Swiss Federation of Clinical Neuro-Societies

Case-based session

Dr. Johanna Lieb[1]

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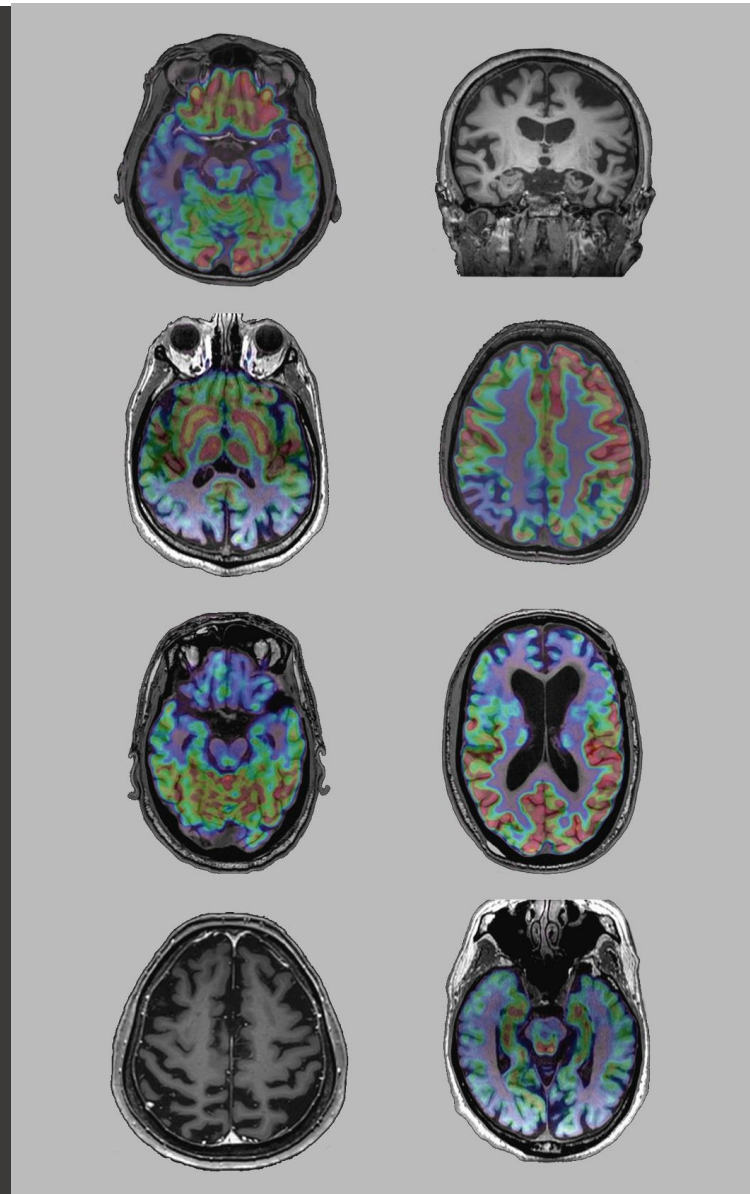
SFCNS Neuroimaging Course

1st Module: Imaging Neurodegeneration



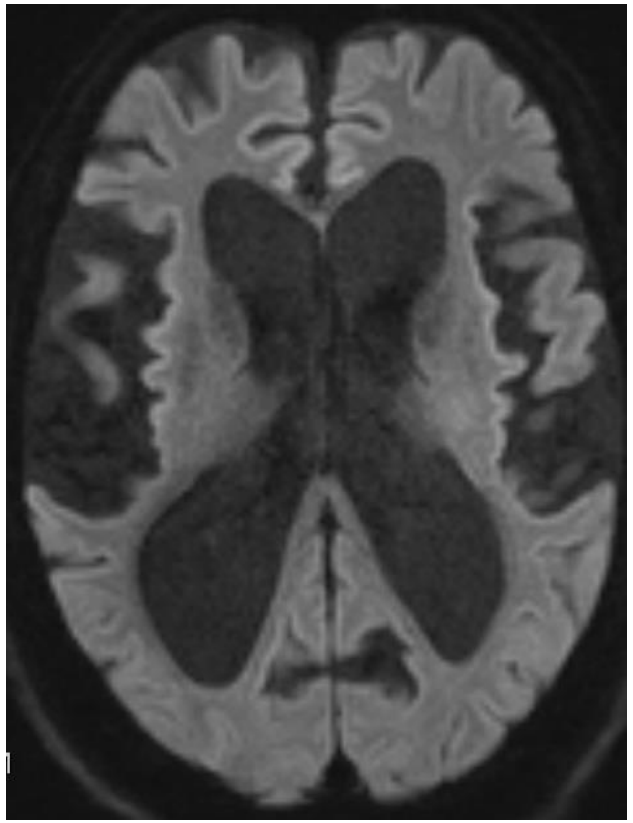
Case 1

67 y.o. male with cognitive decline and insecure gait

Medical history and clinical findings

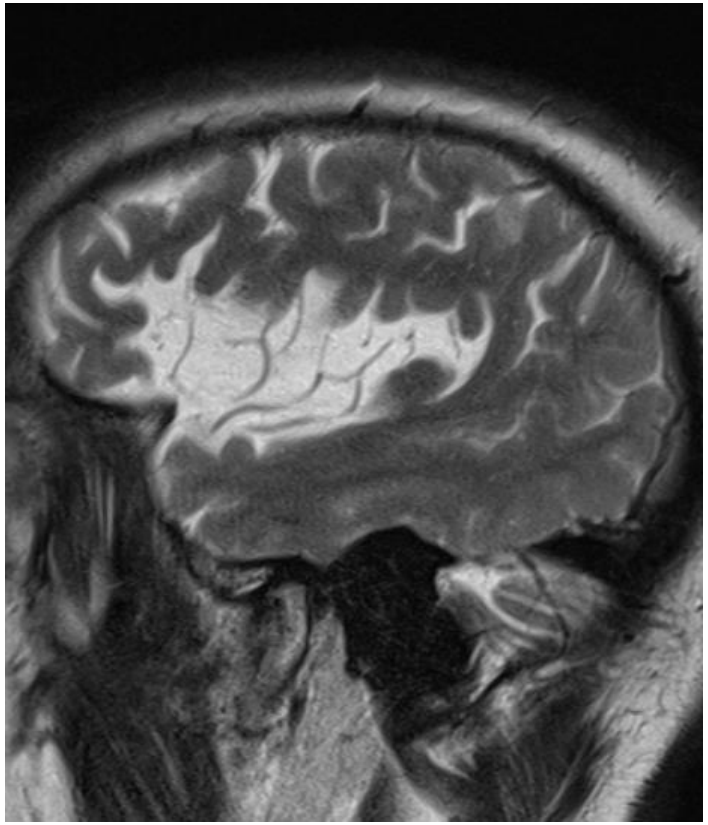
- 67 year old male patient with sleeping disorder, depression, increasing short term memory loss, coordination problems and gait instability, since months
- Initial examination: mild cognitive deficits, insecure gait with gait deviation, no neurological deficits, .
- Medical history: Vitamin B12 deficiency, STEMI (two years ago)
- Initial labs: Vitamin B12 deficiency, otherwise normal
- MRI?

Initial MRI imaging at clinical presentation



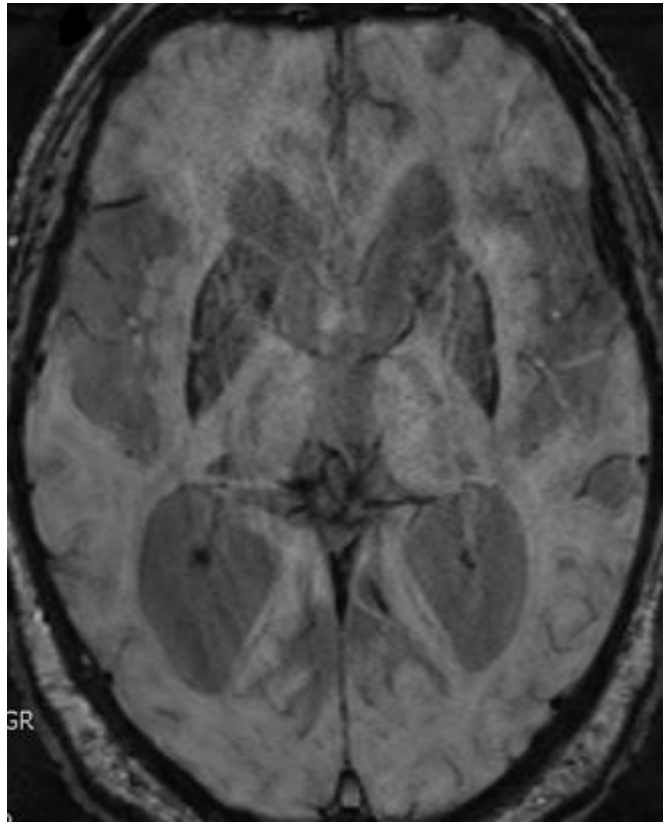
DWI tra

Source: USZ



T2 sag

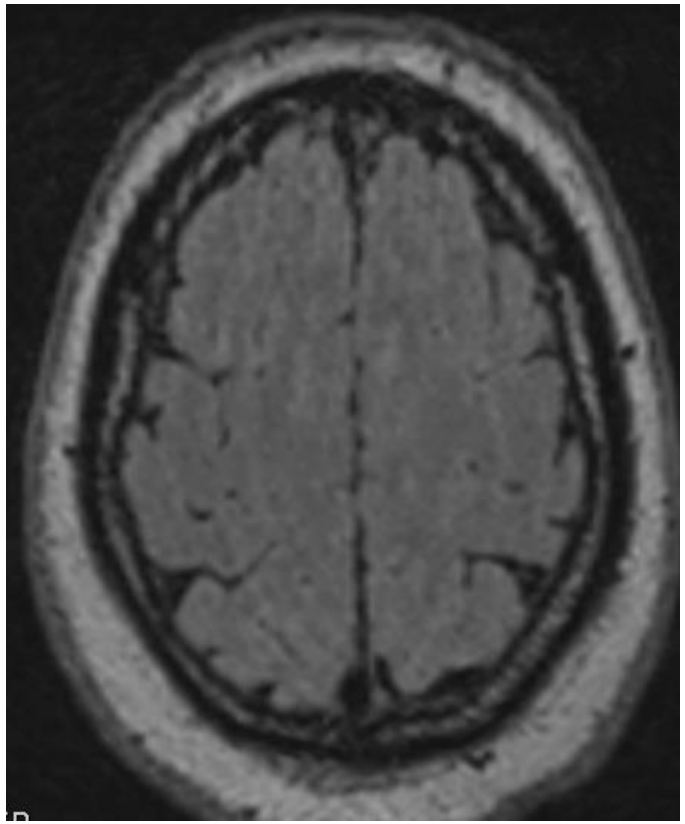
Source: USZ



SWI tra

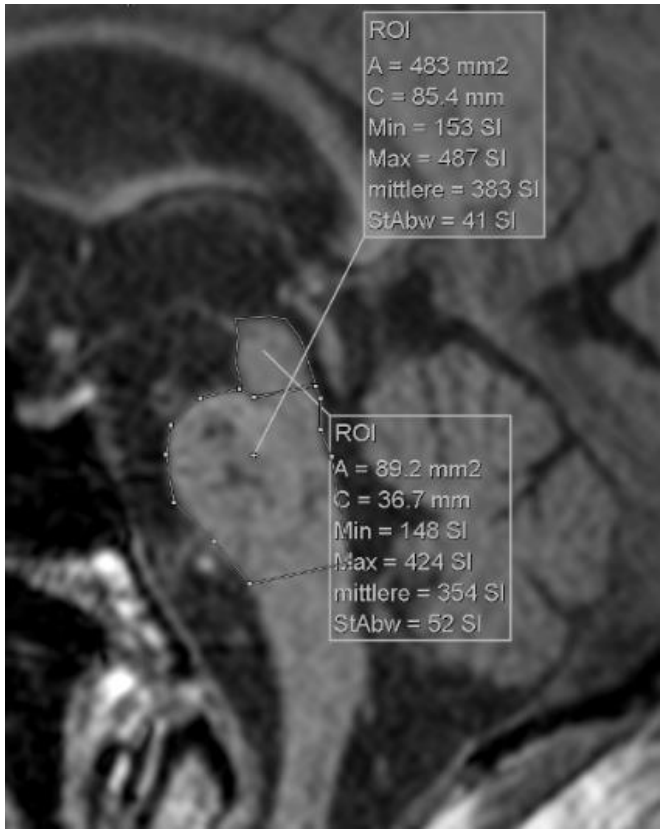
Source: USZ

Initial imaging at clinical presentation



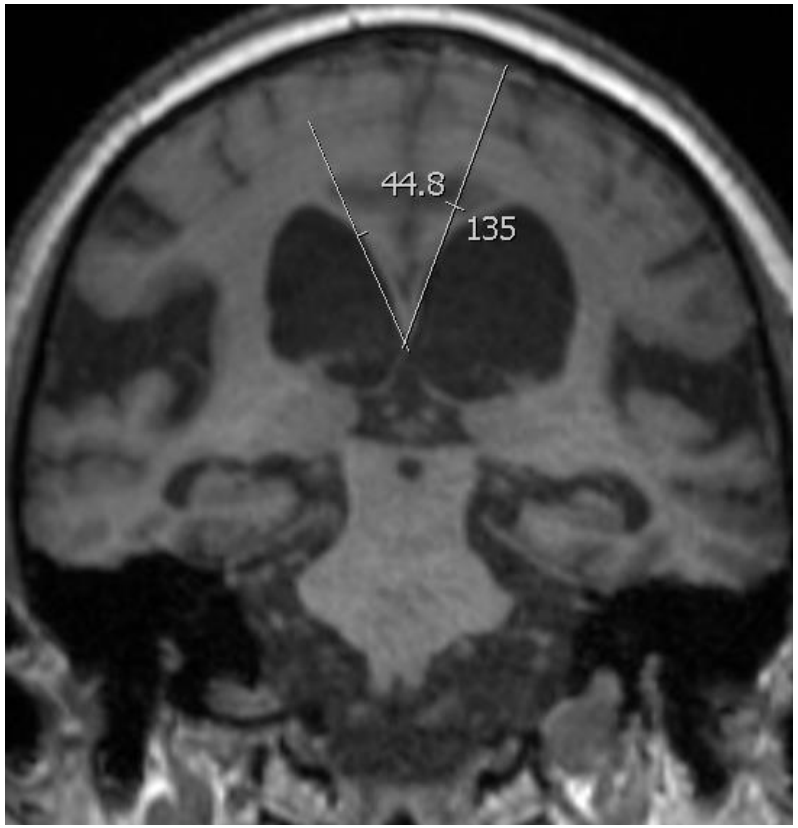
FLAIR 3D tra

Source: USZ



T1 MPRAGE sag

Source: USZ



T1 MPRAGE cor

Source: USZ

MRI findings and further clinical evaluation

- **MRI findings:**
  - No evidence of tumor, ischemia, hemorrhage oder inflammation
  - Enlarged ventricles (except 4th ventricle)
  - Wide Sylvian fissure
  - Crowded apical sulci
  - Sharp dorsal callosal angle (measured at level of posterior commissure)
  - Pontin lacunes, little supratentorial microvessel disease
  - Moderate generalised brain atrophy with accentuated midbrain atrophy

- Clinical symptoms ameliorated after LP!
- Patient declines urinary incontinence.
- No evidence of vertical gaze palsy

Which statement is false?

