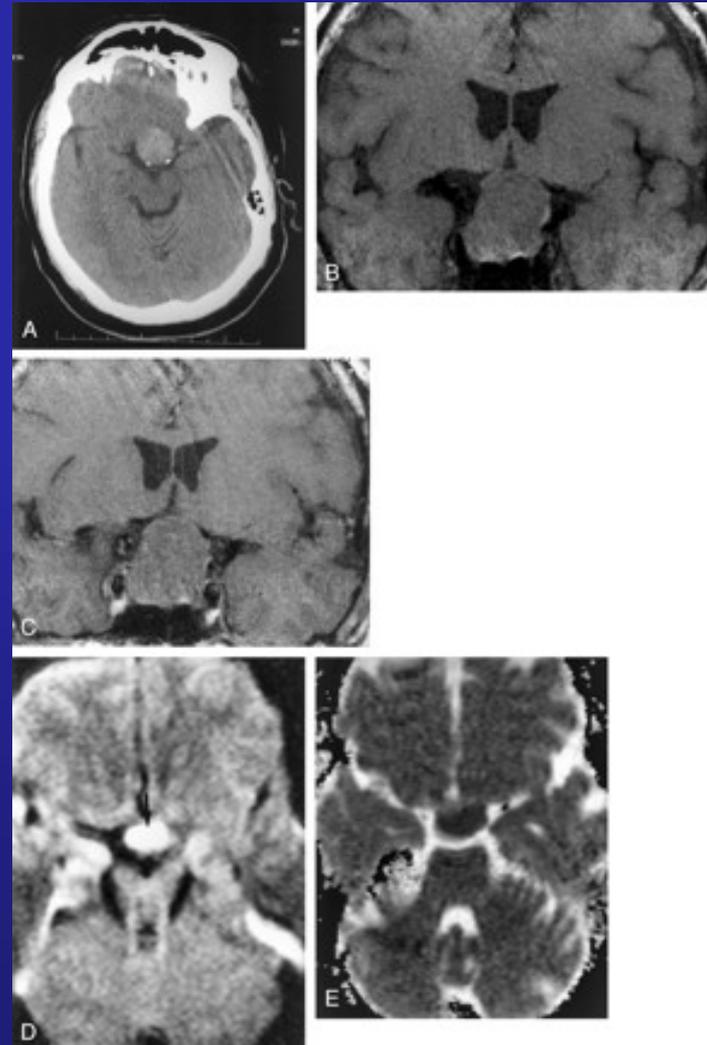
© 2002 American Society of Neuroradiology

## Pituitary Apoplexy: Early Detection with Diffusion-Weighted MR Imaging

Jeffrey M. Rogg<sup>a</sup>, Glenn A. Tung<sup>a</sup>, Gordon Anderson<sup>b</sup> and Selina Cortez<sup>c</sup>

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

B710731DR00Q

22 Nov 2010

Headache since 1 week.

