

# DIAGNOSTICS IN HEADACHE

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**Detailed history:** present headache  
previous headaches (in childhood,  
adolescence, later in life)

**Diary** in pts with recurrent headache:

pain character  
localization  
intensity  
frequency  
duration  
response to analgesics

**Diagnostic work-up** in patients with suspected secondary  
headache

### ■ **Laboratory**

blood  
cerebrospinal fluid

### ■ **Neuroimaging**

X Ray, CT, CTA, MRI, MRA, DS angiography,  
fMRI, SPECT, PET

### ■ **Ultrasound**

extra- and intracranial

### ■ **Electrophysiological methods**

EEG, EP

## **LABORATORY**

- Red, white blood cell analysis
- SE, CRP
- Coagulation tests
- Hepatic, nephrology tests
- Blood glucose
- Blood gases
- Toxicology (alcohol, CO)
  
- Antibody titar (streptococcus)
- Genetic (FHM)



## LUMBAR PUNCTURE

>100 years

Adult patients with headache exhibiting signs of increased intracranial pressure including papilledema, absent venous pulsations on fundoscopic examination, altered mental status, or focal neurologic deficits should undergo a neuroimaging study before having an LP (Level C)

LP is indicated in the evaluation of:

- meningitis, encephalitis
- meningeal carcinomatosis or lymphomatosis
- subarachnoid hemorrhage (SAH) (when CT scan is negative)
- high or low CSF pressure

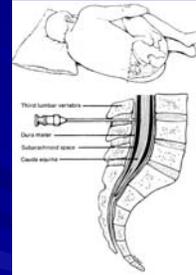
### 1. Pressure measurement

- 100-150 mm H<sub>2</sub>O

### 2. Biochemical analysis:

- decreased glucose, electrolytes = acute infection
- Cl decreased in Tbc meningitis

Post puncture headache up to 7 days



## NEUROIMAGING METHODS

- X ray
- ultrasound
- CT
- MRI
- Angiography (CT, MR, DSA)
- fMRI
- PET

**Detection of treatable lesions** remains the primary reason to obtain neuroimaging studies

**Relieve the patient's anxiety** about having an underlying pathologic condition, therefore neuroimaging may improve patient overall satisfaction

## **EMERGENT NEUROIMAGING “NOW”**

- sudden onset headache, severe
- abnormal finding on the neurological examination
- trauma

## **URGENT NEUROIMAGING** in patients with

- atypical headache patterns
- history of seizures or focal neurological signs and symptoms
- abnormal finding on the neurological examination
- headache worsened by Valsalva maneuver
- headache causing awakening from sleep
- new headache in the older population >50 yrs
- progressively worsening headache
- new-onset headache in patient who has cancer or is HIV positive
- headache associated with symptoms and signs such as fever, stiff neck
- headaches associated with papilledema, cognitive impairment, personality change

## **Reasons to consider neuroimaging for headaches**

### **Temporal profile and headache features**

Subacute headache with increased frequency or severity

A new daily persistent headache

Transformation to a chronic daily headache

Headache always on the same side

Headache not responding to treatment (any more)

## X ray

### ■ X ray head, cervical spine

- Fracture
- Bone destruction
- Degeneration or inflammation of joints

### ■ Specific X ray examination

- Base of skull, mastoid, pyramides, orbits, sinuses



## CT scan

### ■ Emergent, urgent examination

- blood
- ischemic stroke
- trauma
- tumors

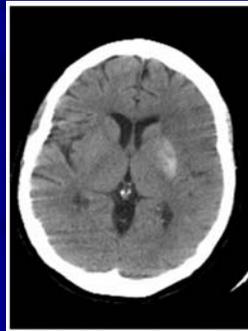
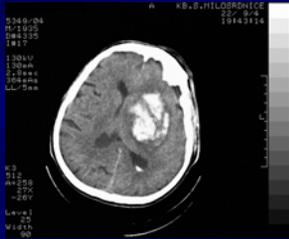
### ■ i.v contrast