A) Typical clinical presentation of normal pressure hydrocephalus (NPH) is gait apraxia, dementia and urinary incontinence (Hakim-triad)

B) Imaging findings in NPH classically involve dilated supraqueductal ventricles, crowded apical sulci and wide sylvian fissures, with dorsal callosal angles usually below 90°.

C) Mesencephal atrophy is often present in NPH, presenting with supranuclear ophthalmoplegia («forth cardinal sign»)

D) Mesencephal atrophy is the hallmark imaging finding in progressive supranuclear palsy (PSP), which often also presents with cognitive impairment, imbalance and walking difficulties, along with eye movement disorders.

E) NPH usually does not present with significant transependemal edema, thus not requiring urgent ventriculostomy/shunting.

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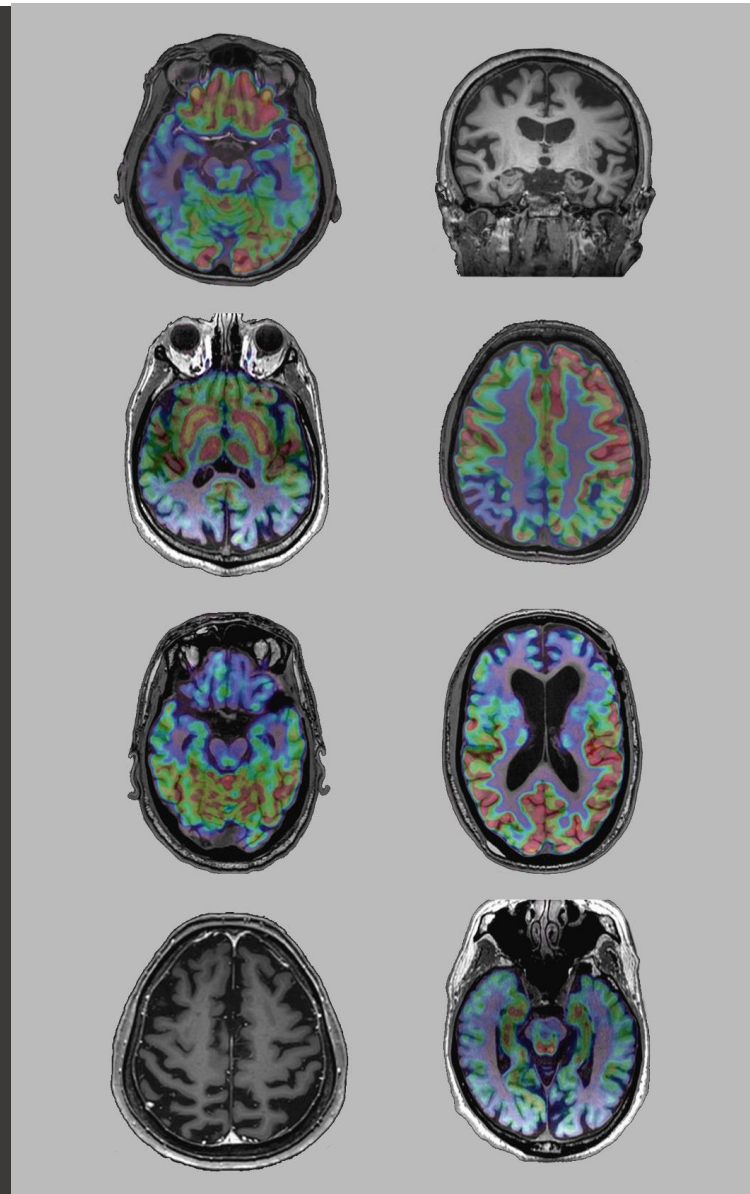
SFCNS Neuroimaging Course

1st Module: Imaging Neurodegeneration

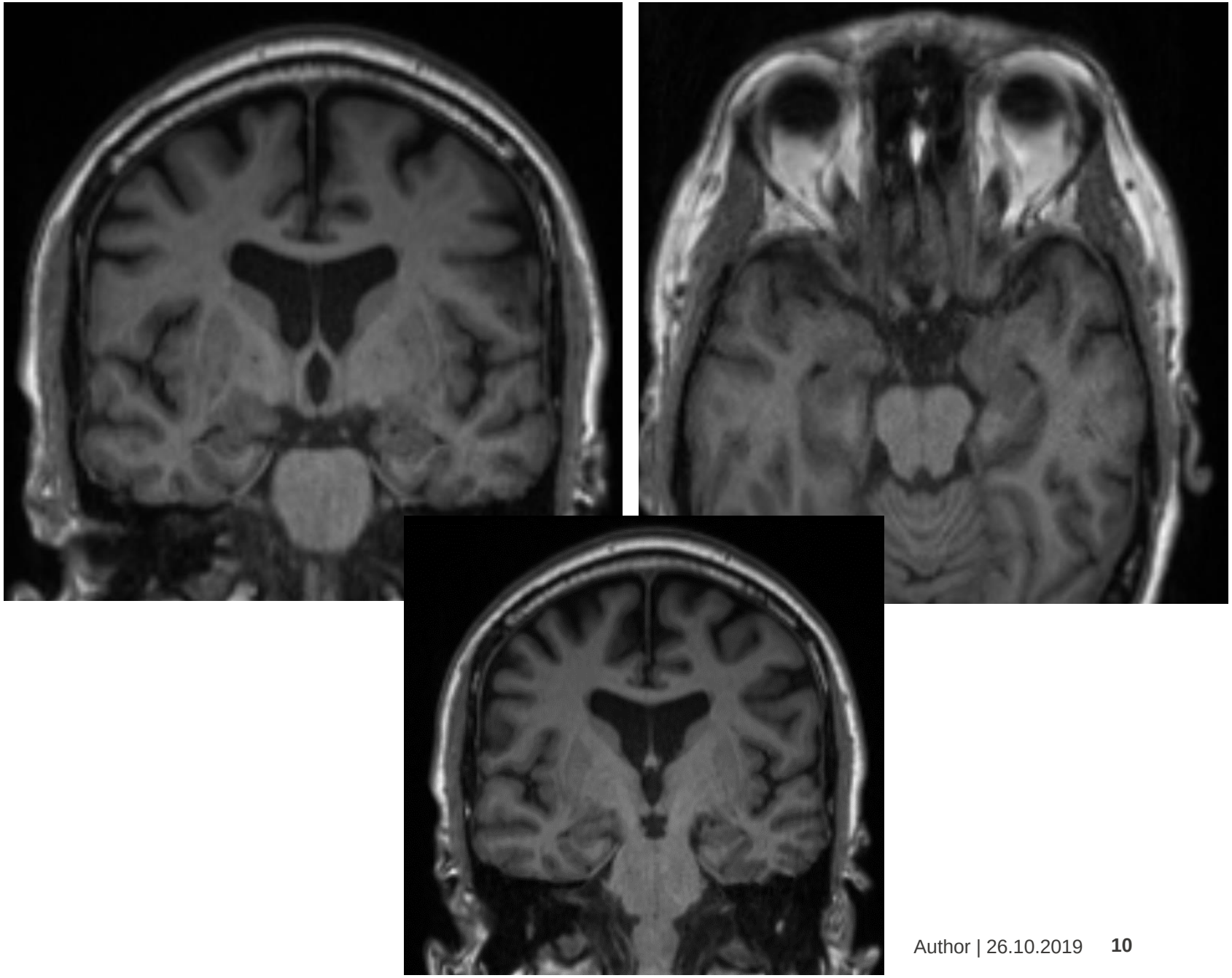


Case 2

- 54 y male
- Slight cognitive decline, short term memory problems
- MMS 26/30
- No psychiatric disorder
- Neuropsychological testing → minor neurocognitive disorder

Case 2

- 54 y male
- MMS 25/30
- No psychiatric disorder
- Minor neurocognitive disorder



Question for Case 1 - Which statement is false?

A) Neurodegenerative disorder less likely

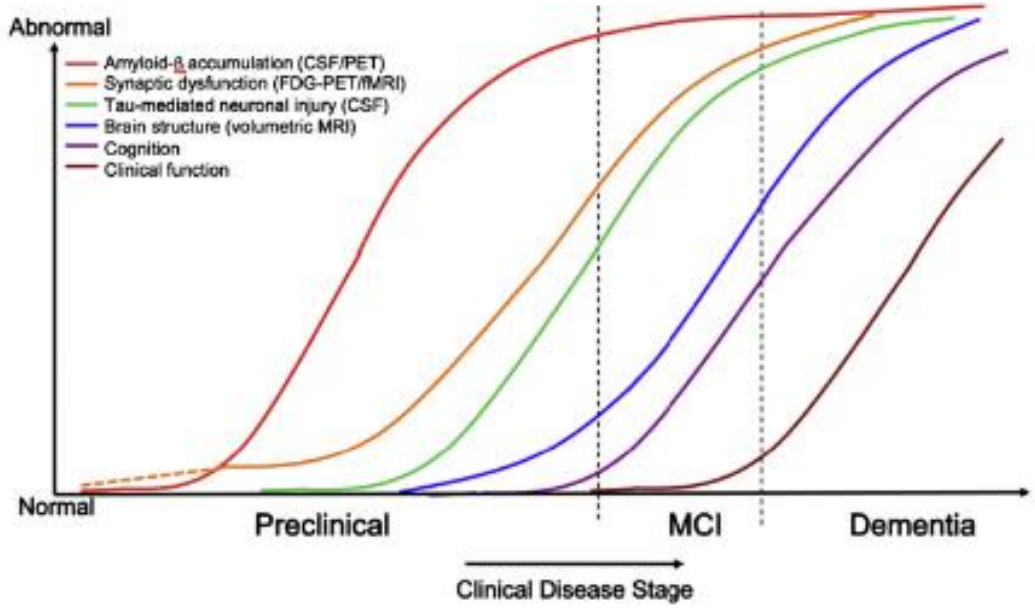
B) Neurodegenerative disorder possible

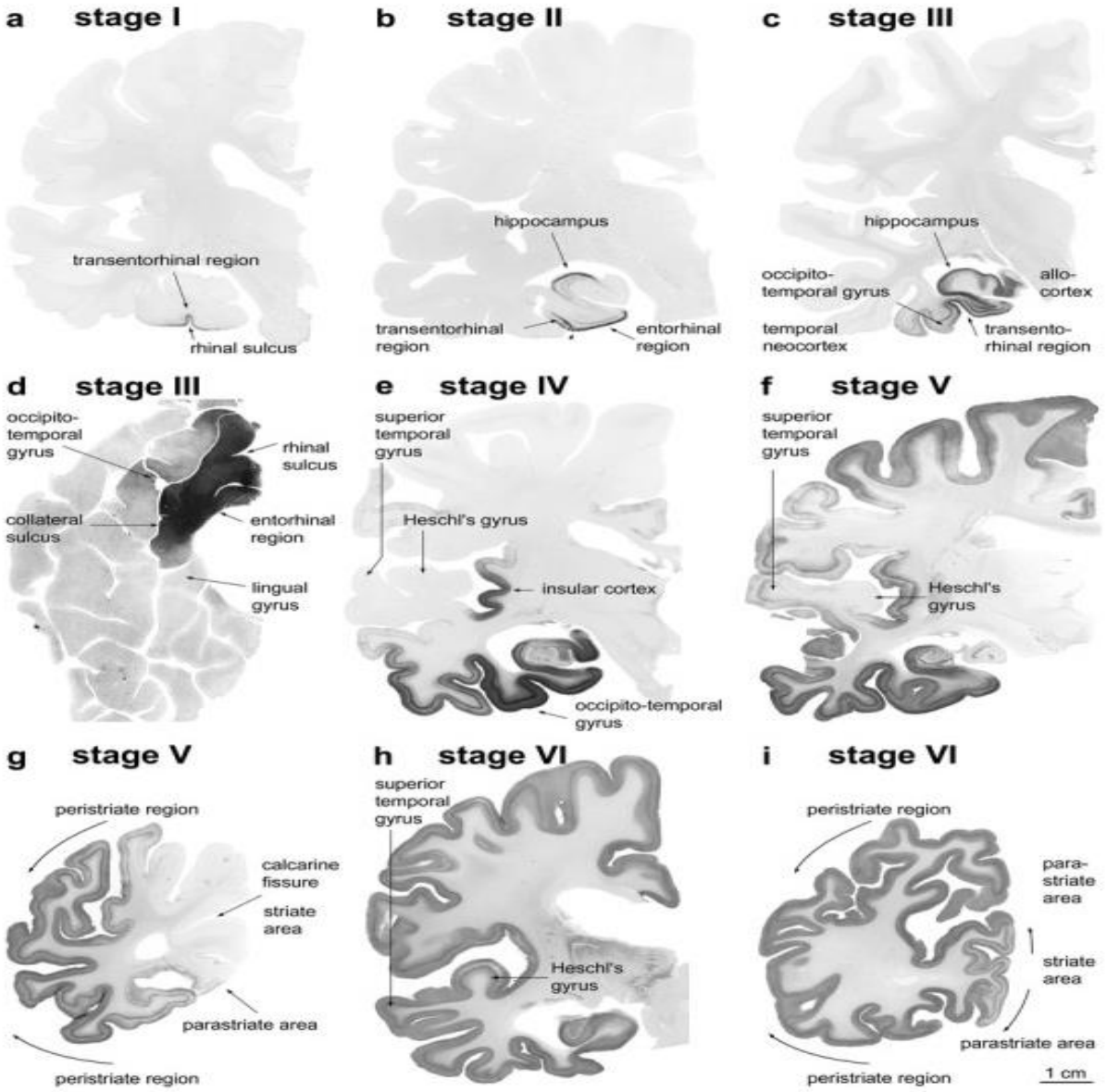
C) AD possible

D) Neurodegenerative disorder can be excluded

E) Normal medial temporal lobe structures

Case 1





- „cognitive reserve“
- functional loss precedes structural loss
- → FDG-PET-CT in symptomatic patients with no or only slight structural abnormalities

