



International Headache Society

Role of imaging to understand the pathophysiology of headache

Margarita Sanchez del Rio
Headache program
Hospital Ruber Internacional
Madrid

1. Migraine

With Aura

$^{133}\text{Xenon}$ -cerebral blood flow

PWI/DWI

BOLD

MEG

without aura

$^{133}\text{Xenon}$ - cerebral blood flow

PWI

BOLD

PET

2. Cluster headache

PET

Voxel based morphometry

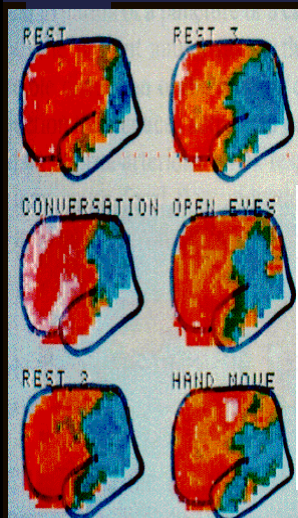
3. Hemicrania Continua- PET

4. Hemicrania paroxistica- PET

5. SUNCT-BOLD

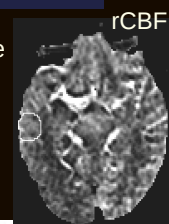


MIGRAINE WITH AURA

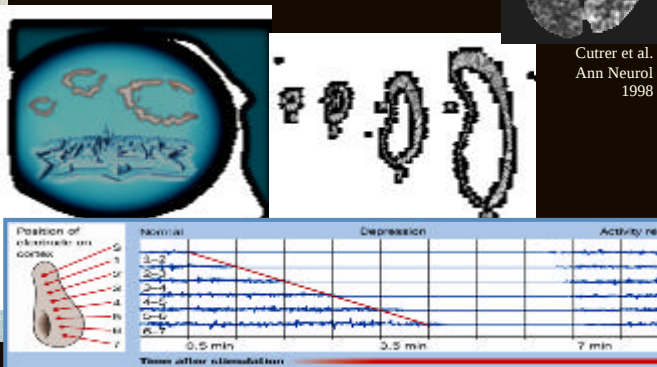


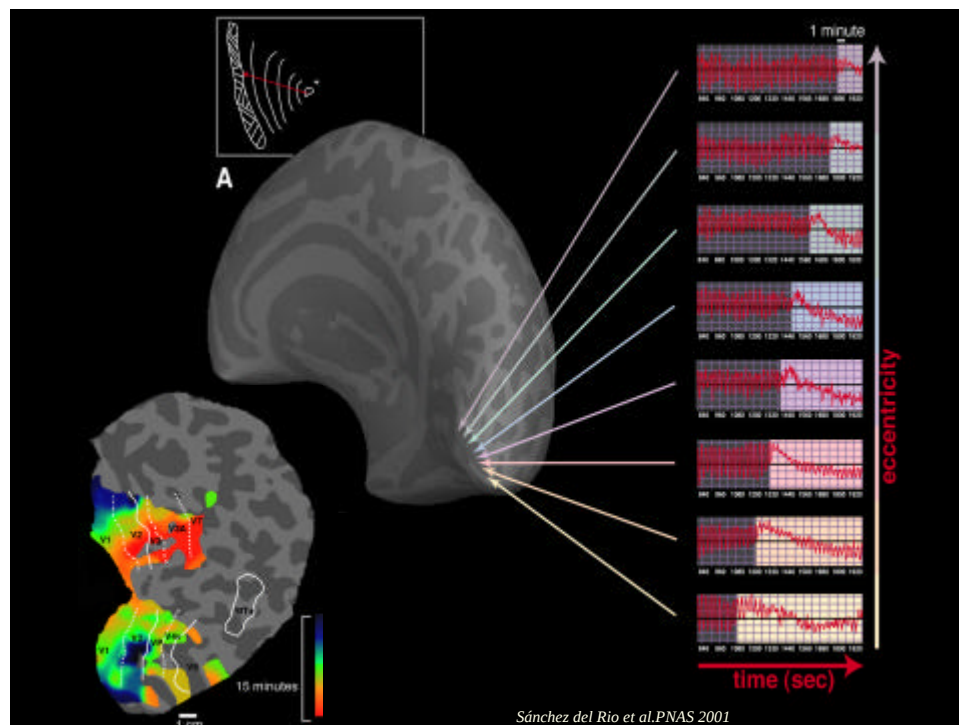
Olesen et al. 1981

- Studies performed during the aura phase
- Investigate CSD-like phenomenon
- Excitability of the cortex