### ■ Insufficient in evaluation of cerebellar structures, cervical spine



## SPONTANEOUS INTRACEREBRAL HAEMATOMA

TYPICAL (basal ganglia) - hypertensive  
ATYPICAL (cortico-subcortical) – AVM

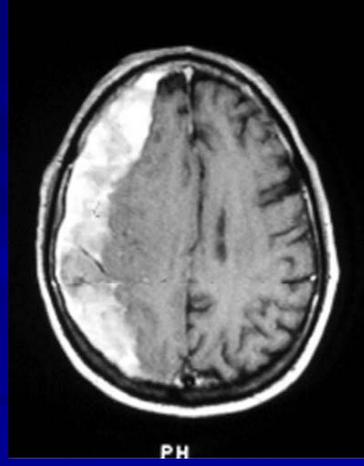


## INTRAVENTRICULAR HAEMORRHAGE

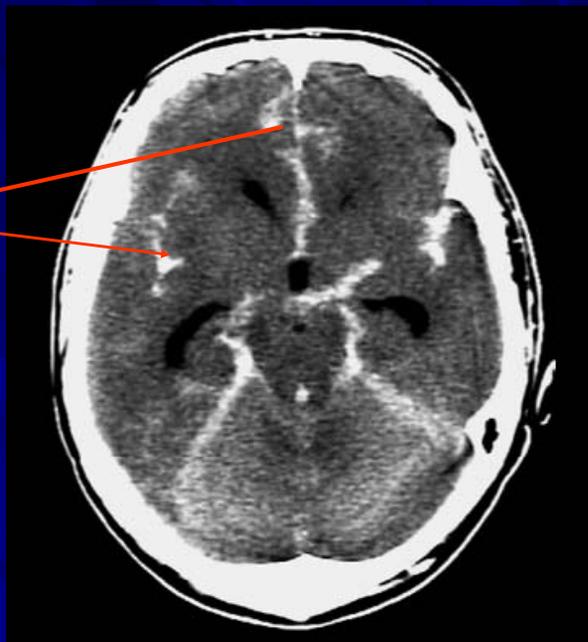
Shift to CL side

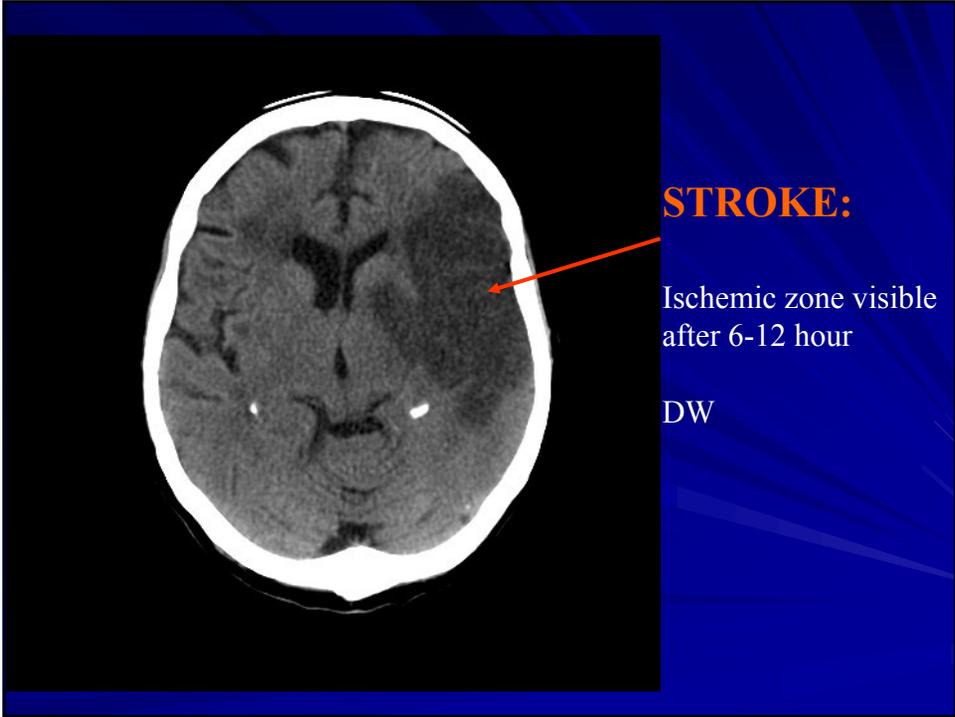


**TRAUMA: EPIDURAL, SUBDURAL  
HAEMATHOMA**



**SUBARACHNOID  
HAEMORRHAGE**

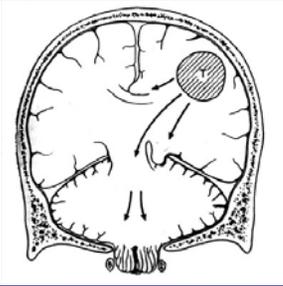




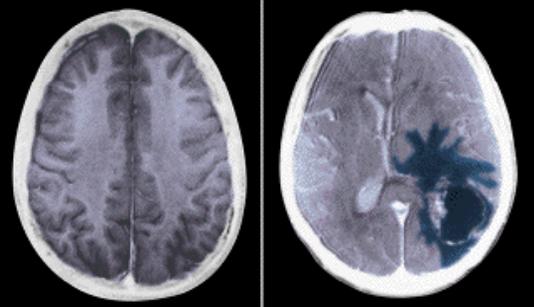
**Mass effect**

**Increased intracranial pressure**  
(headache, nausea, vomiting)

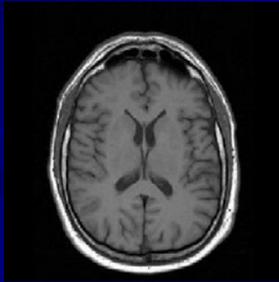