Today, loss of visual acuity and anisocorie

CT and MR performed 22 Nov 2010

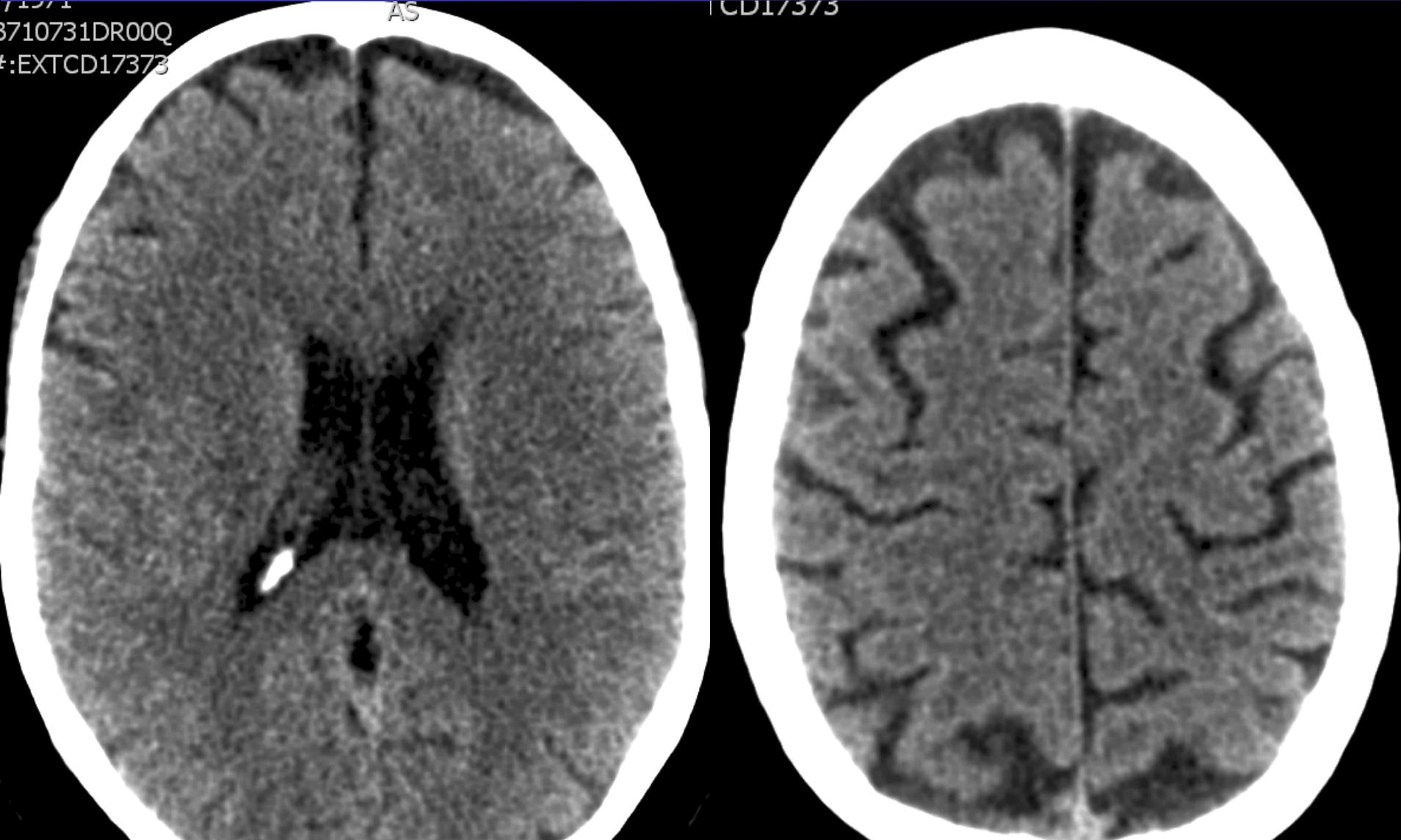