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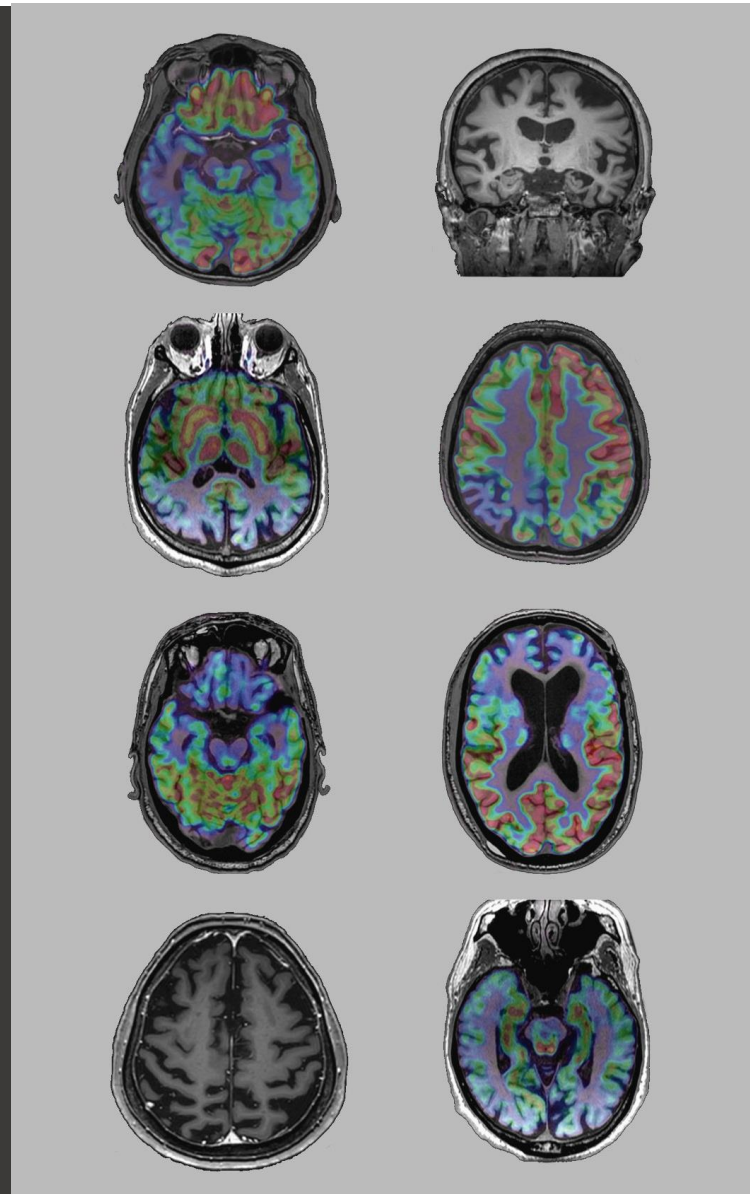


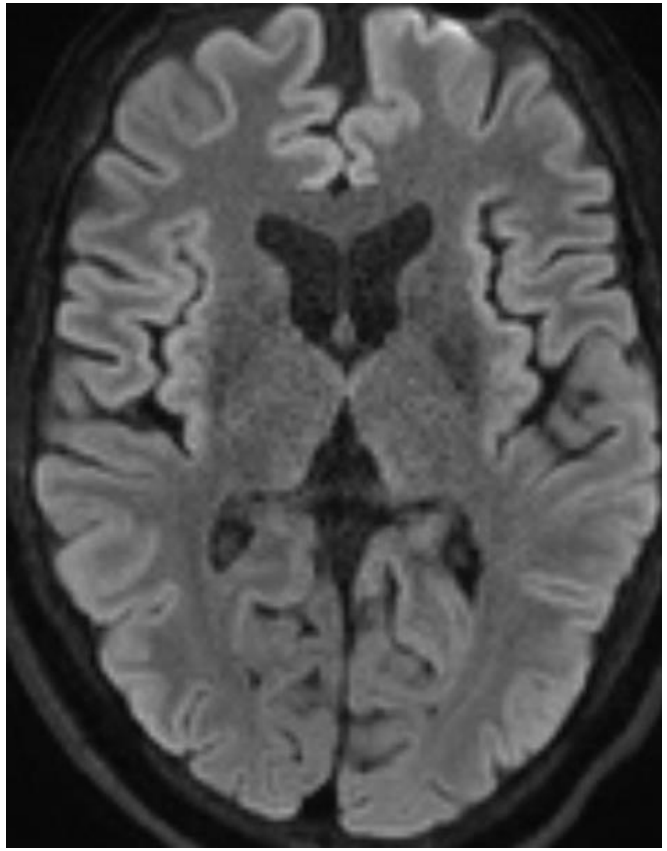
Case 3

30 y.o. female with memory loss and movement disorders

Medical history and clinical findings

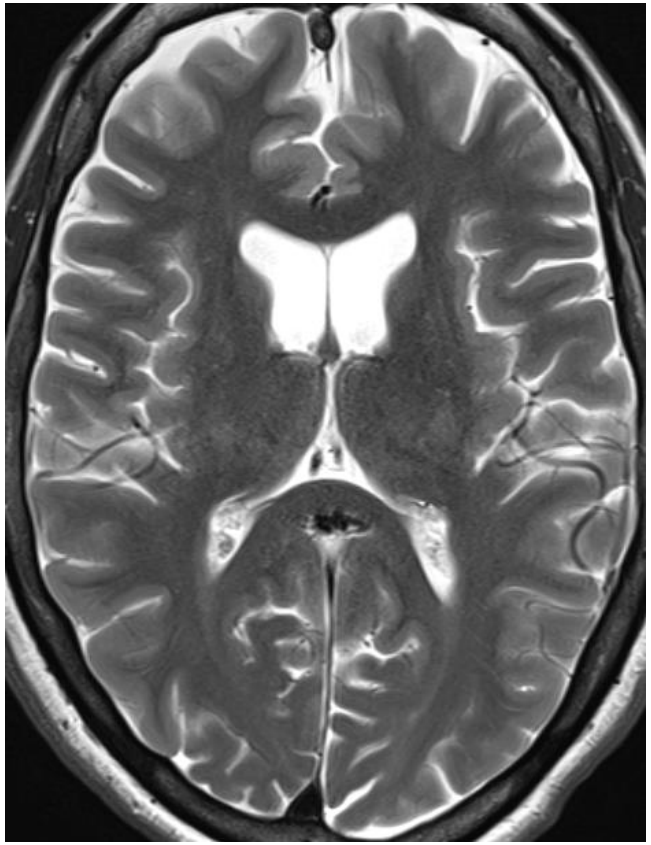
- 30 year old female with increasing memory loss since 2 years
- Examination: Generalised choreaform movement disorder (perioral, right arm and foot), dysdiadochokinesis.
- Medical history: substance abuse (heroin).
- Family history: Father died young, had movement disorder.
- Labs: normal
- MRI?