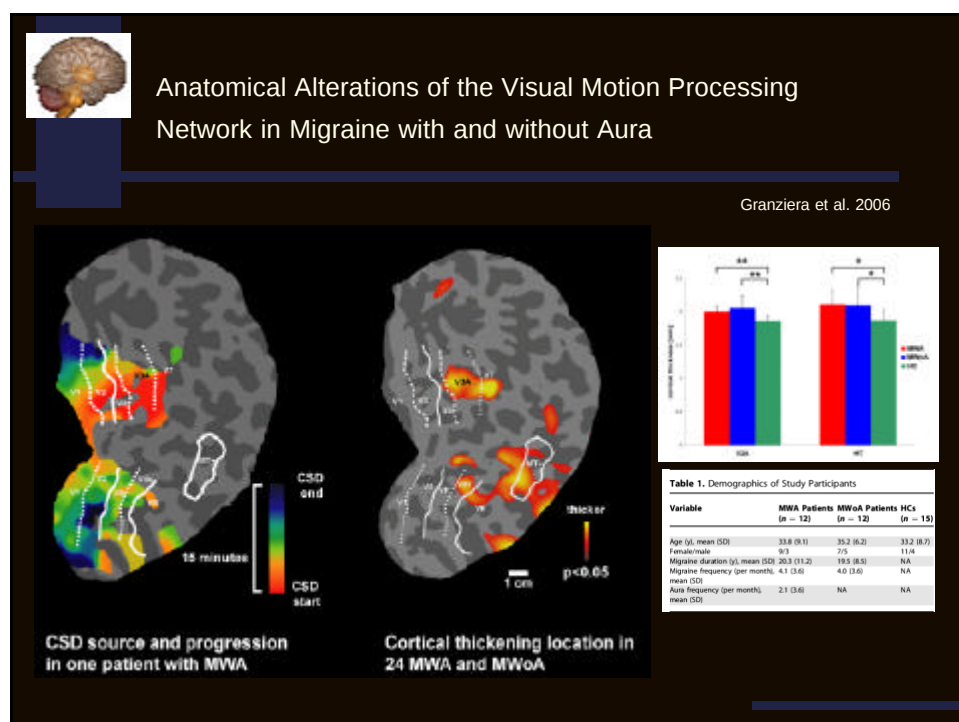
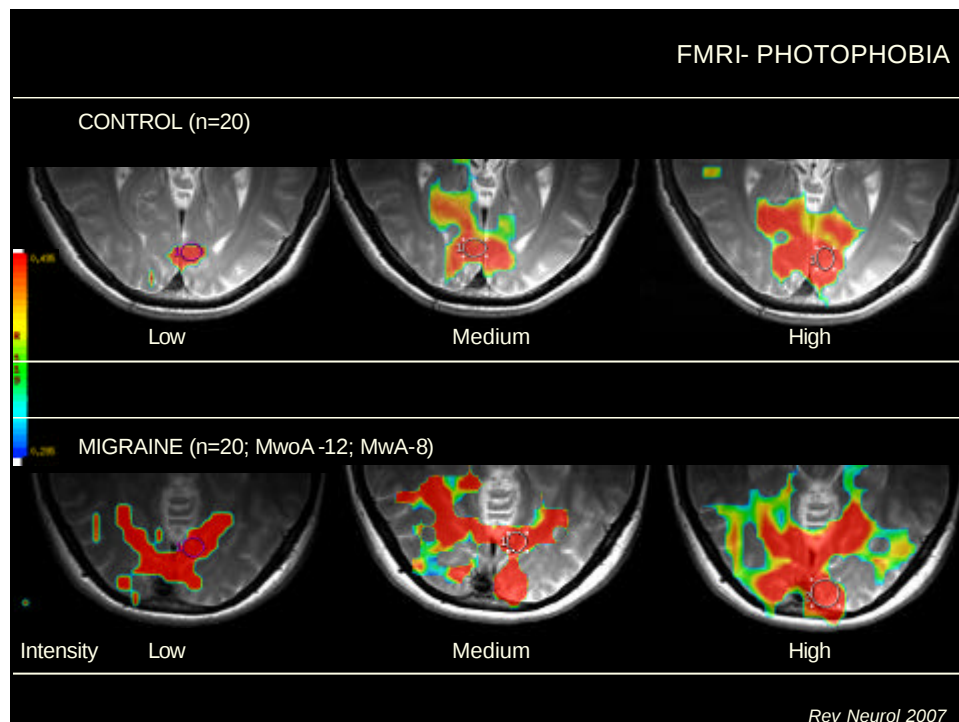


Cutrer et al.
Ann Neurol
1998





	Visual aura	CSD
Cortical gray matter	+	+
Hyperemia	3.3 ± 1.9 min	3-4.5 min
hypoperfusion	2h	1-2 h
suppression of activation	+	+
Rate of spread	3.5 ± 1.1 mm/	2-5 mm/min
Terminates at major sulci	+	+
Amplitude recovery	15 min (80%)	15-30 min (evoked)
first activated/first to recovery	+	+