# Headache with neurological signs

B710731DR00Q CT performed 22 Nov 2010 13:28

710731  
B710731DR00Q  
#:EXTCD17373

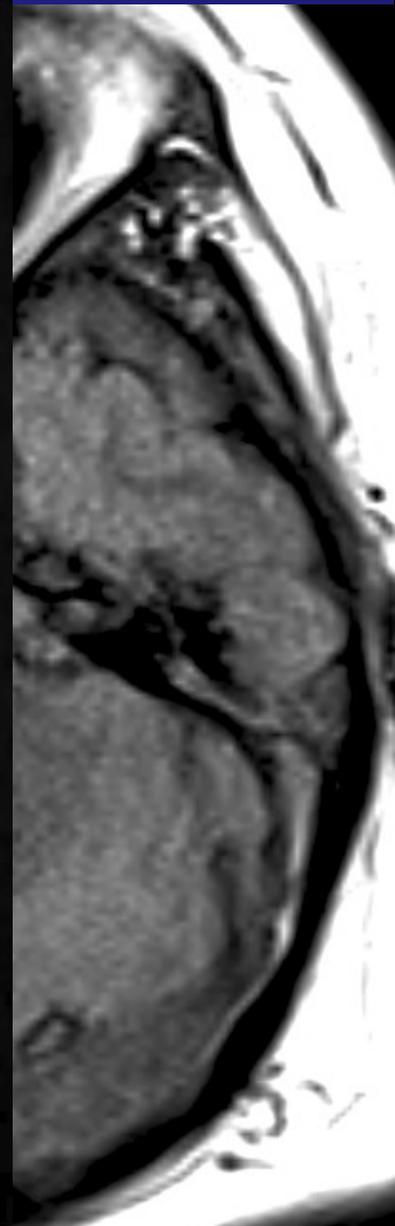
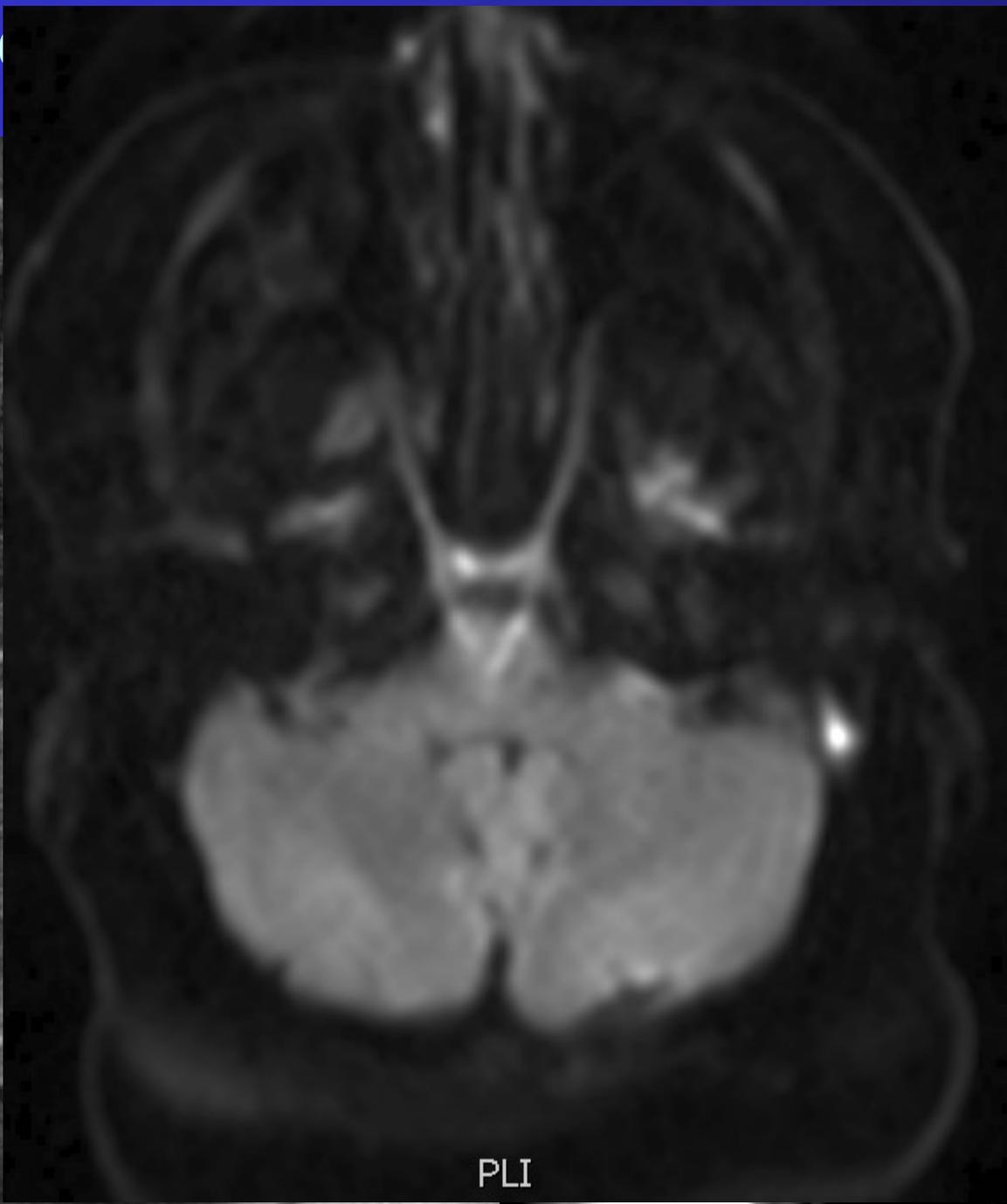
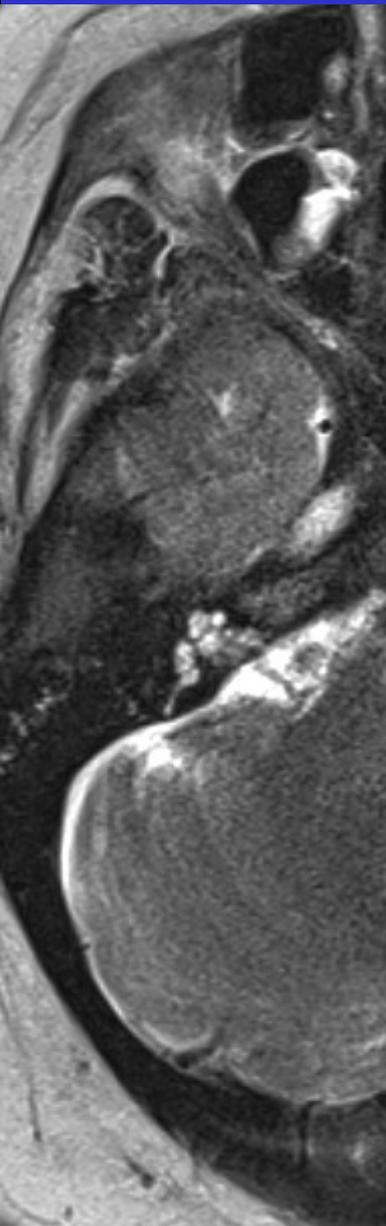
AS