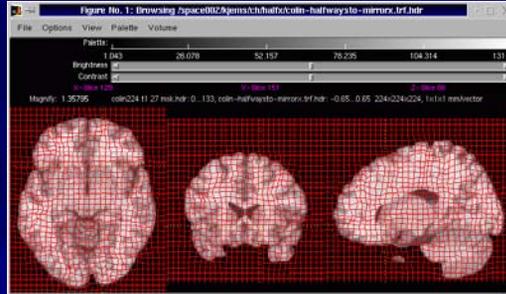
- seizures
- psychic changes
- lost of consciousness
- change of respiration, pulse



**TUMORS:** CT – not sufficient, usually needed MRI

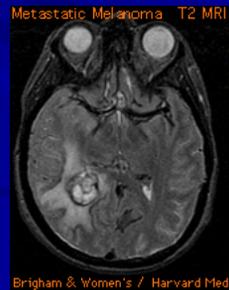


# MRI: transversal, coronal, sagittal,



T1

T2

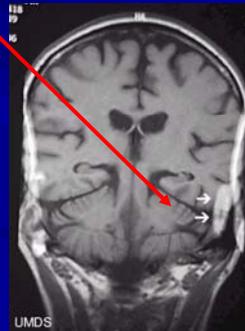
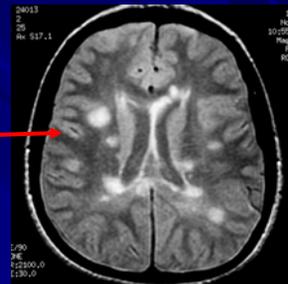


## MRI

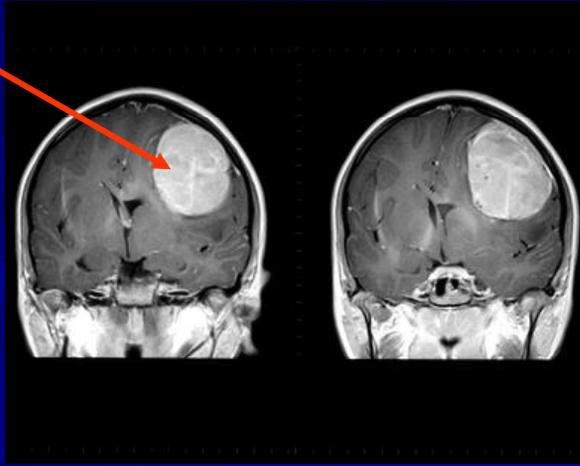
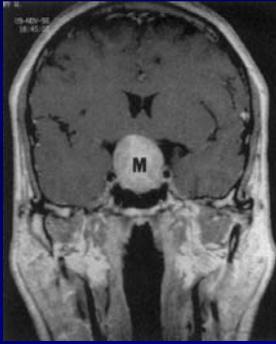
### Better visualisation

- demyelinating plaques
- cerebellar pathology
- craniocervical junction
- cervical spine

- **contraindications:** metal devices (pace maker, prostheses)