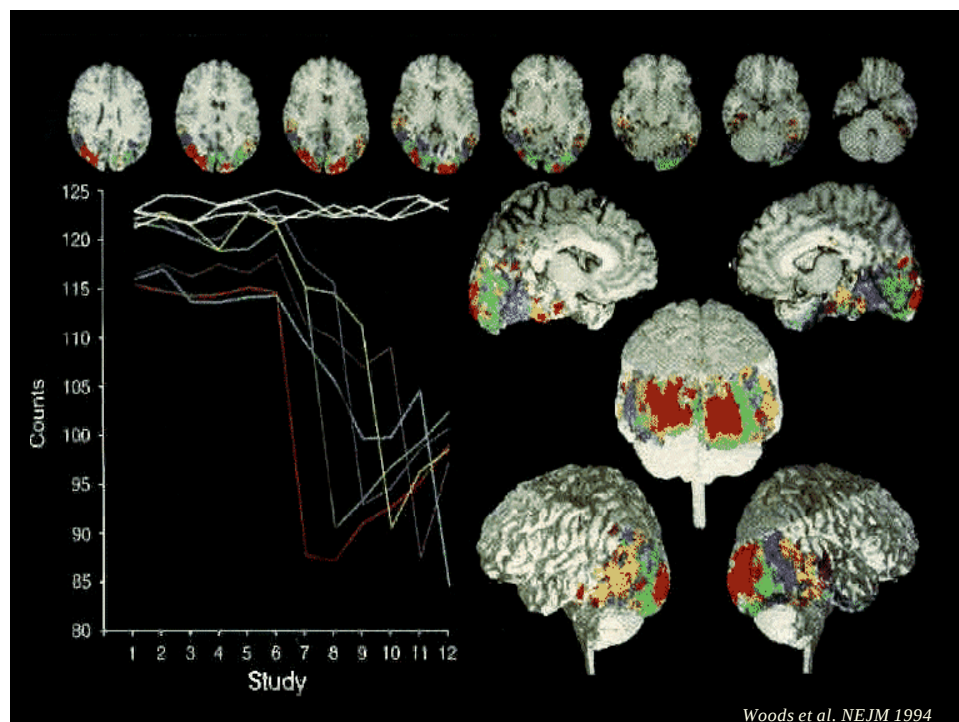
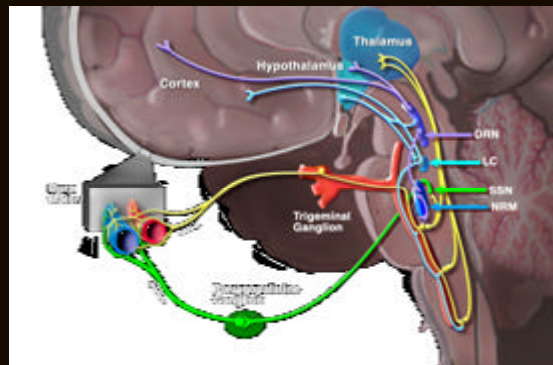


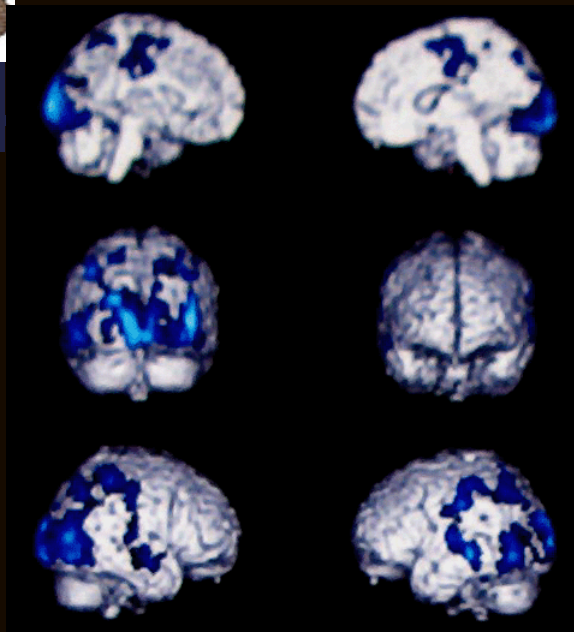


MIGRAINE WITHOUT AURA

Goal:

- Cortex: investigate blood flow changes like in migraine with aura
- Determine the role of subcortical structures





MIGRAINE WITHOUT AURA

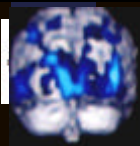
PET

Within 6 h of onset

Spontaneous attack

N=7 (6 W; 1 M)

Geraud et al. Rev Neurol 2005;161:666-70.

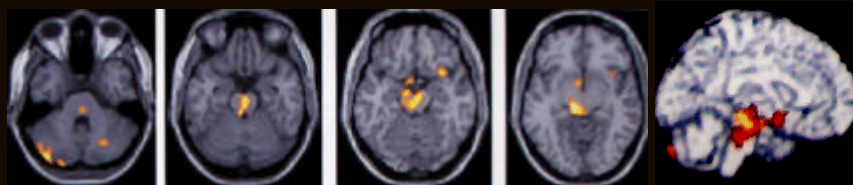


Spontaneous Migraine without aura

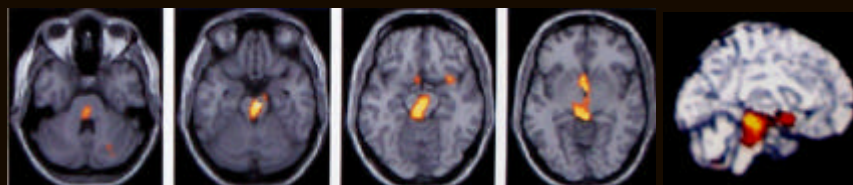
PET

Within 6 h of onset, N=7 (6 W; 1 M)

Before sumatriptan



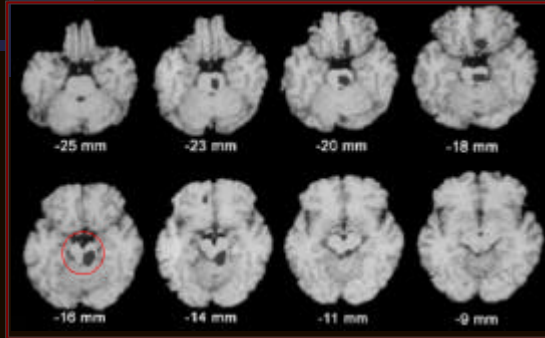
After sumatriptan



Geraud et al. Rev Neurol 2005;161:666-70.