CD17373



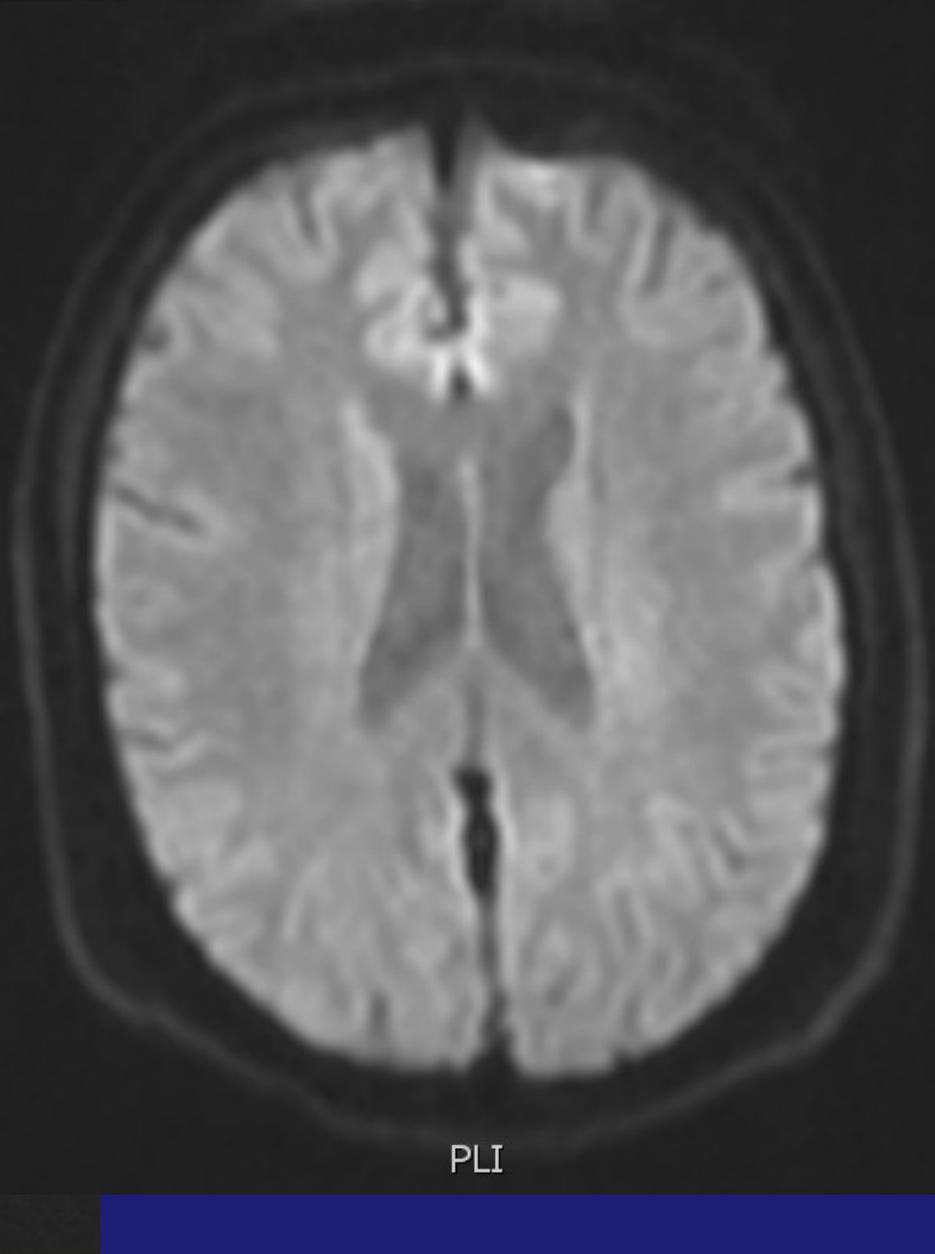