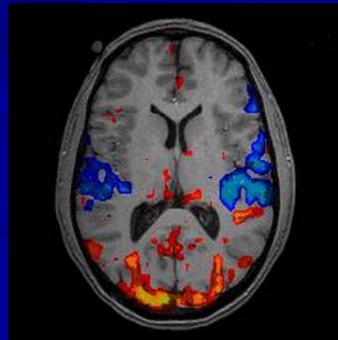
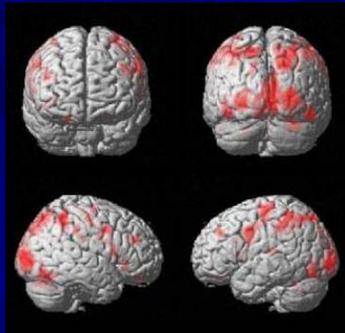
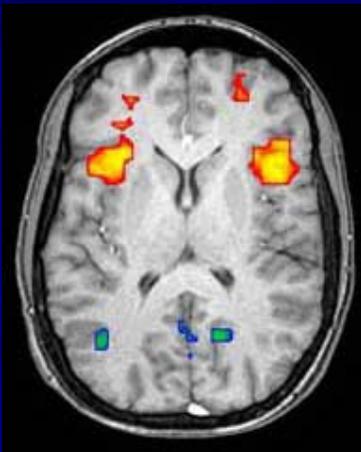


## MR: TUMORS



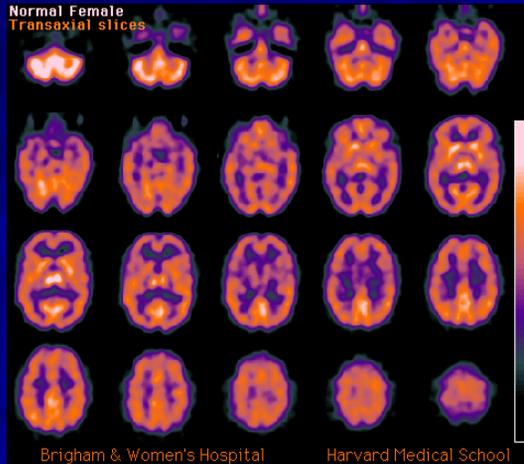
## fMRI

Experimental use



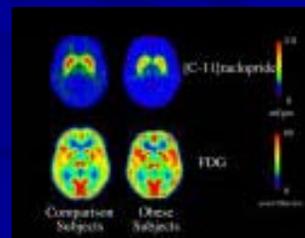
# Single Photon Emission Tomography SPECT

- Regional blood flow in brain by use of radioactive isotope



# Positron Emission Tomography PET

- Regional glucose consumption in certain parts of brain by the use of radioactive glucose
- Metabolic deficit or hypermetabolism



Recurrent headaches defined as **migraine**, including those with visual aura, with no recent change in headache pattern, no history of seizures, and no other focal neurologic signs or symptoms, the routine use of **neuroimaging is not warranted** (level B)



## MR IN MIGRAINE

On T2 WI 6-46% exhibit increased signal in periventricular and deep white matter - result of **micro vascular ischemic damage** from repeated vascular perturbances in regional blood flow during migraine attacks

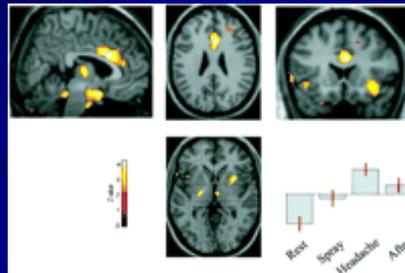
DWI findings in **migraine with aura**

- a) Usually normal despite persistence of focal neurological deficit and extensive blood flow changes
- b) Reversible DWI hyperintensities not respecting vascular territories and corresponding with the localization of aura
- c) Elevated ADC values typically in regions related to the aura phase

**Case report:** in 56 yr old man with persistent visual aura an increased signal intensity on DWI – signal abnormality shifted from occipital to temporoparietal area (day 2 to day 17, no abnormalities on day 56)

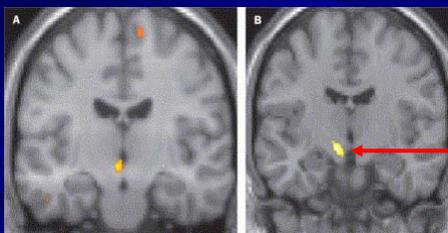
## Voxel – based morphometry in migraine and cluster h.