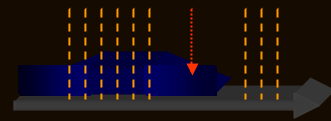


MIGRAINE WITHOUT AURA- PET



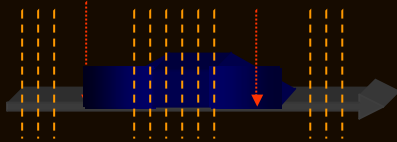
9 spontaneous migraine wo aura

Sumatriptan



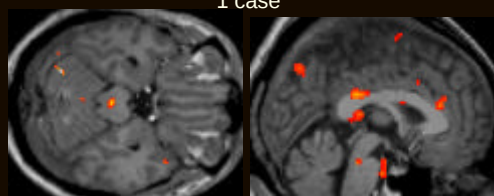
NTG

Sumatriptan



Weiller et al. (1995), Bahra et al (2001)

1 case



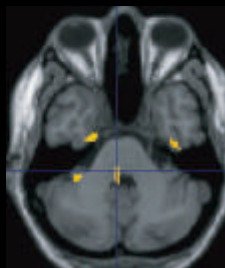
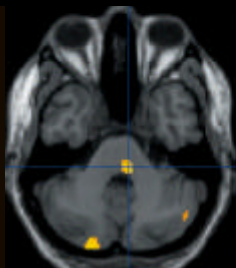
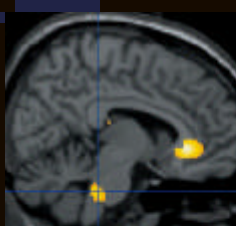
-2,-28,-22



A PET study exploring the laterality of brainstem activation in migraine using glyceryl trinitrate

Afridi et al. 2005

24 migraineurs + 8 controls



Right sided HA

Left-sided HA

Group	Area of activation	Coordinates			Z score of peak activation	P value (SVC)
		x	y	z		
Right-sided headache	Dorsal pons (right)	8	-32	-28	4	0.02
	Rostral medulla (mid-line)	0	-32	-40	4.25	
Left-sided headache	Dorsal pons (left)	-4	-34	-28	3.4	0.03
Bilateral headache	Dorsal pons (left)	-4	-32	-20	3.9	0.01

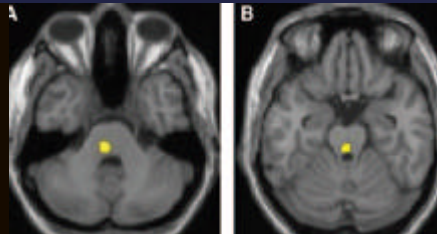
NTG

Sumatriptan

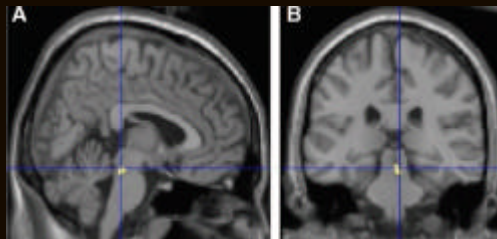




VOXEL-BASED MORPHOMETRY



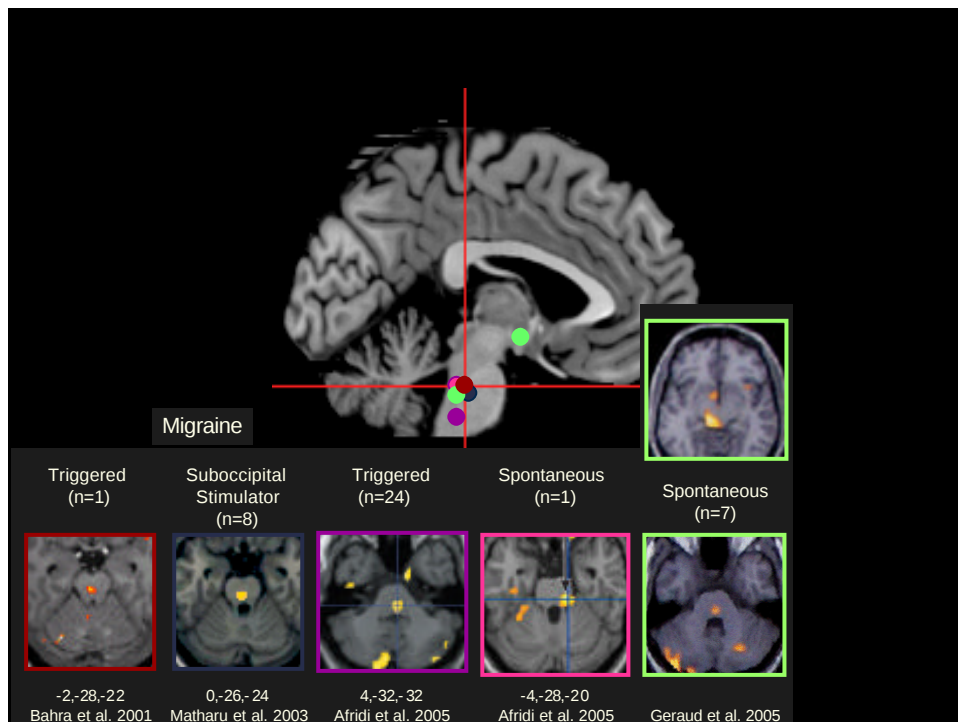
M with aura vs wo aura



Migraine vs controls

- 3T
- 16 migraine patients with T2-visible abnormalities and 15 controls
- migraine patients had $\downarrow$ GM density, mainly in frontal and temporal lobes.
- $\downarrow$ GM density was strongly related to age, disease duration, and T2-visible lesion load
- $\uparrow$ GM density.
 - M with A > M wo A in PAG and dorsolateral pons