Initial MRI imaging at clinical presentation



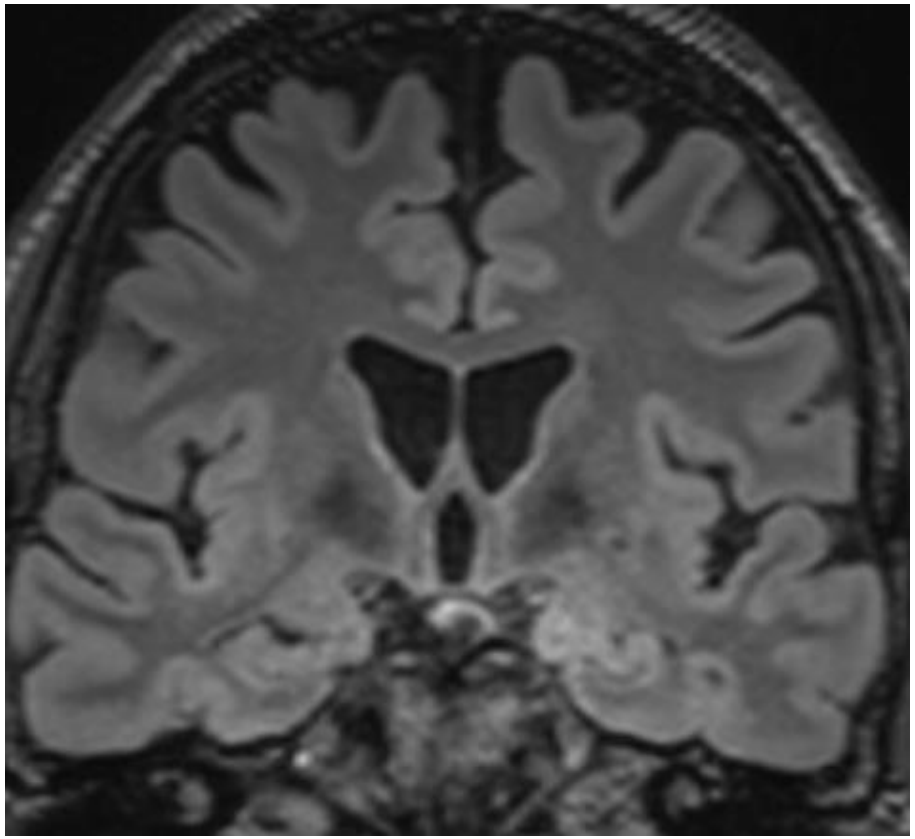
DWI tra

Source: USZ



T2 tra

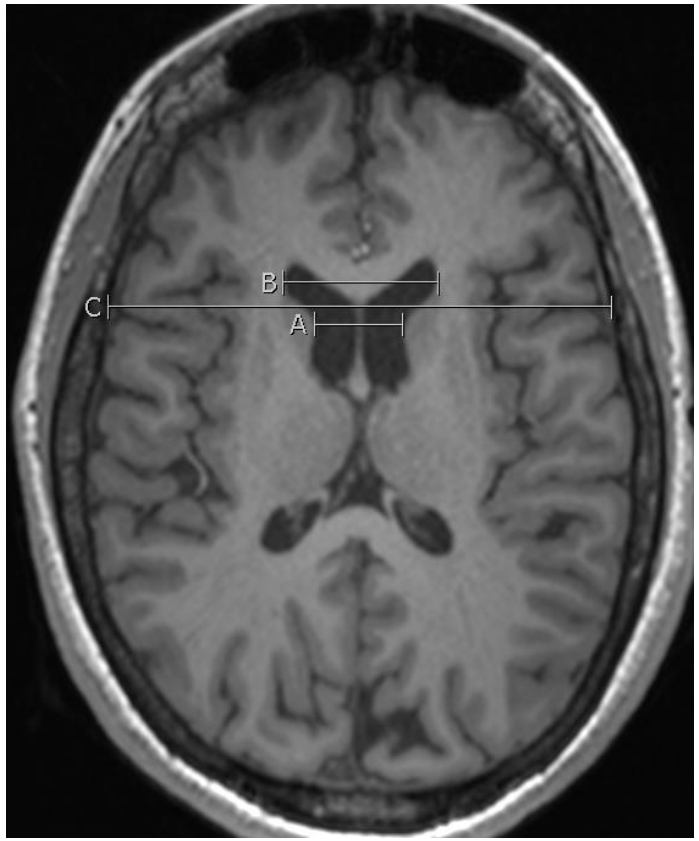
Source: USZ



3D FLAIR cor

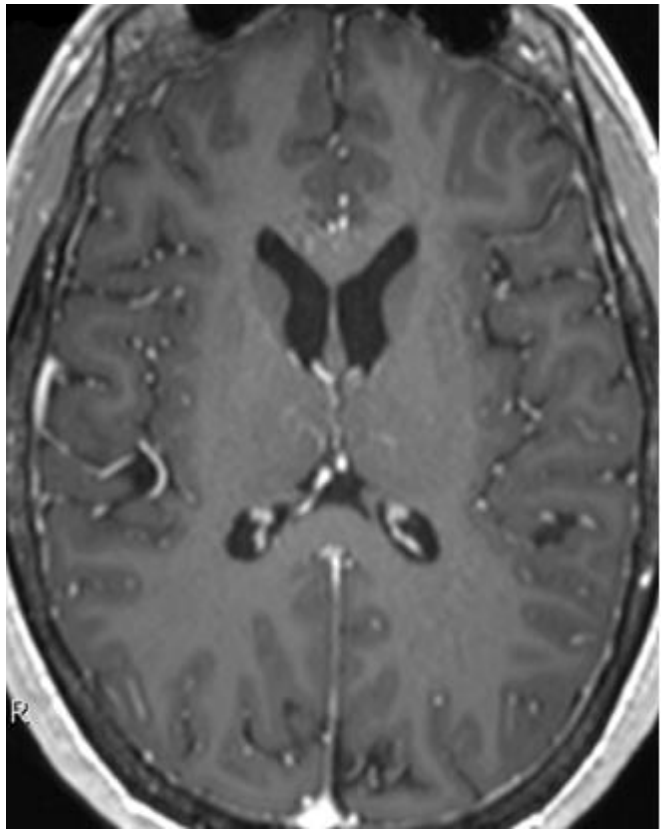
Source: USZ

Initial imaging at clinical presentation



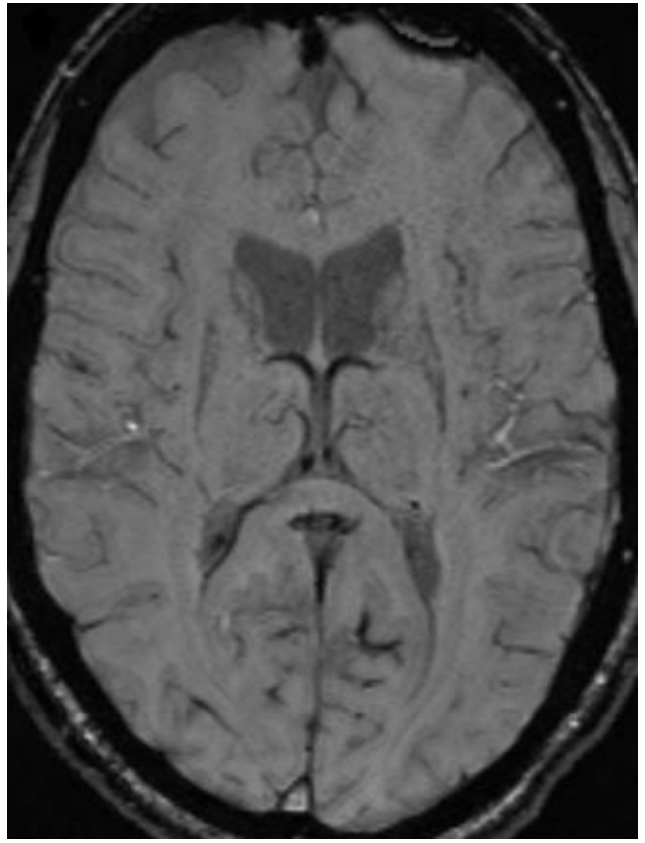
T1 tra

Source: USZ



T1 Gd tra

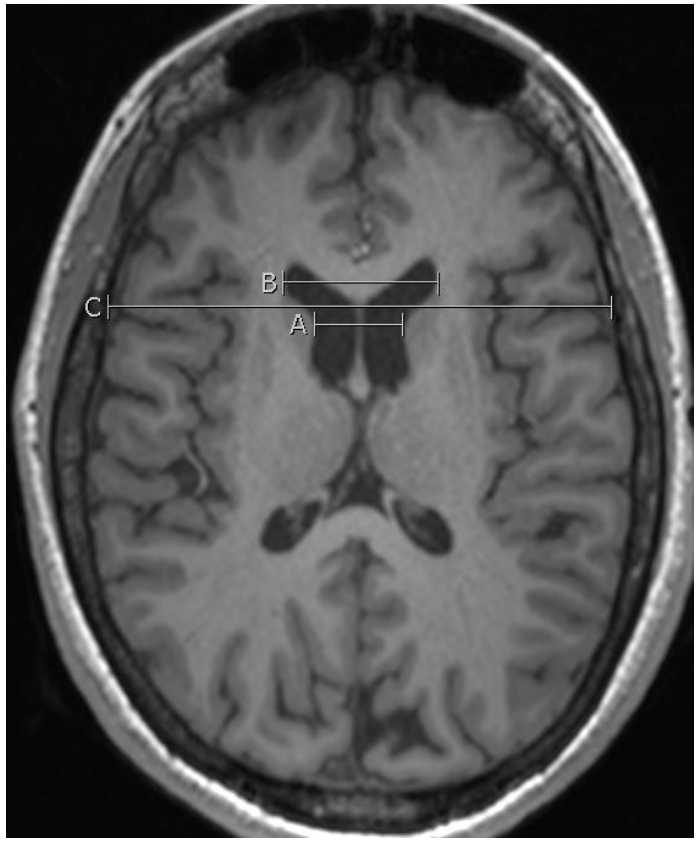
Source: USZ



SWI tra

Source: USZ

Evaluation of MRI results



Source: USZ

- No evidence of tumor, hemorrhage, ischemia or inflammation
- Only abnormality was isolated symmetric reduction in volume of caudate heads
  - Intercaudate distance to inner table width ratio **(CC/IT): 0.175** (normal range 0.09 to 0.12)
  - Frontal horn width to intercaudate distance ratio **(FH/CC): 1.75** (normal range: 2.2 to 2.6)

Which statement is false?

A) Huntington disease is a rare autosomal dominant neurodegenerative disease which affects young to middle aged adults of both genders

B) The typical imaging feature of Huntington disease is caudate head atrophy resulting in enlarged frontal horns with «box-like» appearance.

C) In the juvinile form of Huntington disease, the putamena are also atrophied and often demonstrate high T2-signal.

D) The earliest sign of Huntinton disease is often diffusion restriction of the caudate heads before apparant volume loss, and thus can be mistaken for CJD.

E) PET scans in Huntington disease usually demonstrate hypometabolism by decreased FDG uptake in basal ganglia and frontal cortex even before noticeable caudate nucleus volume loss

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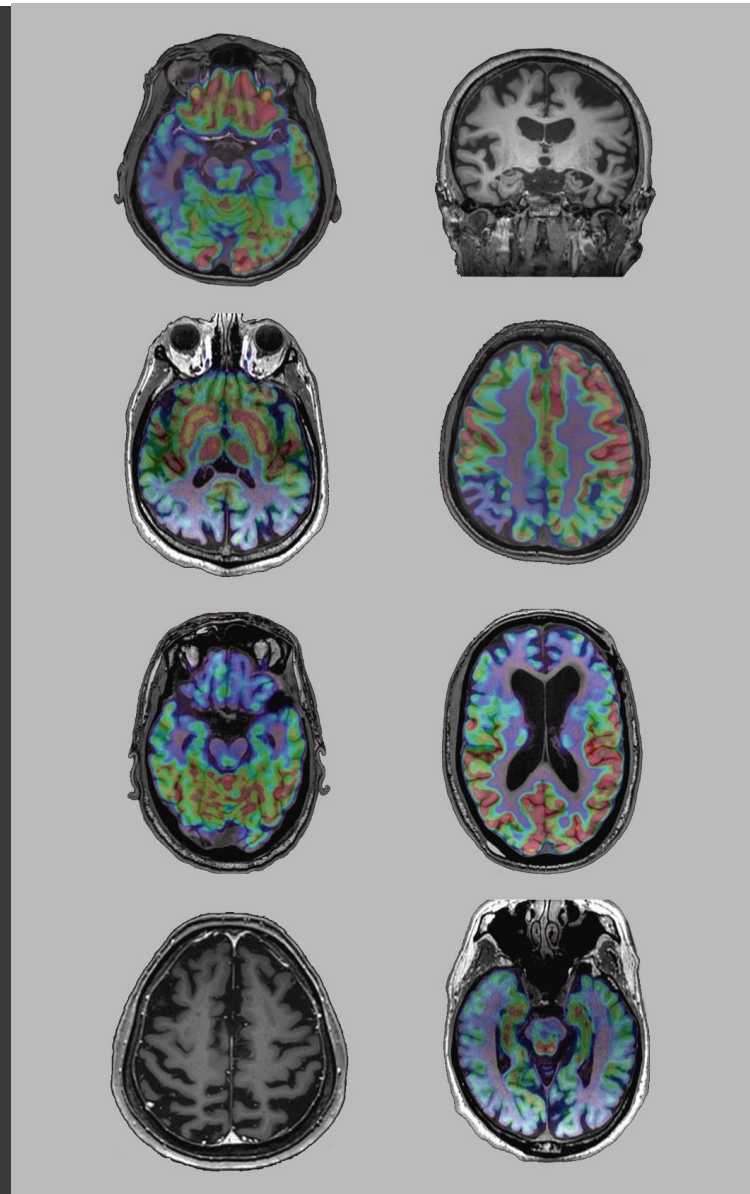
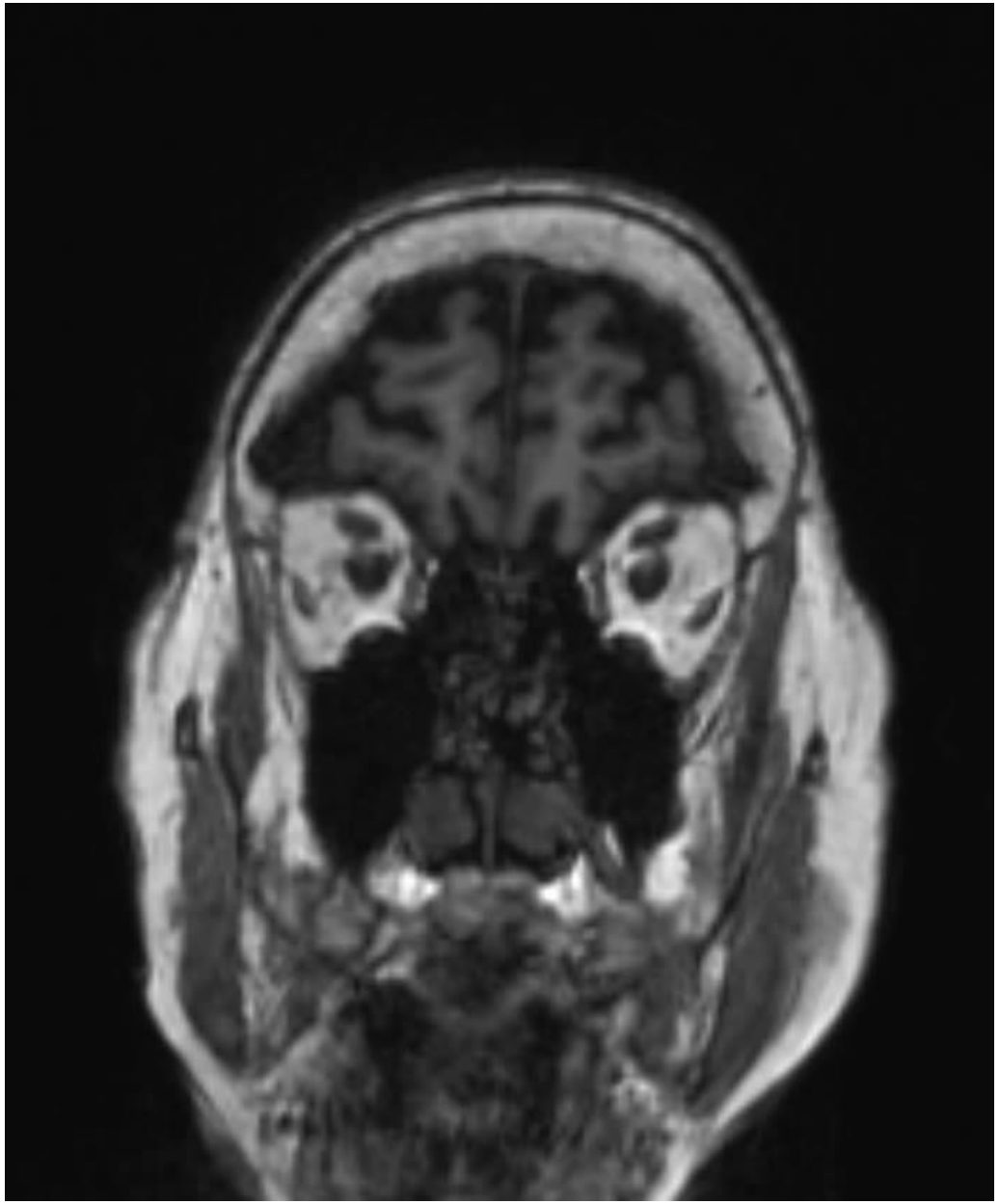


Case 4

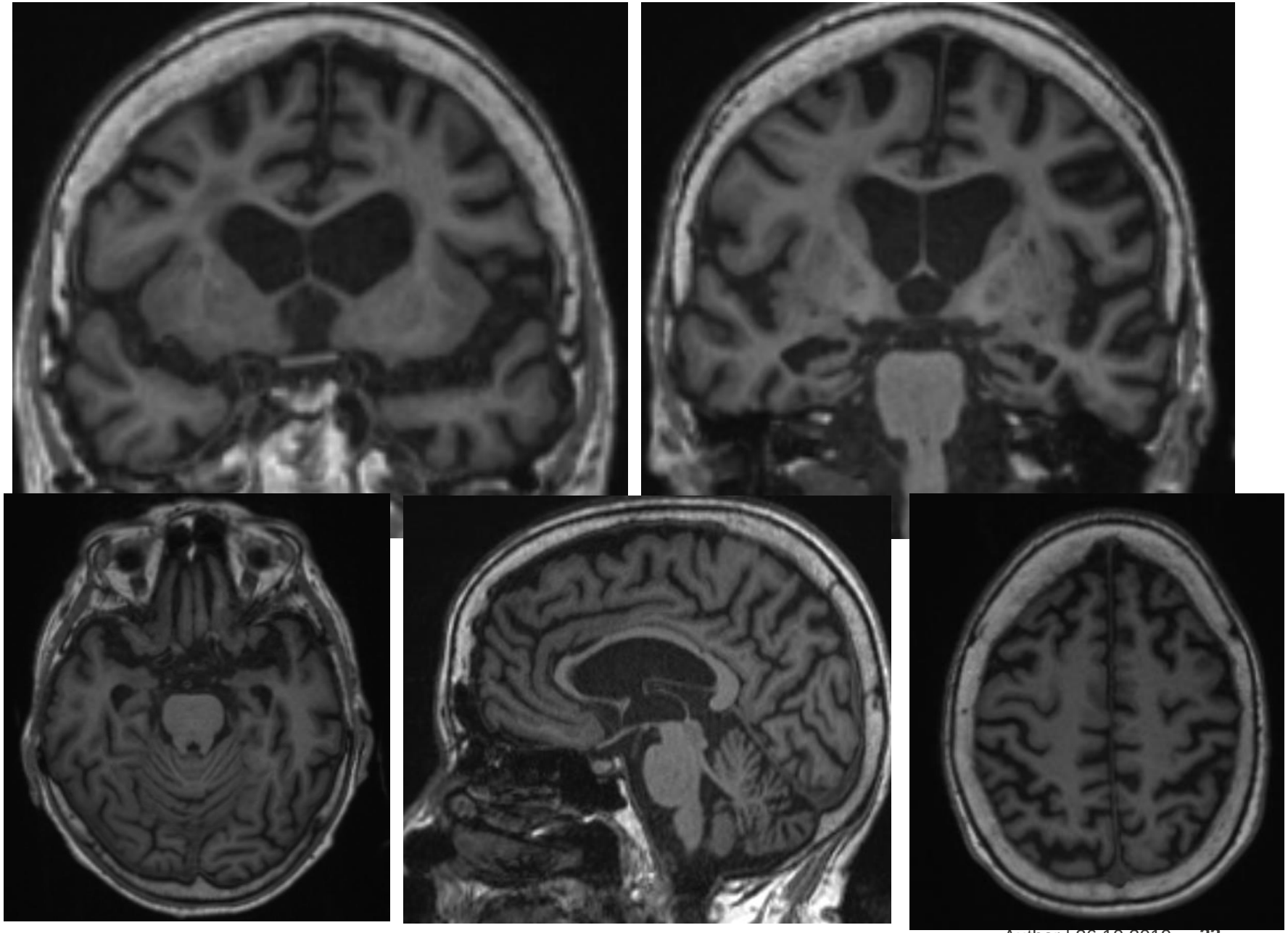
- 89y female
- MMS 18/30
- No psychiatric disorder
- Neuropsychological testing and history taking
- → Major neurocognitive disorder, moderate (basic ADLs affected)
- MRI

Case 4



Case 4

- 89y female
- MMS 18/30
- → Major neurocognitive disorder



Question for Case 4 - Which statement is describing this case best?