- allows quantitative evaluation of brain morphology
- In several trigeminal-autonomic headaches the hypothalamic grey is involved in the pain process; observed activation in:
  - migraine – brainstem (dorsal pontine region)
  - acute cluster headache, SUNCT, parox hemicrania, hemicrania continua (posterior hypothalamic grey matter)
- first study: significant structural difference (increased density) in gray matter in the inf. posterior thalamus of **cluster** pts
- also functional activation shown by PET studies!!



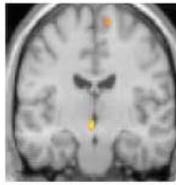
## fMRI, PET in cluster headache

- when an acute CH attack was triggered with NTG, activation occurred in the:
  - ipsilateral posterior inferior hypothalamic gray
  - contralateral ventroposterior thalamus
  - anterior cingulate cortex
  - ipsilateral basal ganglia
  - right anterior frontal lobe
  - both insulae
- these studies resulted in the use of DBS – over 50 pts successfully treated



Activation on fMRI/PET in the posterior hypothalamic grey matter  
ONLY ipsilateral to the on the side of the pain

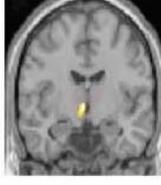
## Hypothalamic activation in TAC



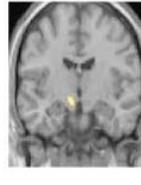
Cluster, PET, n=9  
May et al. 1998



Cluster, PET, n=1  
Spranger et al. 2003



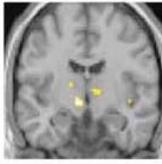
atypical TAC, PET, n=1  
Spranger et al. 2005



Cluster, VBM, n=29  
May et al. 1999



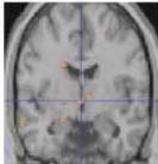
Cluster, DBS & PET, n=10  
May et al. 2006



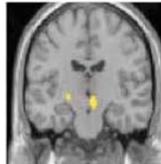
SUNCT, f-MRI, n=1  
May et al. 1999



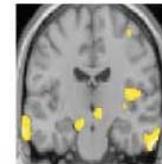
SUNCT, f-MRI, n=1  
Spranger et al. 2003



SUNCT, f-MRI, n=1  
Cohen et al. 2004



PH, PET, n=10  
Matharu et al. 2005

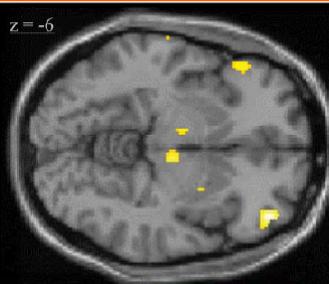
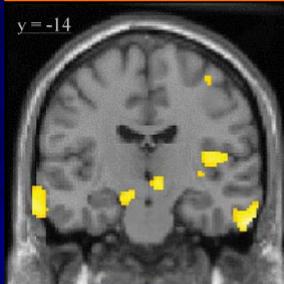


HC, PET, n=7  
Matharu et al. 2004

## PET in hemicrania continua

Medscape®

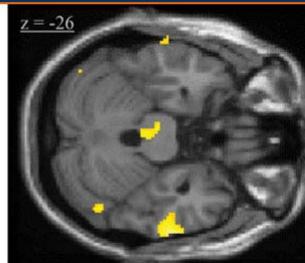
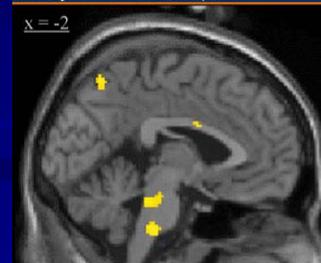
www.medscape.com



Medscape®

www.medscape.com

Source: Headache © 2004 Blackwell Publishing



Source: Headache © 2004 Blackwell Publishing

**VBM: Decrease of gray matter in pain transmitting structures:**

- **migraine** is a progressive disorder: repeated migraine attacks over time result in selective damage of brain regions involved in central pain processing: migraine pts have significant reduction of gray matter in insula, motor/premotor prefrontal cortex, cingulate, orbitofrontal, right posterior parietal cortex

Not interpret as "brain damage" !