Rocca et al. Stroke 2006





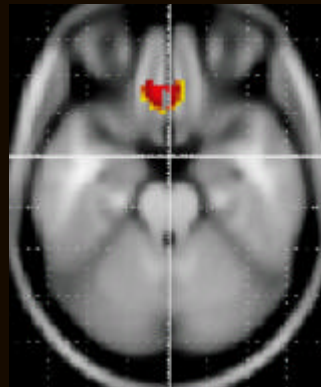
ORBIFRONTAL CORTEX INVOLVEMENT IN CHRONIC MOH EVOLVING FROM EPISODIC MIGRAINE

Fumal et al. Brain 2006

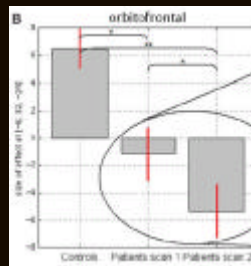
18F-FDG-PET

Persistent abnormal glucose metabolism
in medial Orbitofrontal cortex

N=18 MOH
N=68 controls



Z = -24mm



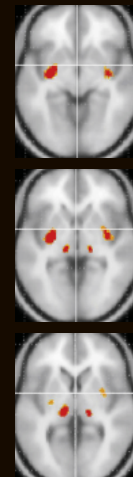
before 3 weeks after
withdrawal

VAS

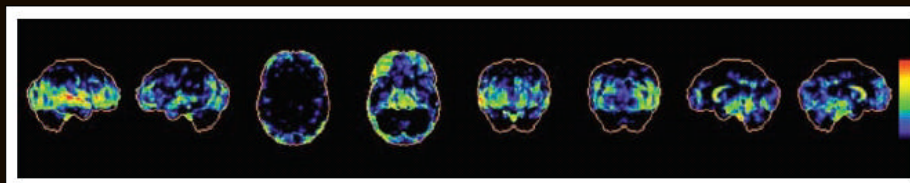
Scan 1- 2.9 ± 2
Scan 2 - 2.1 ± 1.7

Headache days

Scan 1- 19.4 ± 2.3
Scan 2- 11.9 ± 4.3



BRAINSTEM DYSFUNCTION IN CHRONIC MIGRAINE AS EVIDENCED BY NEUROPHYSIOLOGICAL AND PET STUDIES



- 18F-FDG PET
- 10 chronic migraineurs with and without medication overuse.
- Interictal scans
- No controls

- Compared to global metabolism
 - Increased metabolism in:
 - Pons
 - Right temporal cortex
 - Decreased in:
 - Caudate bilateral
 - Medial frontal
 - Somatosensory cortex

Aurora et al. Headache 2007



IMAGING INTRACRANIAL PLASMA EXTRAVASATION IN A MIGRAINE PATIENT

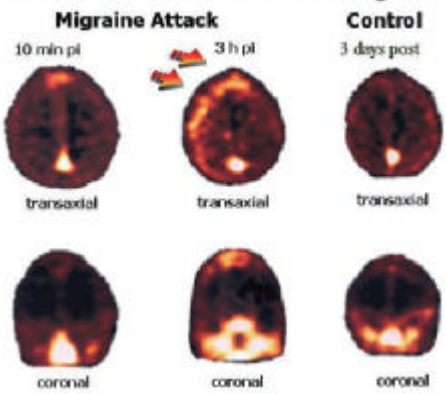
Knotkova & Pappagallo. Pain Medicine 2007

- SPECT-(Tc-99m) human serum albumin
- 46-y.o. Woman suffering Migraine w/o aura for > 20 years.
- First scan- 3h after onset. Pain intensity 5/10
- 2nd scan- 3h interval. Sumatriptan 6mg sbc given prior to scan.