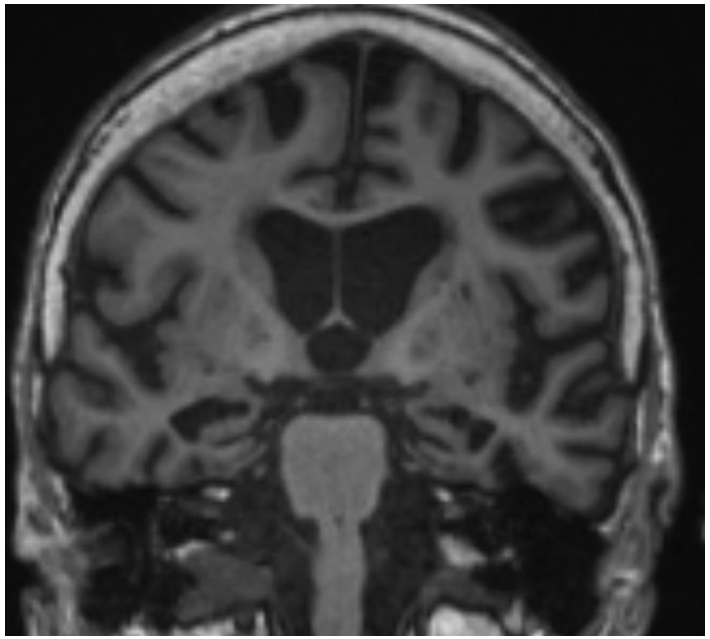
A) Moderate to severe medial temporal lobe atrophy, typical AD pattern

B) Slight medial temporal lobe atrophy, hippocampal sparing AD pattern

C) Severe medial temporal lobe atrophy, limbic type AD pattern

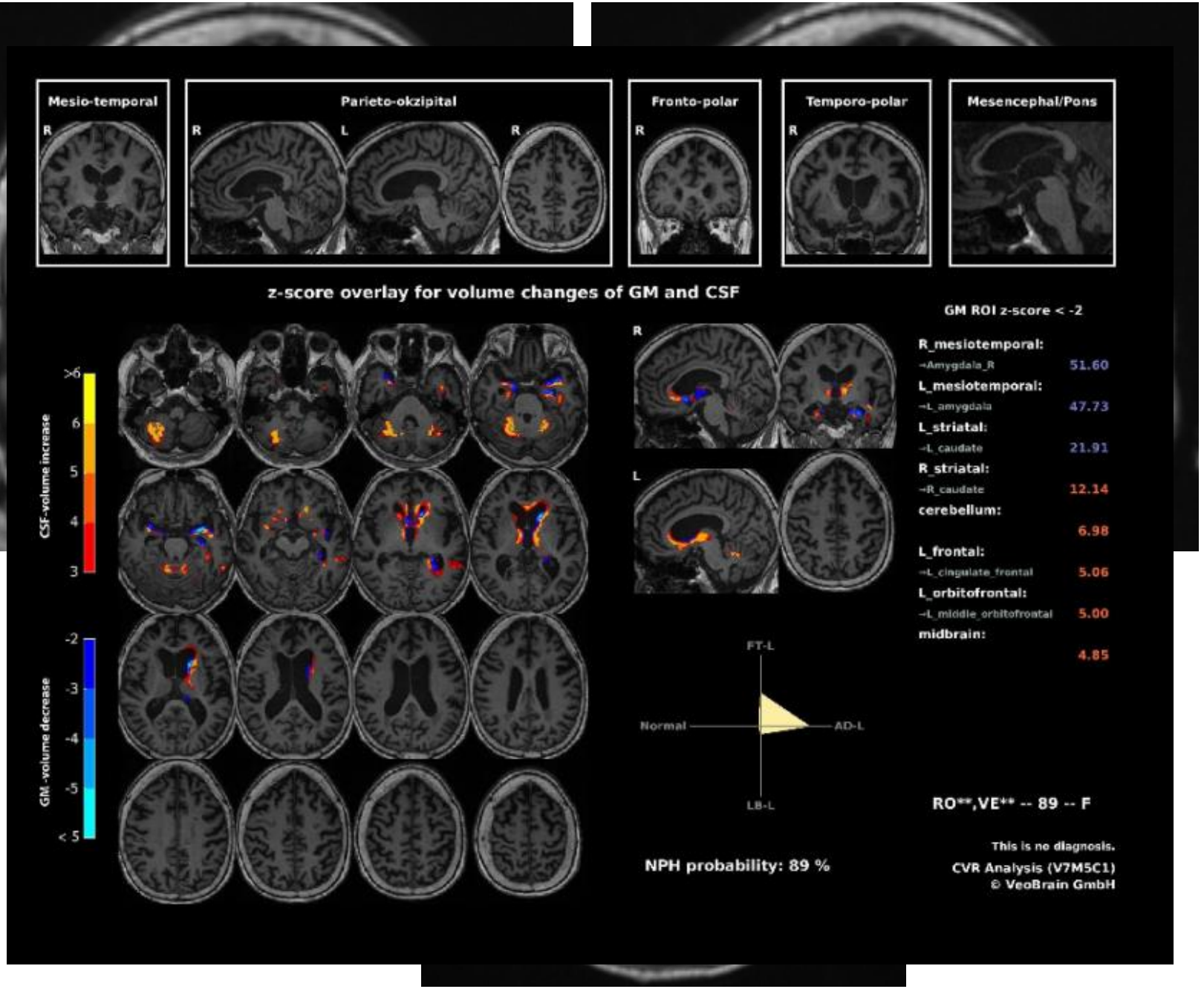
D) Severe global atrophy, suspicion of neurodegenerative disorder

E) Moderate to severe bilateral temporal lobe atrophy, FTLD pattern



Case 4

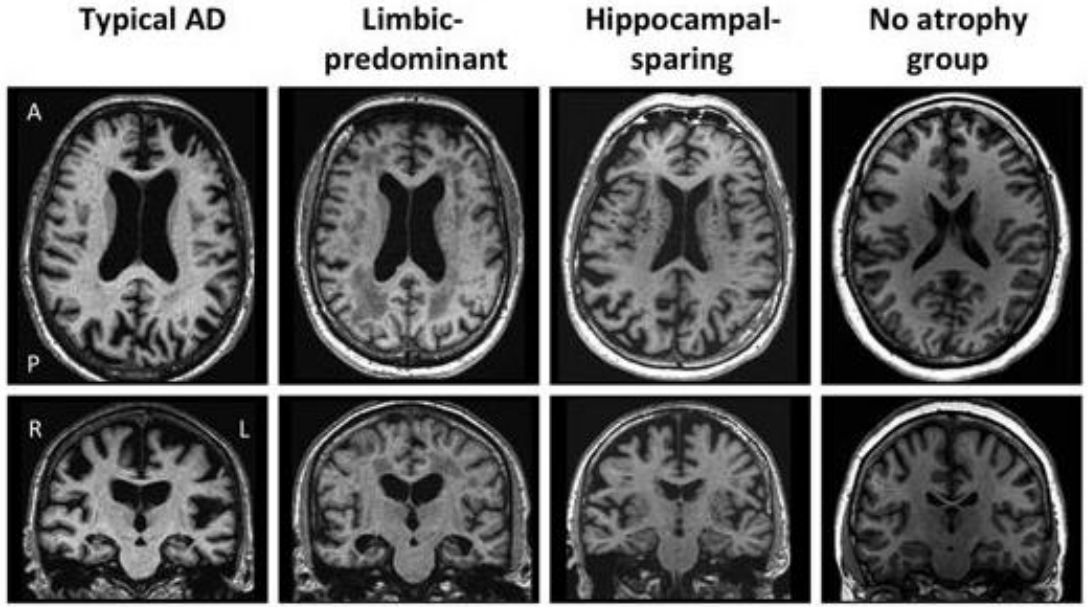
- 89y female
- MMS 18/30
- → Major neurocognitive disorder



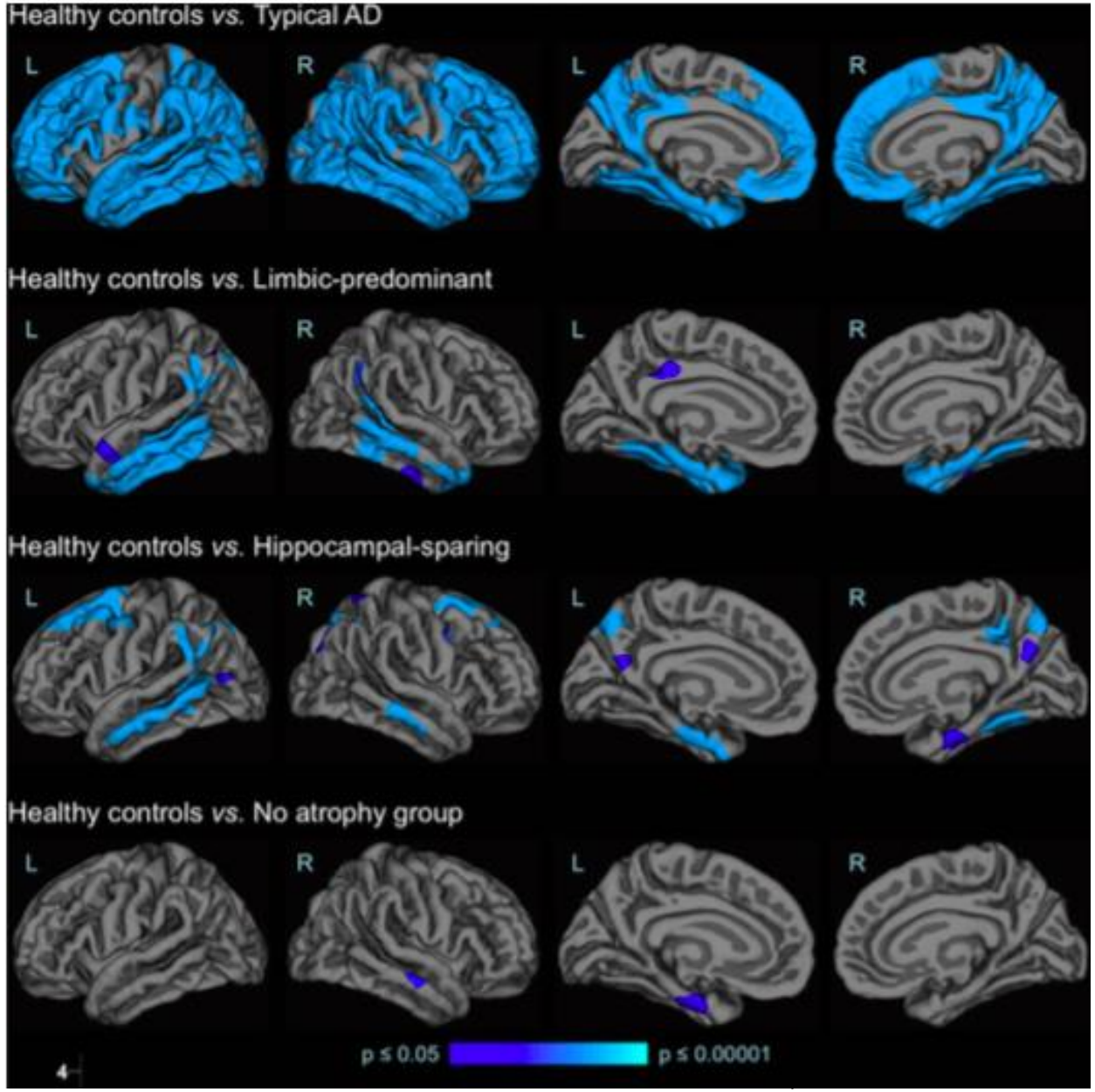
SFONS Neuroimaging Course

Case 4 – AD pattern

Figure 1: Subtypes of AD based on patterns of brain atrophy from visual rating scales.



Ferreira et al; Distinct subtypes of Alzheimer`s Disease based on patterns of brain atrophy; Nature 2017



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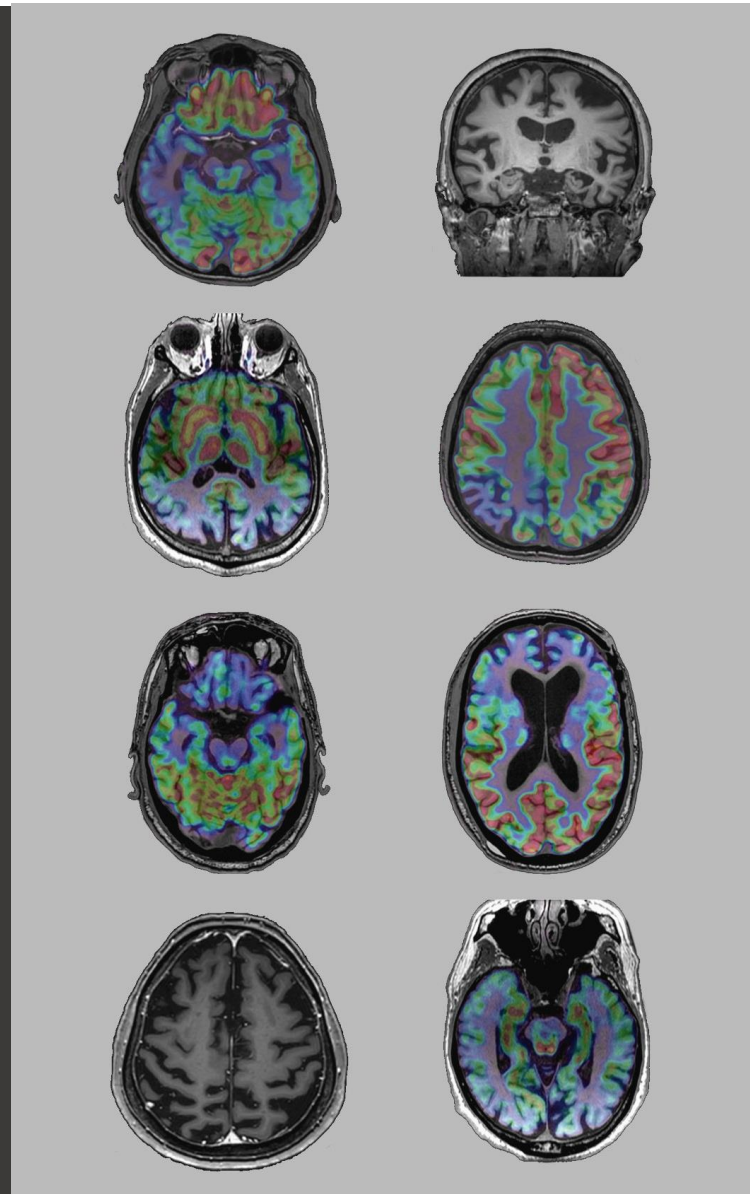


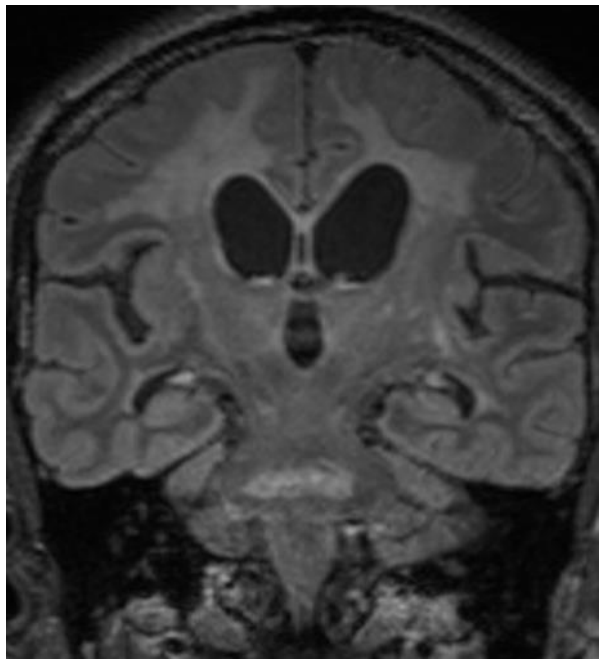
Case 5

56 y.o. male with seizure, dementia and insecure gait

Medical history and clinical findings

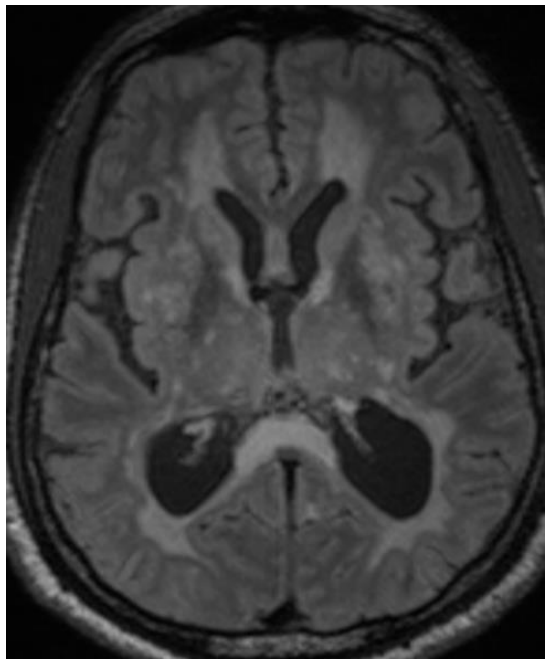
- 56 year old sub-saharan african male presents with tonic-clonic seizure
- Initial examination: patient reports increasing cognitive decline (objective pronounced cognitive deficits), gait disturbance, postural instability and urinary incontinence.
- Medical history: Diabetes mellitus Type 2 (*Metformin*), arterial hypertension (*Losortan*), no history of malaria
- Patient reports having had seizures in Ghana prior to current ER-presentation
- Initial labs and LP/CSF: normal. Screening for vasculitis, virology/bacteriology: negative.
- EEG: no epileptic potentials
- No clinical improvement after spinal tap.
- MRI?