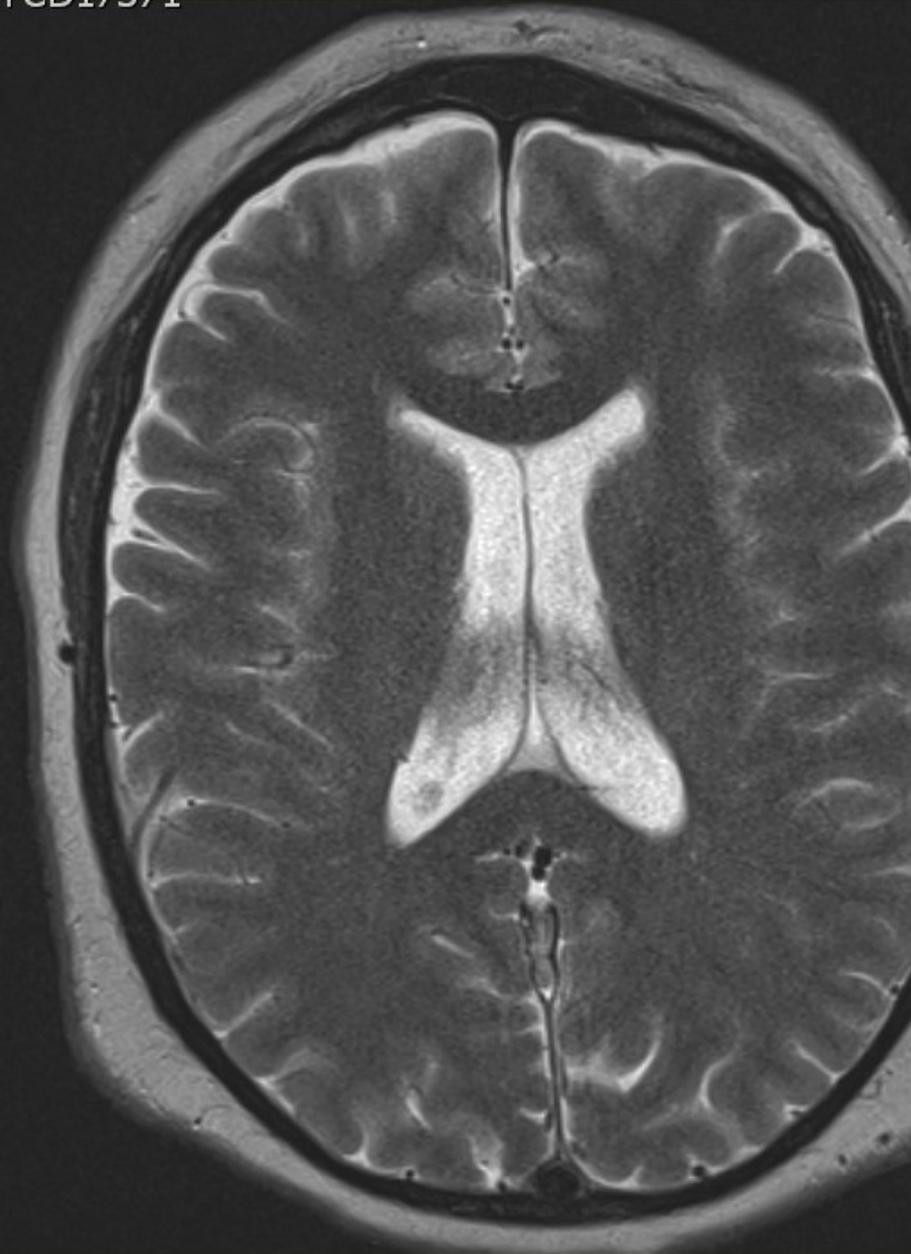
Headache