Radiotracer accumulation R/L

Accumulation of Tc-99m HSA in Migraine



1.77

1.04

1. Migraine

With Aura

¹³³Xenon-cerebral blood flow

PWI/DWI

BOLD

MEG

without aura

¹³³xenon- cerebral blood flow

PWI

BOLD

PET

2. Cluster headache

PET

Voxel based morphometry

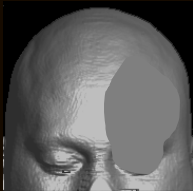
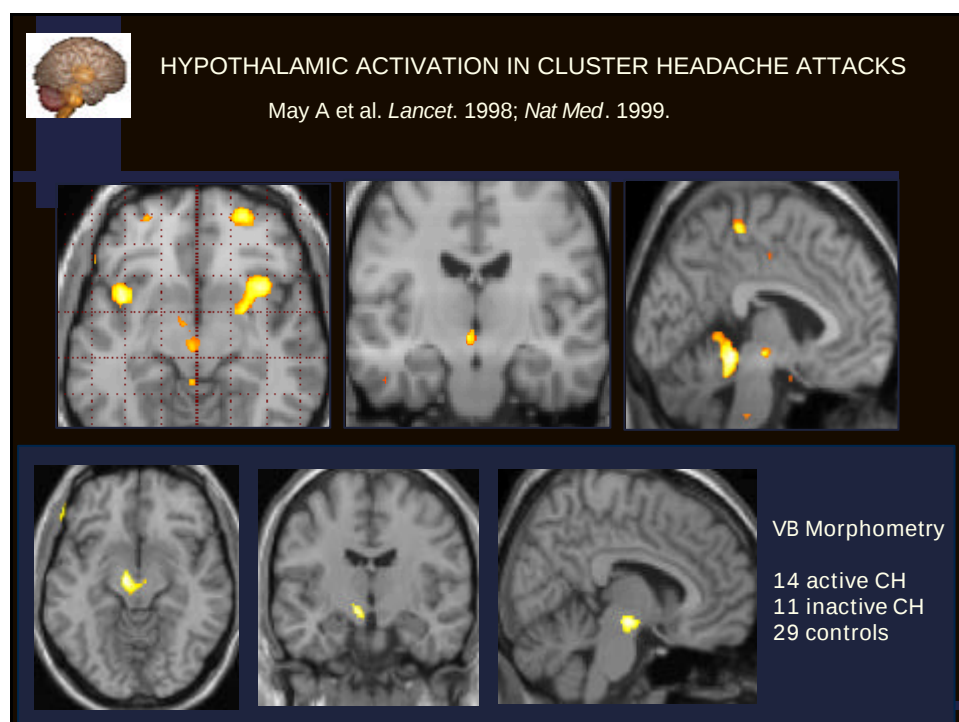
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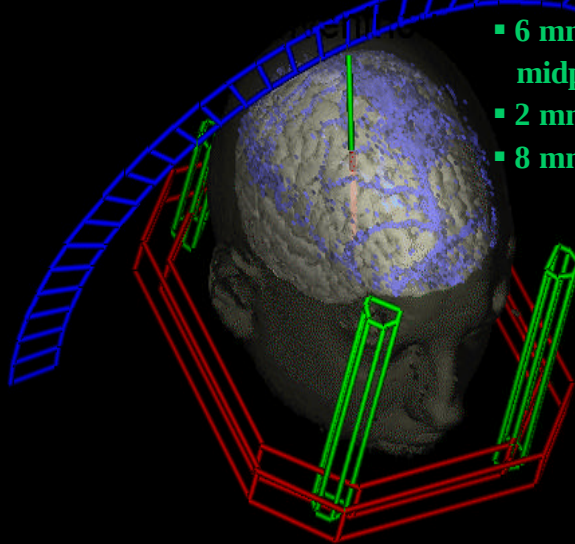


	Cluster	SUNCT	HParox	HCont
Gender (M:F)	4:1	2.3:1	1:1	1:1
Duration	15-180 min	5-250 s	1-30min	hours
Frequency	1-8/day	1/day-30/hr	3-30/day	varies
Autonomic signs	+	+	+	+
Refractory periods	+	-	-	-
Mechanical stim	-	+	-	-

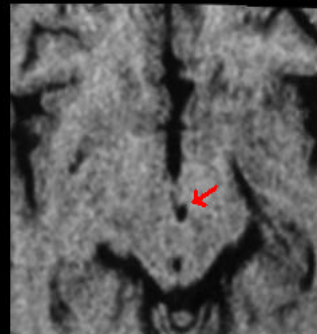



Stimulation of the posterior hypothalamus

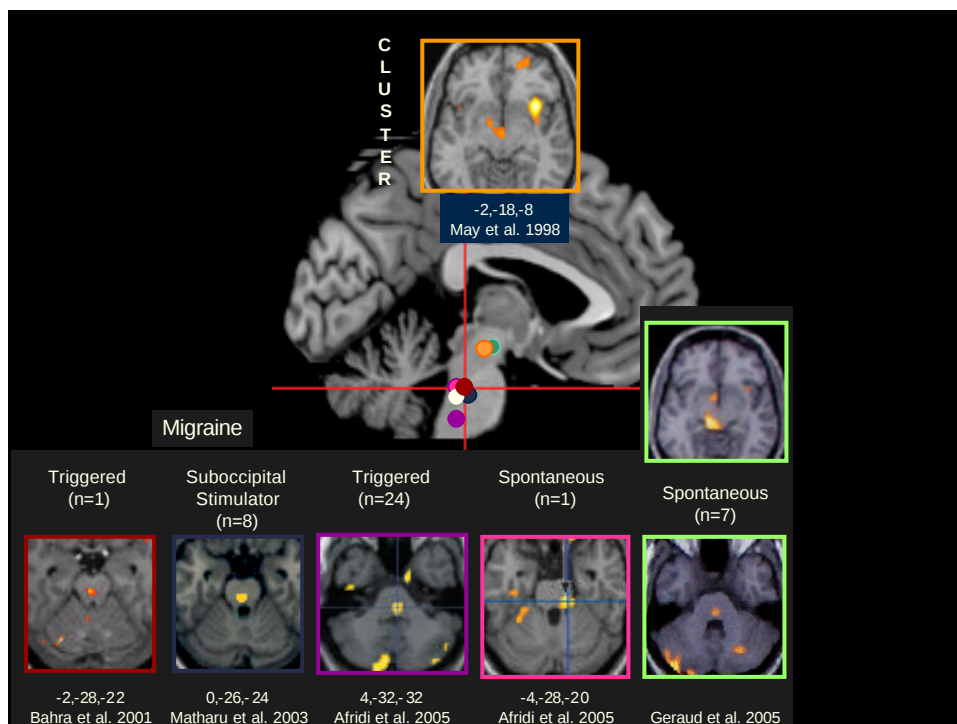
- 6 mm posterior to AC-PC midpoint
- 2 mm left of midline
- 8 mm below commissural plane