**Study**

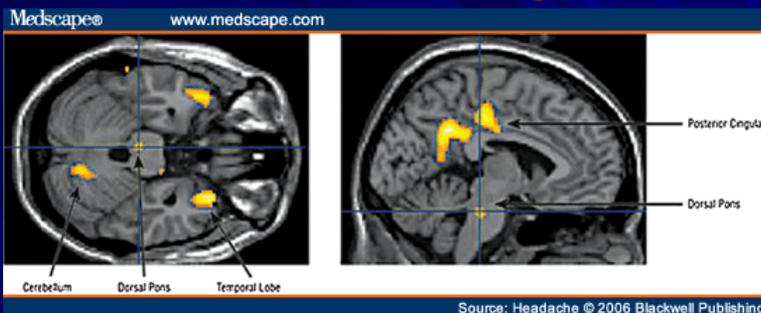
- using VBM it was demonstrated that repeated 20 min painful stimulation resulted in **thickening of the somatosensory cortex**

Modern neuroimaging suggests that most primary headache syndromes are predominantly driven from the brain, activating the trigeminovascular reflex

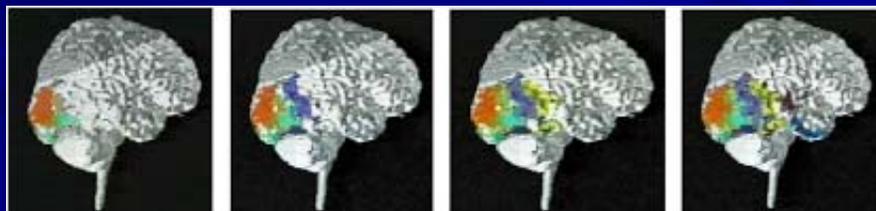
Dilatation of cranial vessels is not specific to any particular headache syndrome but generic to cranial neurovascular activation, probably mediated by the trigemino - parasympathetic reflex.

Need for therapeutics that act on both sides: centrally and peripherally.

**PET in migraine**



Increased rCBF of visual cortex during migraine attack

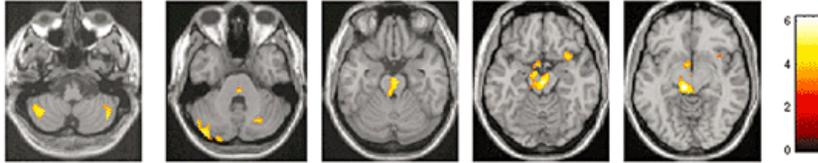


# PET in migraine

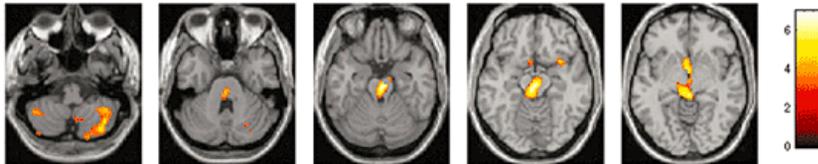
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www.medscape.com

## Before sumatriptan



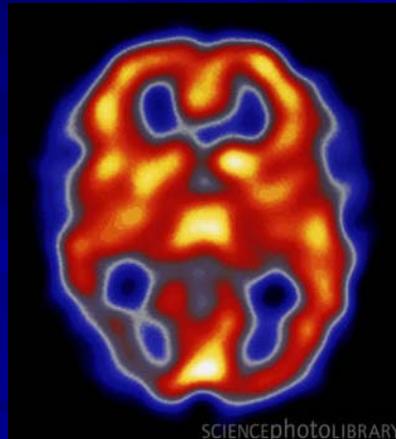
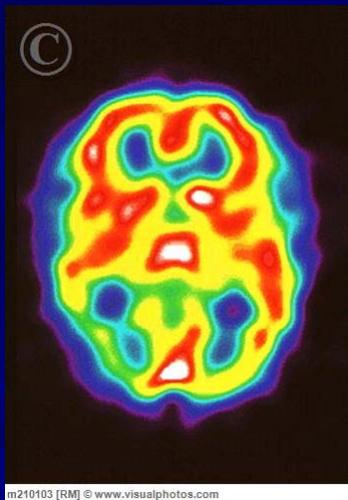
## After sumatriptan



Activations during migraine attack, before sumatriptan and after sumatriptan, are shown as statistical parametric maps which show the areas of significant rCBF increases ( $p < 0.001$  uncorrected) in colour superimposed on an anatomical reference derived from a T1-weighted MRI. Colour bar is for Z score.