Headaches



PLI

# Headache with neurological signes



# Headache with neurological signes

B710731DR00Q

*Radiologist report: normal CT and MR*

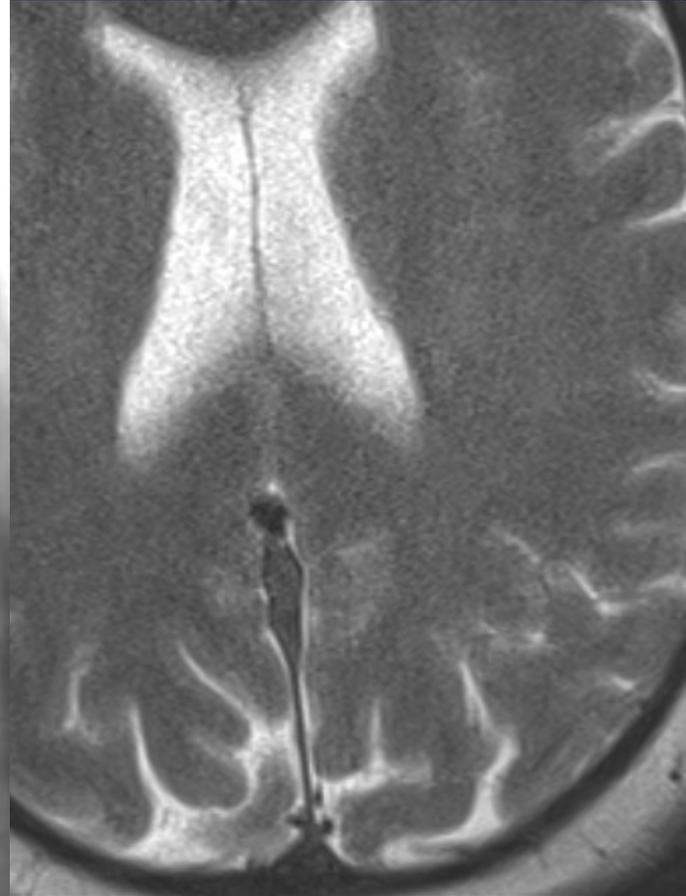
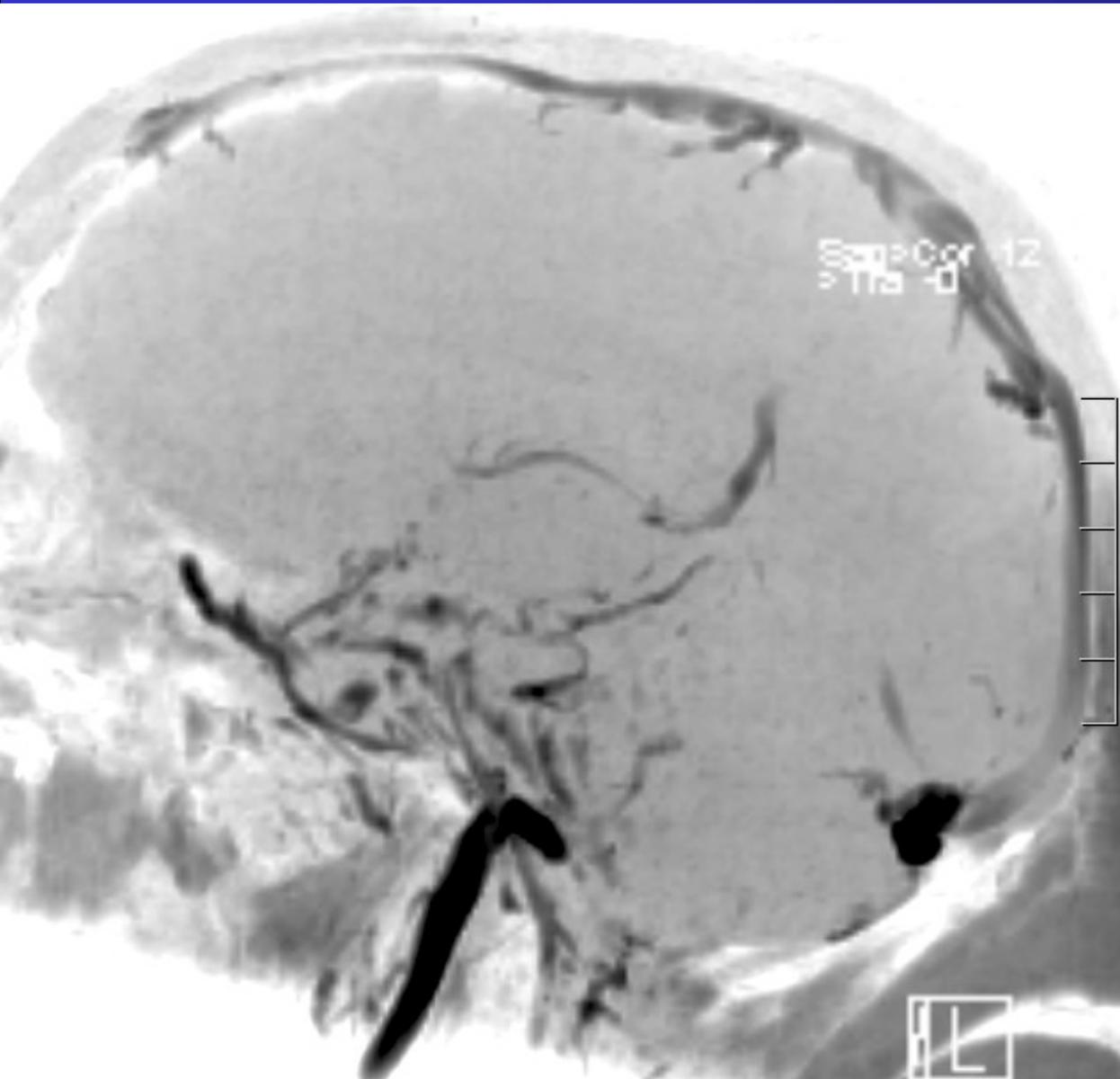
*Evolution:* progressive blindness, paralysis n. abducens