Initial MRI presentation



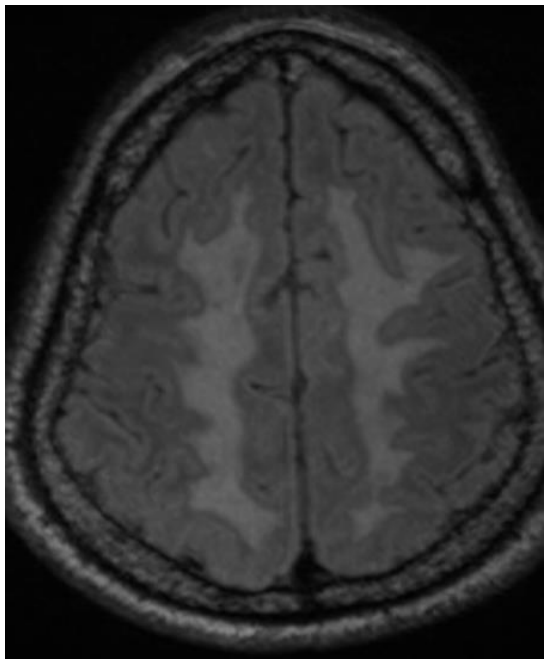
FLAIR 3D cor

USZ



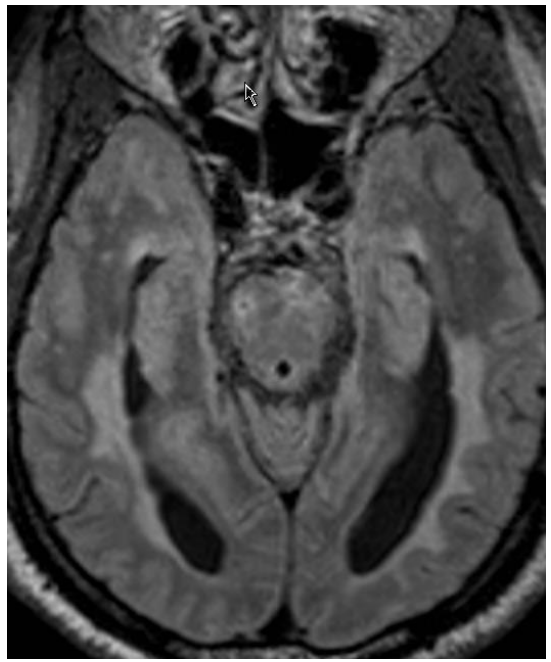
FLAIR 3D tra

USZ



FLAIR 3D tra

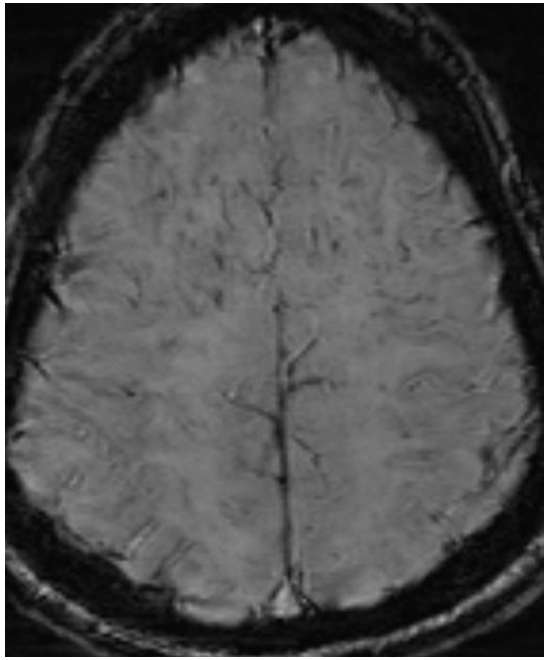
USZ



FLAIR 3D tra

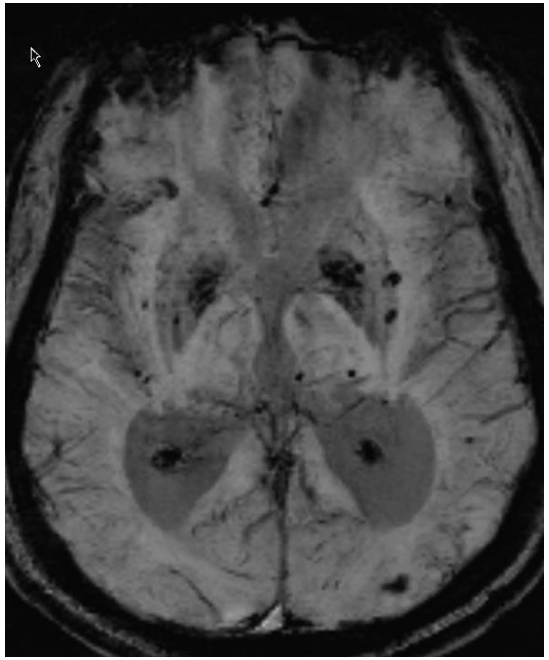
USZ

Initial MRI presentation



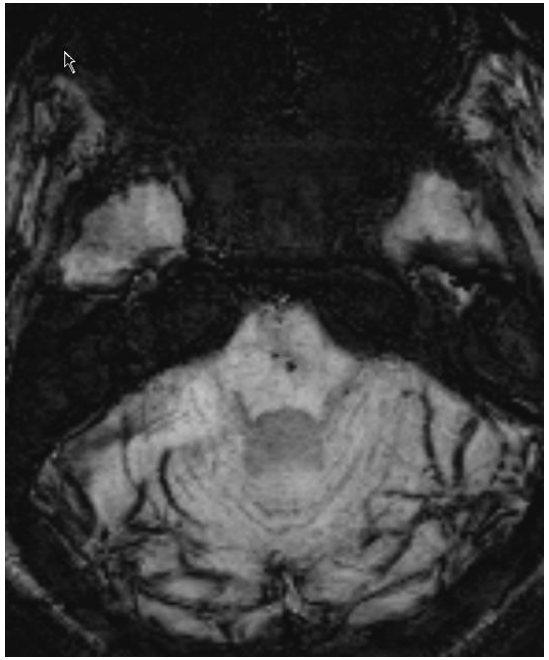
SWI tra

USZ



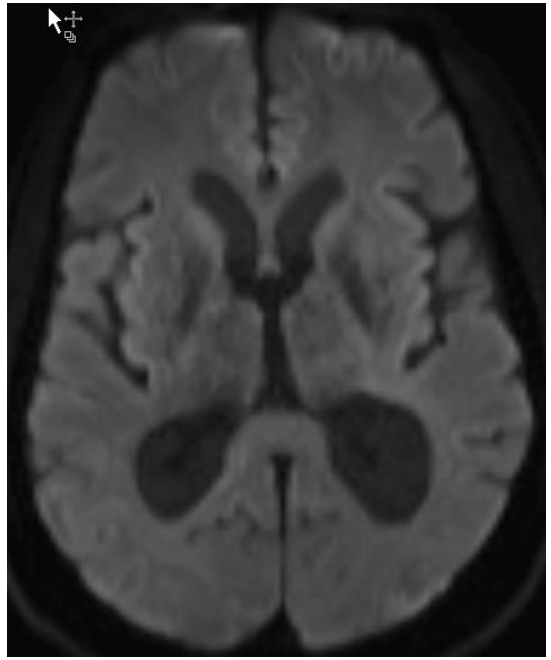
SWI tra (MIP)

USZ



SWI tra (MIP)