Source: Headache © 2007 Blackwell Publishing

## SPECT scan of a patient's brain during a migraine attack

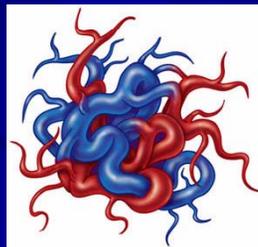
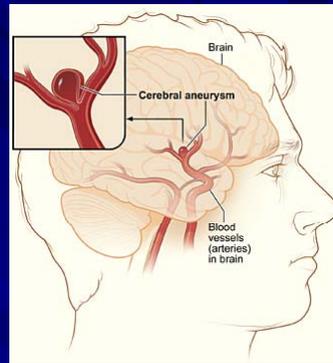


m210103 [RM] © www.visualphotos.com

## ANGIOGRAPHY

- 1) CT angio
- 2) MR angio
- 3) DSA – invasive

- Aneurysms
- AVM
- Extra- intracranial stenosis
- occlusion
- dissection
- fibromucular dysplasia
- venous thrombosis



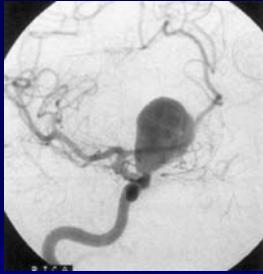
CT angiography

MR



## DSA – digital subtraction angiography

- invasive
- highly sensitive for detection of small aneurysms, AVMs and dural vascular malformations



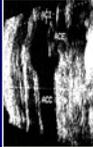
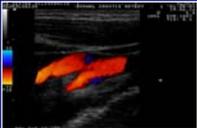
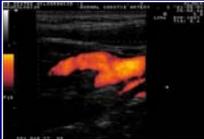
## DSA – digital subtraction angio

**SAH vs thunderclap headache:** if the initial DSA is normal and the pattern of haemorrhage on original CT is perimesencephalic in distribution, there is generally no need for a repeat angiogram

**Reversible cerebral vasoconstriction syndrome:** multiple segments of narrowing in vessel calibre; repeated DSA: improvement in vessel calibre



# Christian Doppler ULTRASOUND



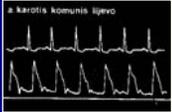
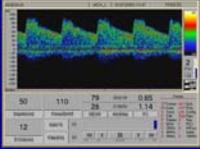
Satomoura i Kaneko 1960

**Extracranial**

**Transcranial**



**Diagnostics**  
**Therapy**  
**Prevention**

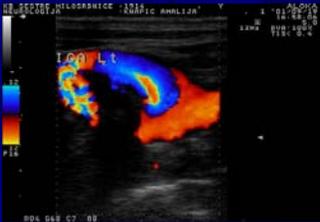
# Color coded duplex sonography

**MORHOLOGY**

- anatomical position of the vessel, tortuosity
- ath. plaques, IMT; stenosis

**HAEMODINAMIC INFORMATION**

- Spectral analysis
- Direction flow
- Flow disturbances (stenosis, occlusion)



**carotid artery**



**vertebral art.**  
extracranial  
acranial

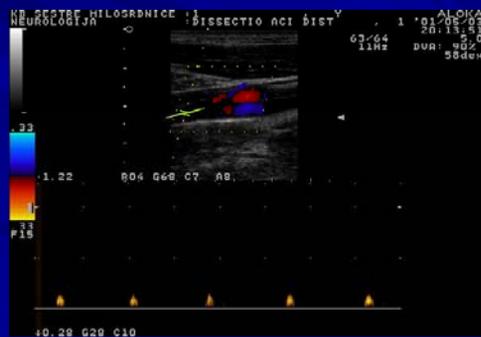
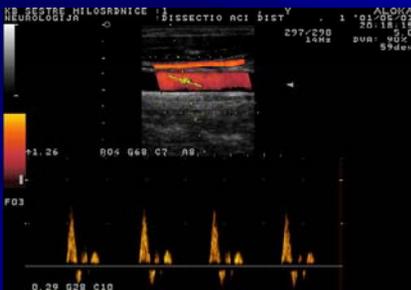


## Arterial dissection

Ultrasound finding:

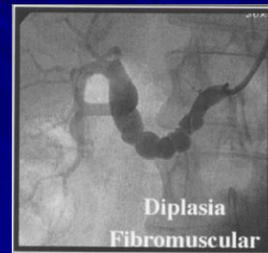
- String sign, string-pearl
- Subintimal flow
- Double lumen
- Distal occlusion