Left



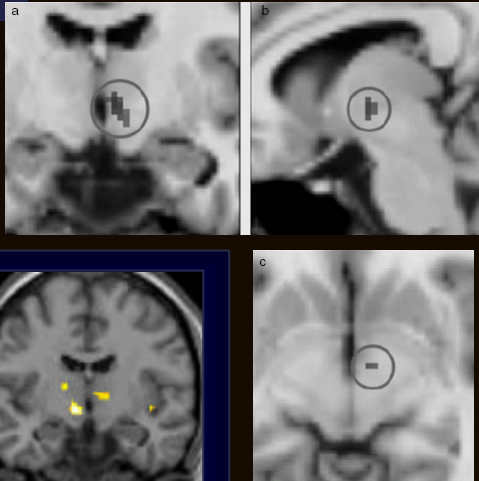
Leone et al. NEJM 2001





HYPOTHALAMIC ACTIVATION IN TRIGEMINAL AUTONOMIC CEPHALGIA:

Sprenger et al. Cephalalgia 2004



68 y.o. Patient

3 attacks of left periorbital HA

3 min duration (<1min-20min)

Up to 100 attacks/day

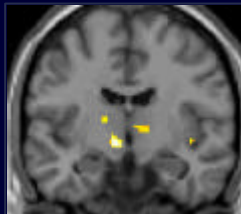
left sided conjunctival injection

Rhinorrhea

Lacrimation

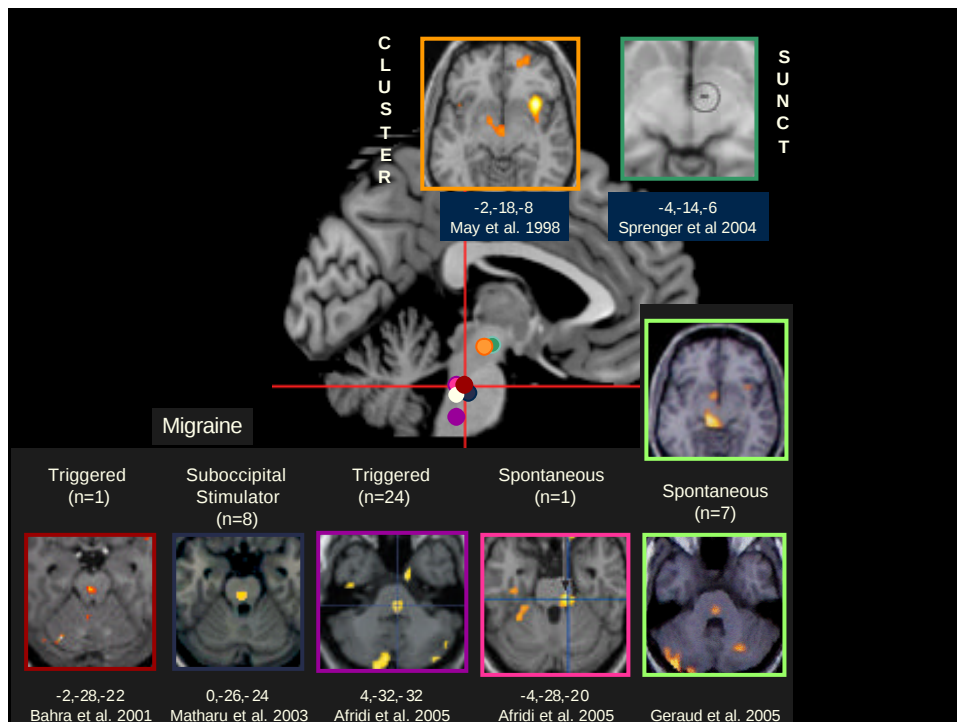
facial sweating

hypersalivation



SUNCT-fMRI n=1

May et al. Ann.Neurol 1999

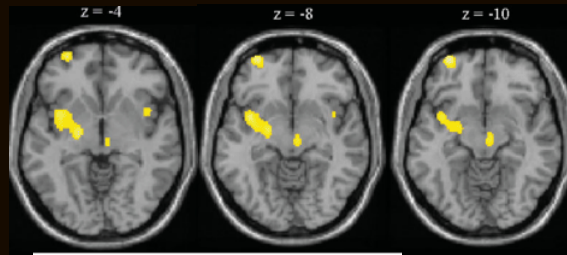




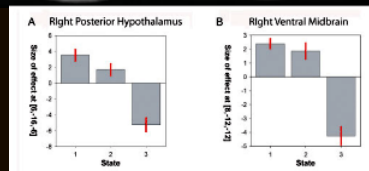
POSTERIOR HYPOTHALAMIC ACTIVATION IN PAROXYSMAL HEMICRANIA

Matharu et al. Ann Neurol 2006

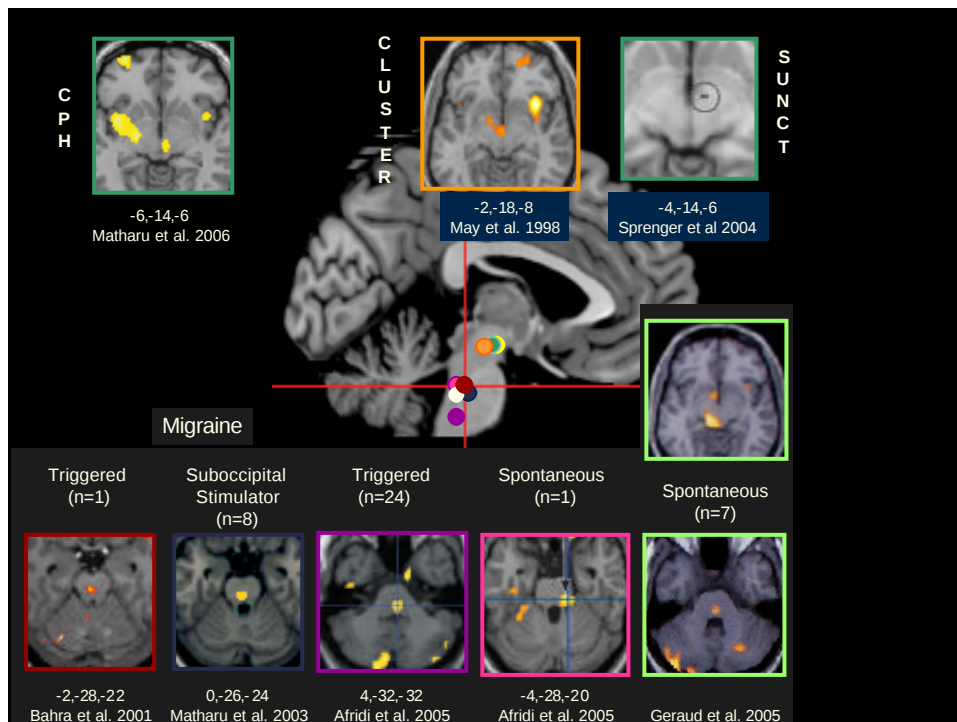
severe, strictly unilateral headache that lasts 2 to 30 minutes, occurs more than five times daily, is associated with trigeminal autonomic symptoms, and is exquisitely responsive to indomethacin.



N = 7



1. Off indomethacin, with pain
2. Off indomethacin, without pain
3. 100mg indomethacin, pain-free

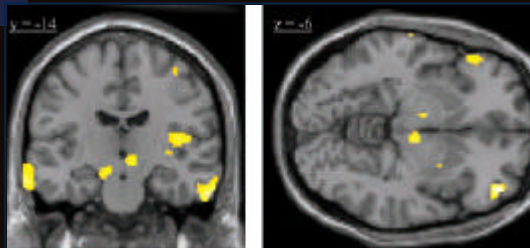




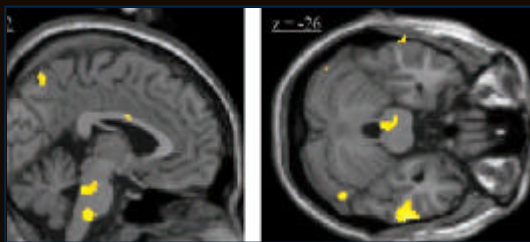