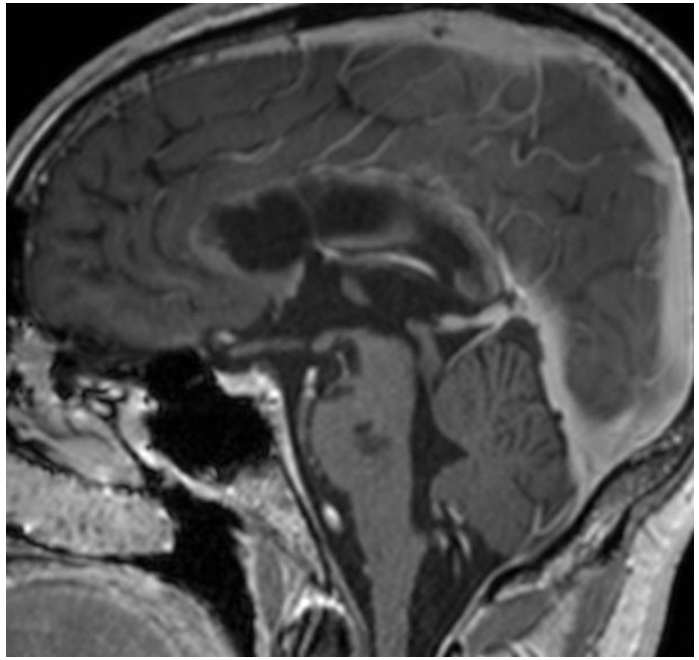
USZ



DWI tra

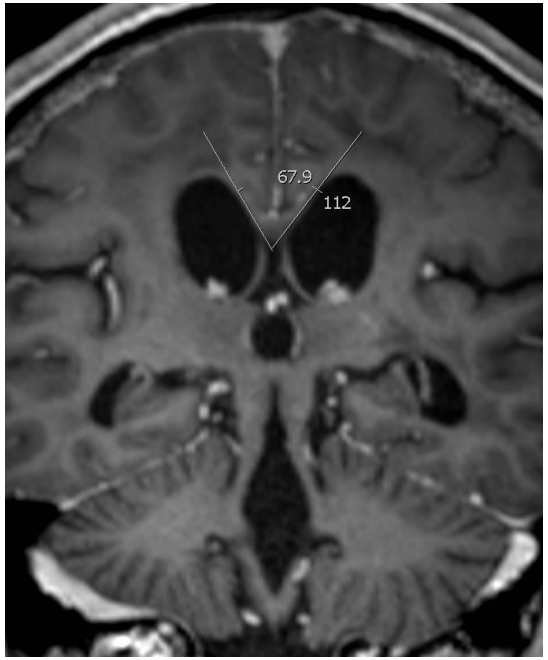
USZ

Initial MRI presentation



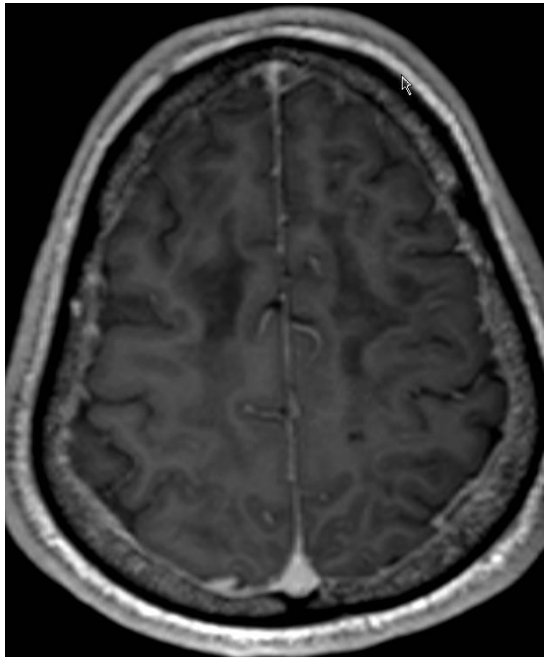
T1 MPRAGE Gd sag

USZ



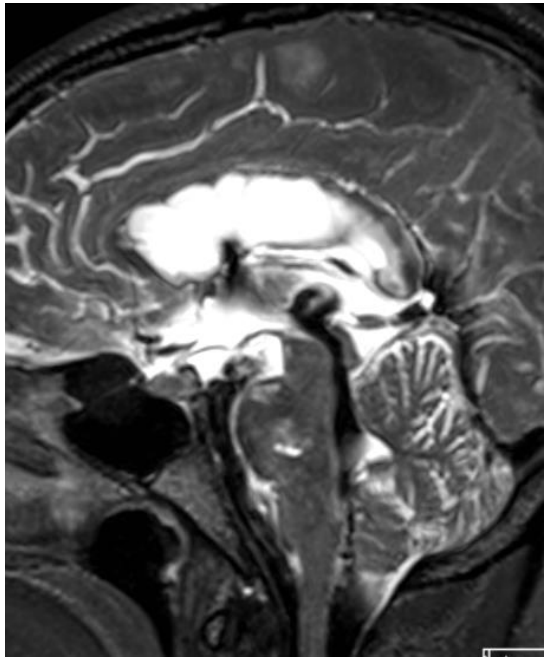
T1 MPRAGE Gd cor

USZ



T1 MPRAGE Gd tra

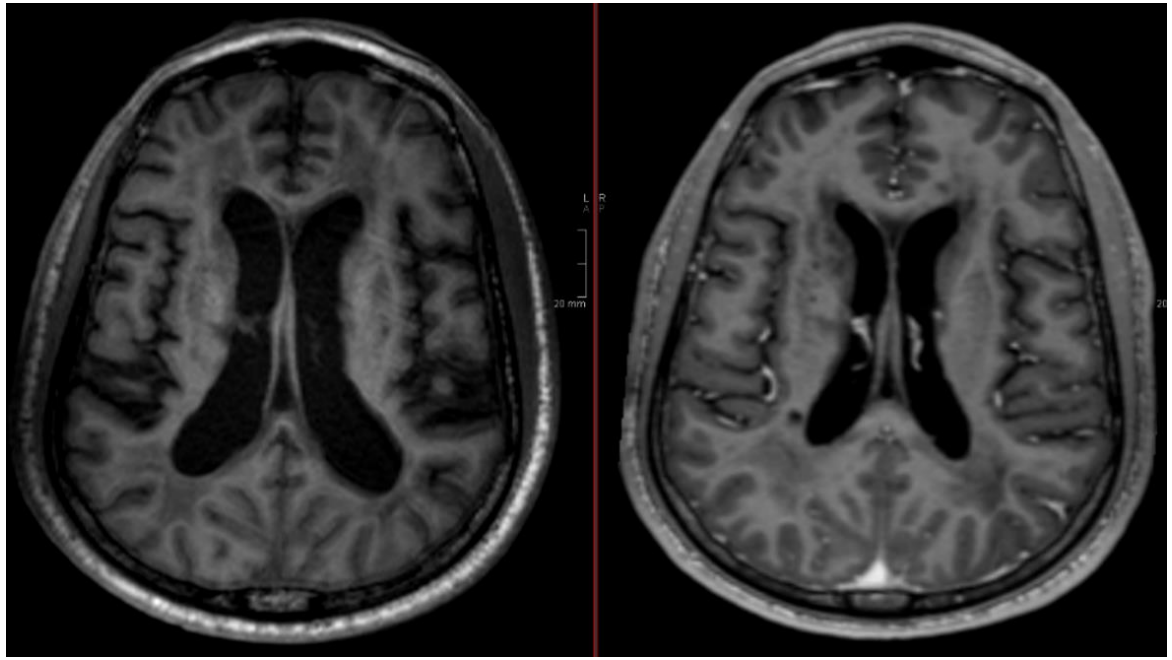
USZ



T2 space sag

USZ

Initial MRI presentation compared to previous MRI 4 years prior

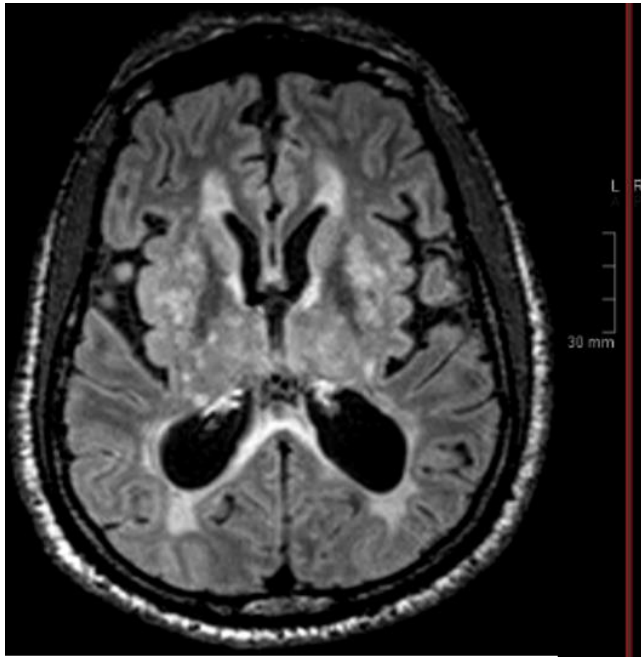


T1 MPRAGE tra (2019)

USZ

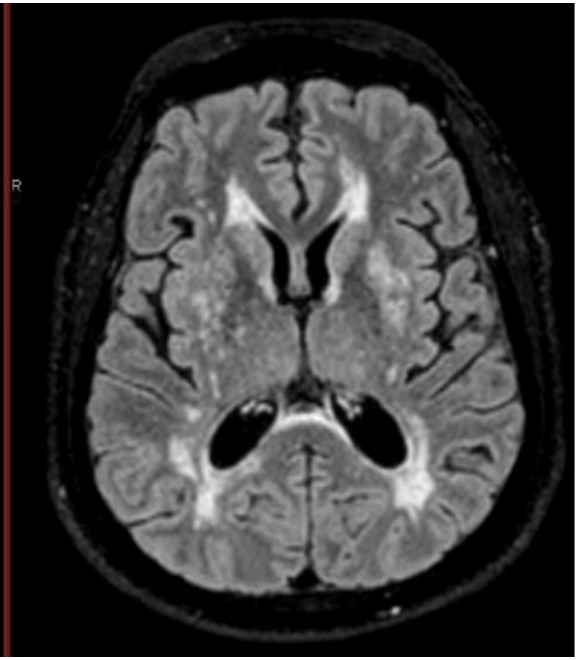
T1 MPRAGE Gd tra (2015)

USZ



FLAIR 3D tra (2019)

USZ



FLAIR 3D tra (2015)

USZ

MRI findings and differential diagnosis

- **MRI findings:**
- No evidence of tumor, acute ischemia, macrohemorrhage oder acute inflammation

Advanced and progressive periventricular and subcortical leucenphalopathy, with lacunar infarctions, including basal ganglia, thalami, temporal poles, brainstem and corpus callosum

Hypertensive leucencephalopathy? CADASIL? Cerebral Malaria? Post-inflammatory?

Increasing ventricles, wide Sylvian fissure, crowded apical sulci, sharp dorsal callosal angle. Strong T2-flow void through aqueduct, no aqueductal stenosis

NPH? E vacuo atrophy due to white matter disease and/or neurodegeneration?

Multiple microhemorrhages, in basal ganglia, brainstem and corticomedullary junction, as well as along perivascular spaces (centrum semiovale)

Hypertensive ? Cerebral amyloid angiopathy? CADASIL? Malaria?

Which statement is false?

A) Periventricular and subcortical leucencephalopathy with lacunar infarctions combined with microhemorrhages in the basal ganglia and brainstem are hallmark findings of hypertensive encephalopathy.

B) Cerebral amyloid angiopathy typically presents with microhemorrhages in the corticomedullary junction and/or superficial siderosis or parenchymal macrohemorrhage, usually in combination with white-matter disease.

C) Inflammatory white matter lesions in multiple sclerosis are typically associated with microbleeds in the corpus callosum

D) Desribed features of cerebral malaria are T2/FLAIR hyperintensities in periventricular white matter, corpus callosum, occipital subcortex and thalami, as well petechial microbleeds.

E) Aqueductal increased CSF-flow-void (T2) is a frequently observed finding in normal pressure hydrocephalus (NPH).

Swiss Federation of Clinical Neuro-Societies

Case-based session

Dr. Johanna Lieb[1]

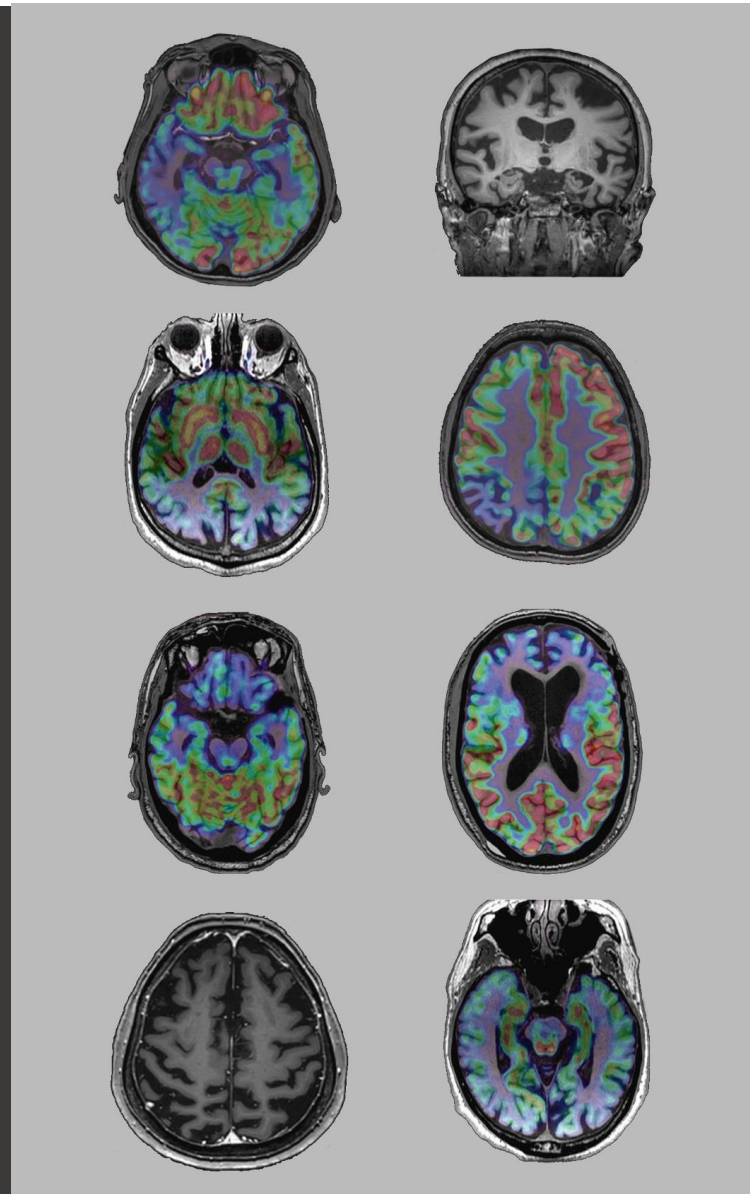
Dr. Anthony Tyndall[2]

[1] Department of Neuroradiology, University Hospital Basel

[2] Department of Neuroradiology, University Hostipal Zürich

SFCNS Neuroimaging Course

1st Module: Imaging Neurodegeneration

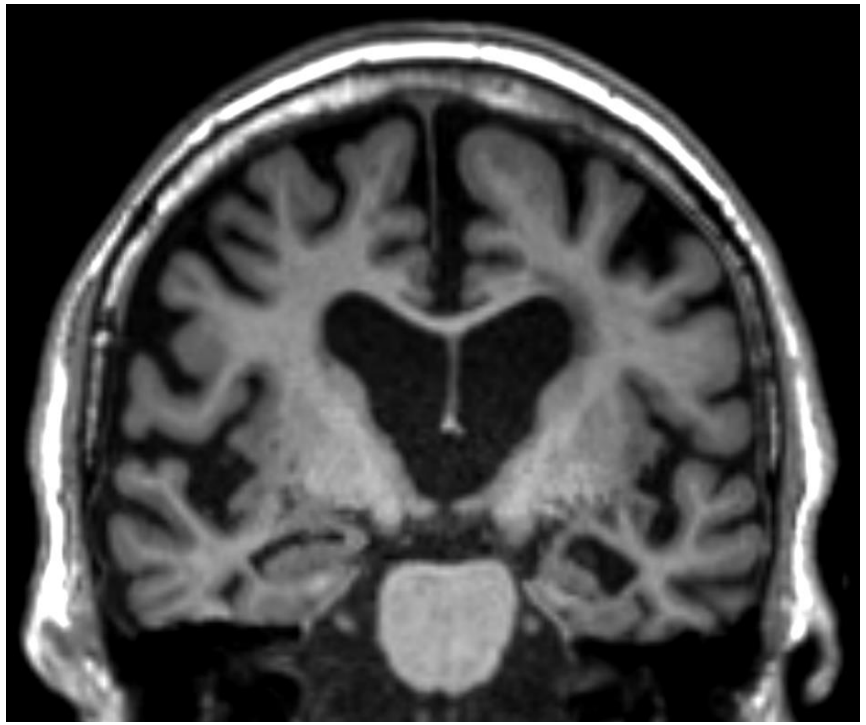


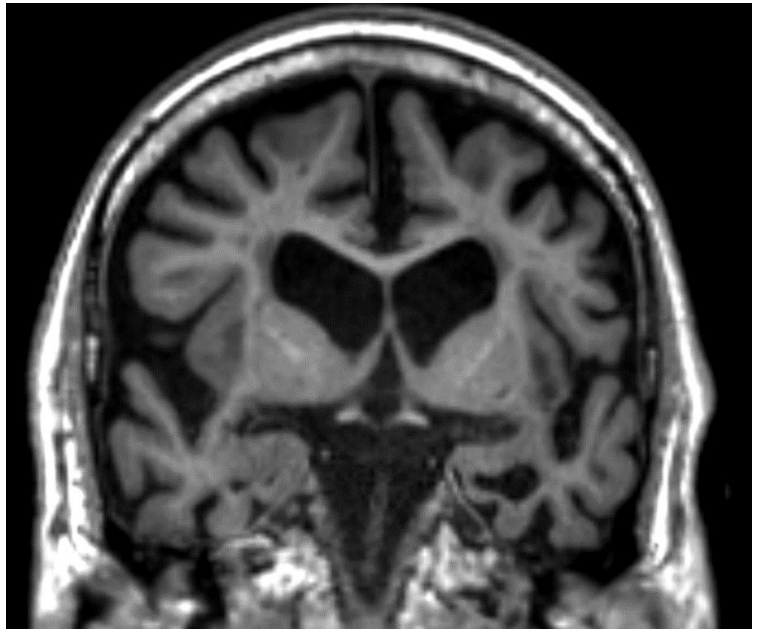
Case 6

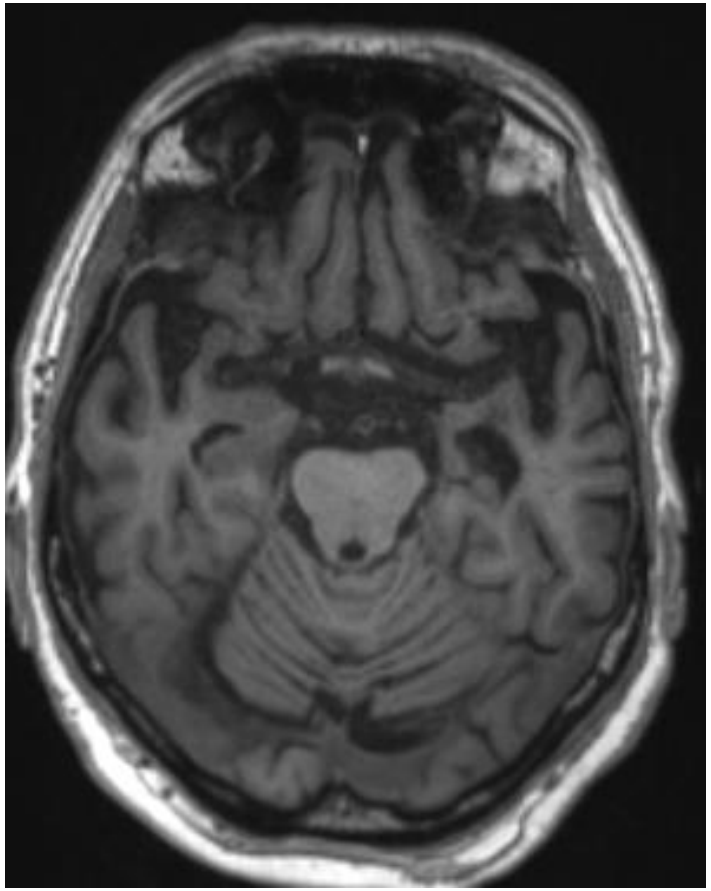
- 86y male
- MMS 26/30
- No psychiatric disorder
- Neuropsychological testing
- Major neurocognitive disorder,
  multiple domains, mild (iADLs affected)
- MRI