Follow-up of dissected artery



## VASCULOPATHY Fibromuscular dysplasia

- Concentric narrowing and enlargement of vessel wall
- Tendency to dissection, embolisation



# VASCULITIS

## Temporal arteritis

- involvement of external carotid artery: TSA

ultrasound:

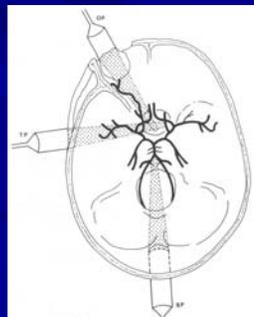
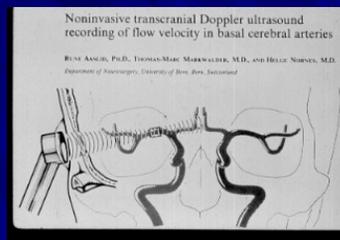
- determination of biopsy location
- dark "halo": oedema
- increase of echogenicity: fibrotic repairment



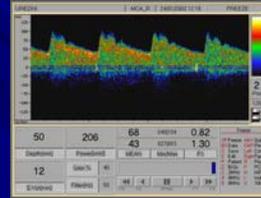
## Transcranial Doppler sonography (TCD) Rune Aaslid 1982.



Zagreb 2008



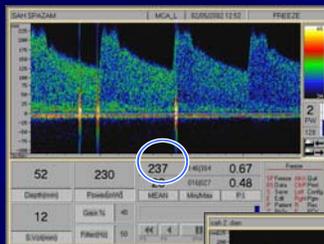
## Clinical use of TCD



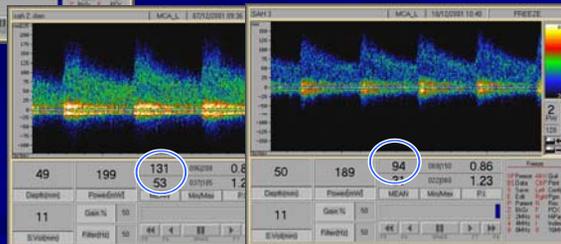
- Monitoring and follow up:
  - hemodynamics in circle of Willis
  - detection of stenosis
  - collateral pathways in extracranial carotid disease
  - detection of AVM
  - vasoreactivity
  - **vasospasm in SAH**
  - TCD in brain death
  - emboli monitoring (symptomatic carotid stenosis, during CEA)
  - TCD enhanced thrombolysis

## TCD: follow up of spasm in SAH

- BFV in correlation with severity of clinical symptoms, localisation of blood on CT scan and vasospasm



1. day

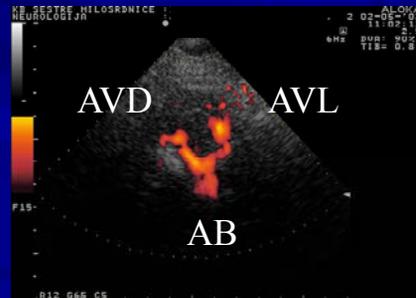
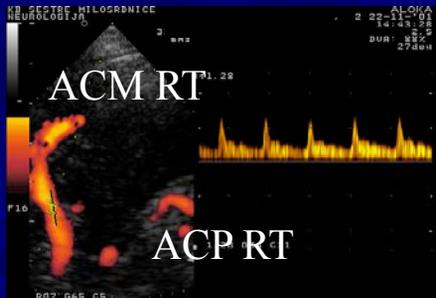
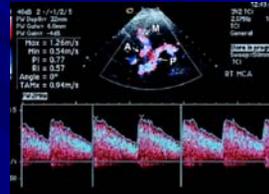


2. day

3. day

# TCCS

- Stenosis
- AVM
- Aneurysm



## Electrophysiology

**EEG** - not indicated in the routine evaluation of headache. This does not exclude the use of EEG to evaluate headache patients with associated symptoms suggesting a seizure disorder such as atypical migrainous aura or episodic loss of consciousness.

**VEP** – pathological in migraine

- interictally persisting dysfunction of precortical visual processing
- latency of N2 significantly prolonged in MA and tend to be delayed in MO subjects

## **CONSULTATION**

### **OPHTHALMOLOGIST**

- funduscopy
- refraction abnormalities
- visual acuity

### **EAR, NOSE THROAT**

- infection

### **INTERNAL MEDICINE**

- cardiac cephalalgia
- hepatic, nephrologic disease