**Diagnosis:** idiopathic intracranial hypertension

**What you need in such a situation:**

- **New CT?**
- **New MR?**
- **Second opinion?**

# Headache with neurological signes



# Headache with neurological signes

B710731DR00Q 23 Nov 2010 20h

Transfert UZ VUB

**Teleradiology 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

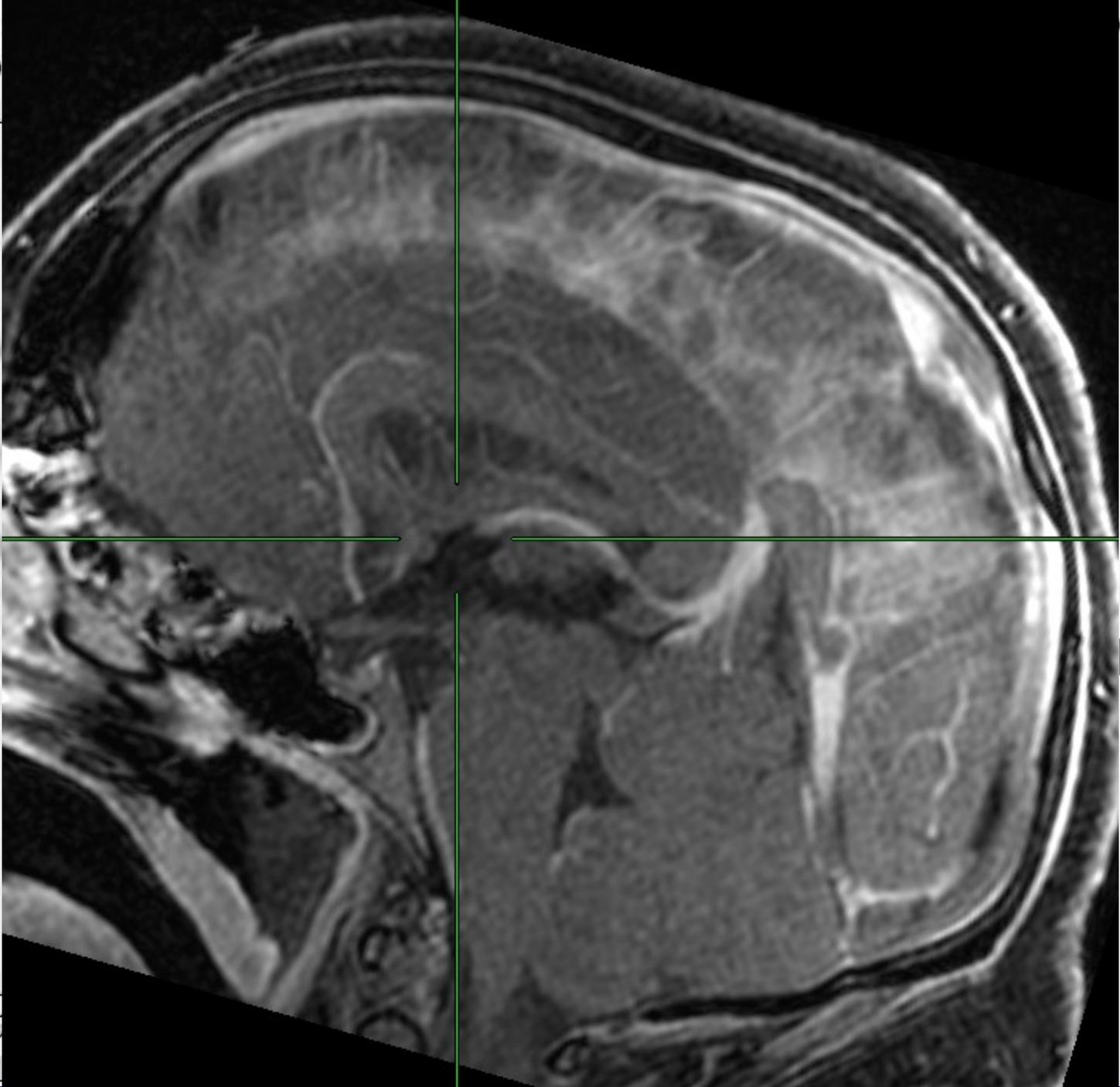
induction with Pentothal, high dose

required for loss of consciousness

**MRI:**

CC  
2:0  
4:1

10



P  
I  
L  
O

R:1  
E:6  
W:1

# Headache with neurological signes

B710731DR00Q 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?*

**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**

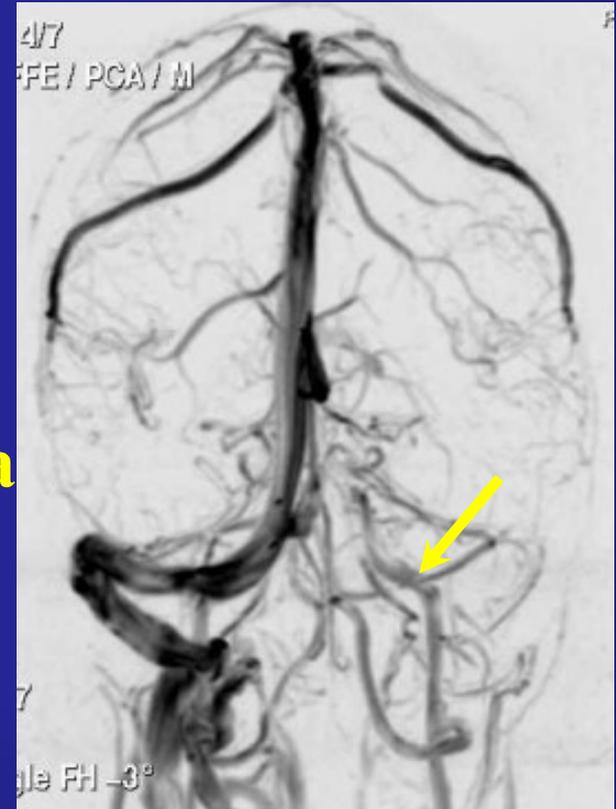
**Or CTscanner  
without injection +  
CT angiography**

**(Less reliable than MRI, but more accessible)**

# 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**



# *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)**

# *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](mailto:stadnik@vub.ac.be)*