POSTERIOR HYPOTHALAMIC AND BRAINSTEM ACTIVATION IN HEMICRANIA CONTINUA

Matharu et al. Headache 2004

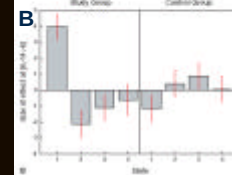
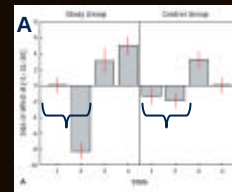
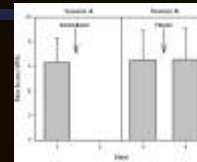
A



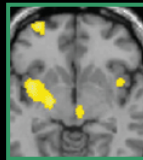
B



N= 7-HC; 7 control

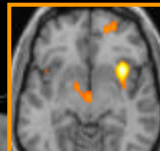


C
P
H



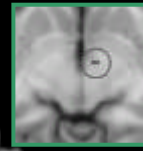
-6,-14,-6
Matharu et al. 2006

C
L
U
S
T
E
R



-2,-18,-8
May et al. 1998

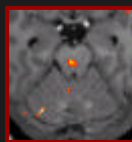
S
U
N
C
T



-4,-14,-6
Sprenger et al 2004

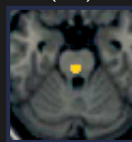
Migraine

Triggered
(n=1)



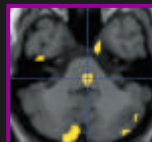
-2,-28,-22
Bahra et al. 2001

Suboccipital
Stimulator
(n=8)



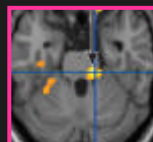
0,-26,-24
Matharu et al. 2003

Triggered
(n=24)



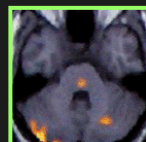
4,-32,-32
Afridi et al. 2005

Spontaneous
(n=1)



-4,-28,-20
Afridi et al. 2005

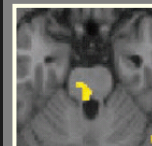
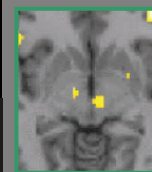
Spontaneous
(n=7)



Geraud et al. 2005

-6,-14,-6

HC



-2,-32,-26
Matharu et al. 2004

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