Case 6

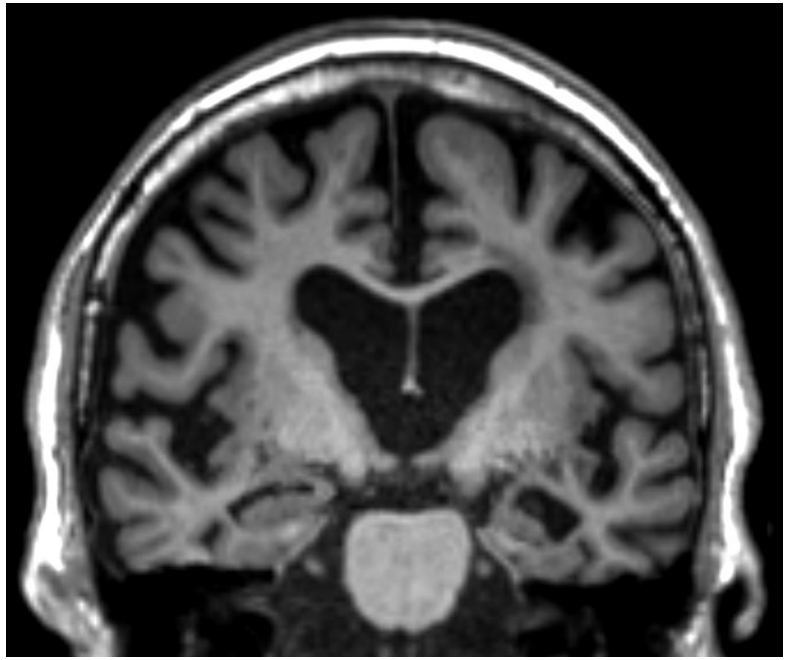
- 86y male
- MMS 26/30
- Major neurocognitive disorder, multiple domains, mild (iADLs affected)

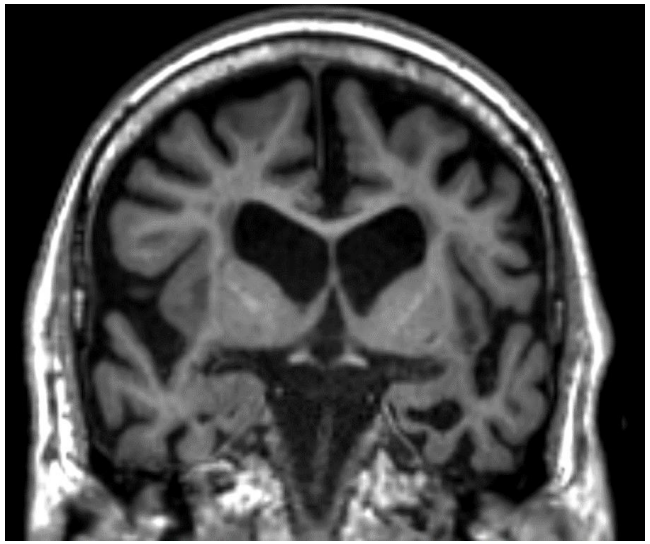






Question for Case 6 - Which statement is false?





A) Asymmetry is not typial for AD

B) AD can be asymmetric

C) AD is more commonly pronounced on the left side

D) Asymmetric findings expand differential diagnosis to AD and FTLD

E) FTLD is affecting medial temporal lobe structures

Swiss Federation of Clinical Neuro-Societies

Case-based session

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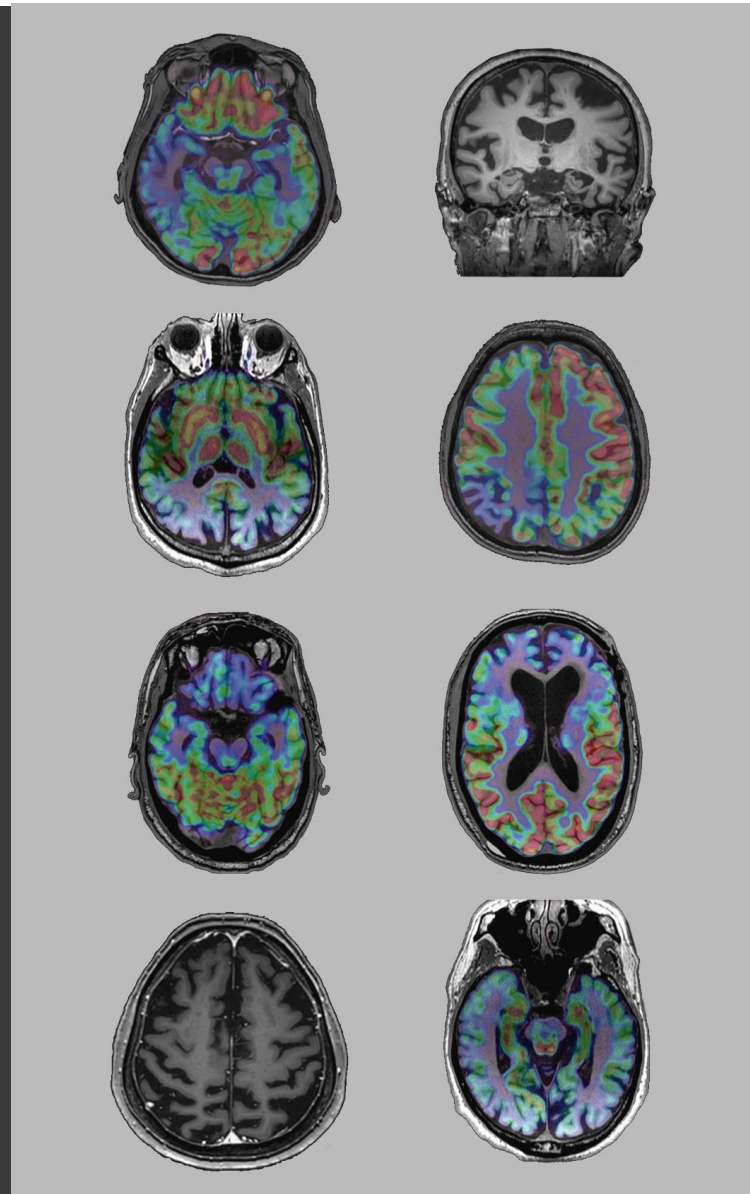
SFCNS Neuroimaging Course

1st Module: Imaging Neurodegeneration



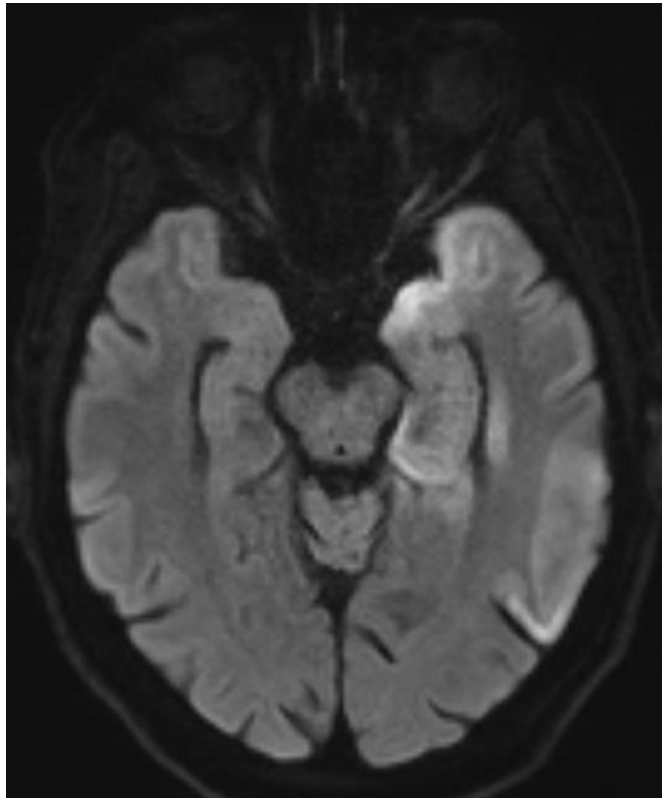
Case 7

73 y.o. female with rapidly advancing memory loss and coordination difficulties

Medical history and clinical findings

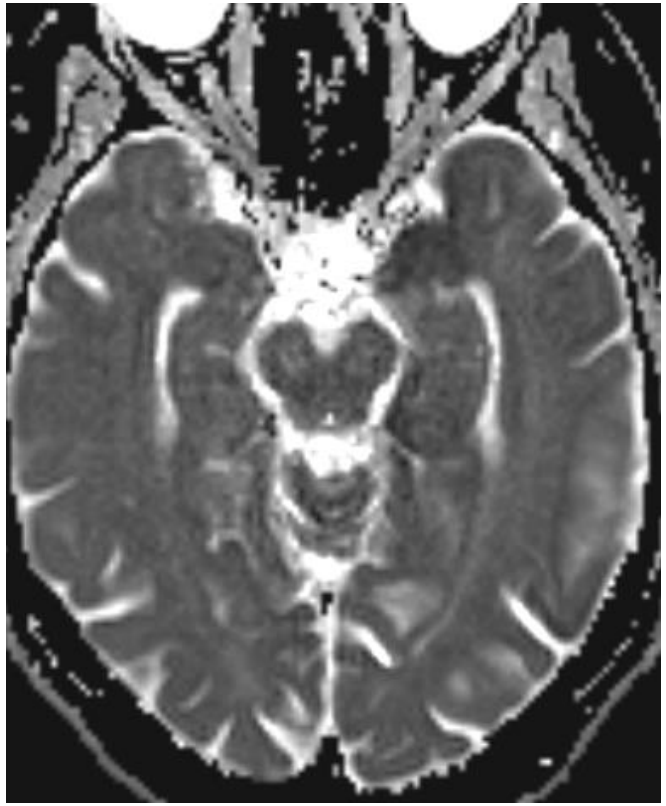
- 73 year old female patient with coordination problems and fatigue (while dancing, getting out of bed) since months
- Memory loss and cognitive decline, difficulty remembering words and especially names, orientation difficulties
- Initial examination: mild psychomotoric deficits, no neurological deficits.
- Medical history: Diabetes mellitus Typ 1, arterial hypertension, hypercholesteria. No history of tumor.
- Initial labs: normal
- MRI?

Initial MRI imaging at clinical presentation



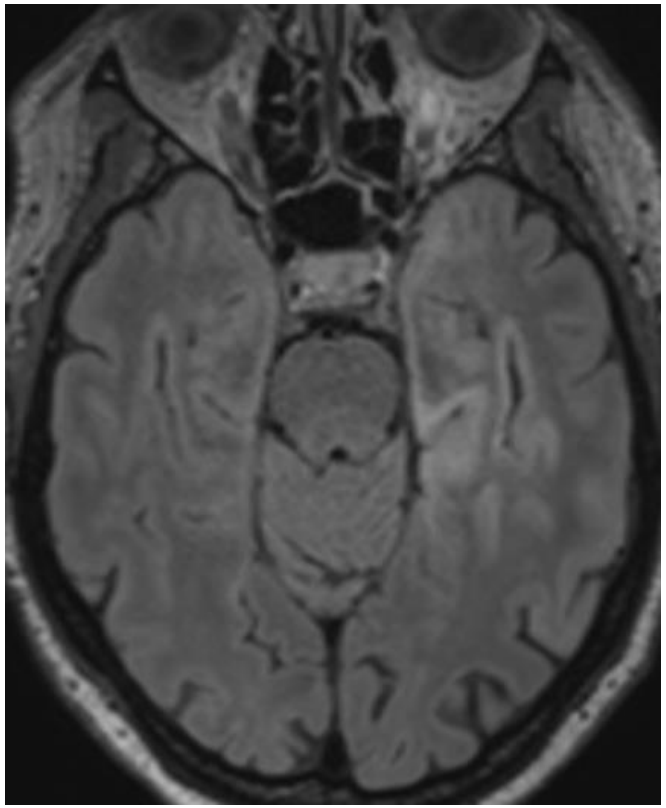
DWI tra

USZ



ADC tra

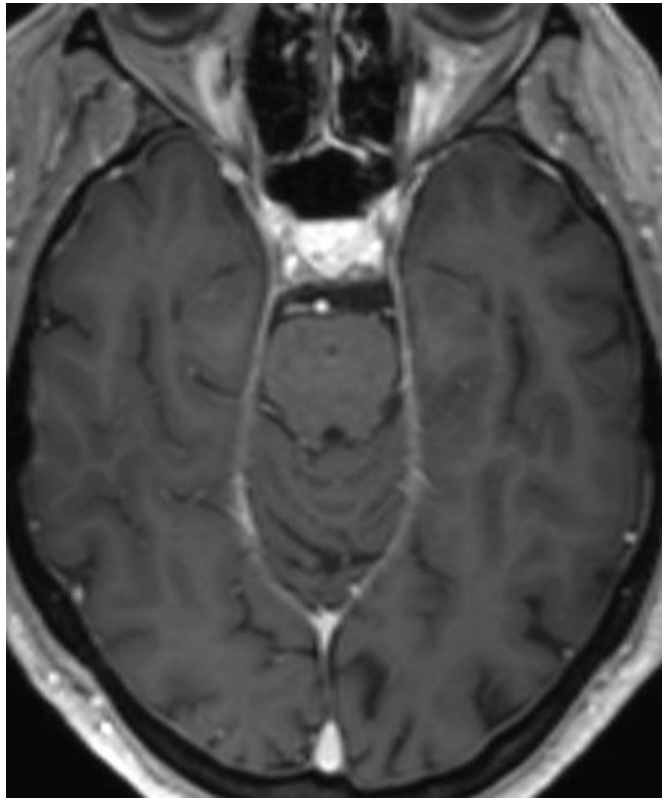
USZ



3D FLAIR tra

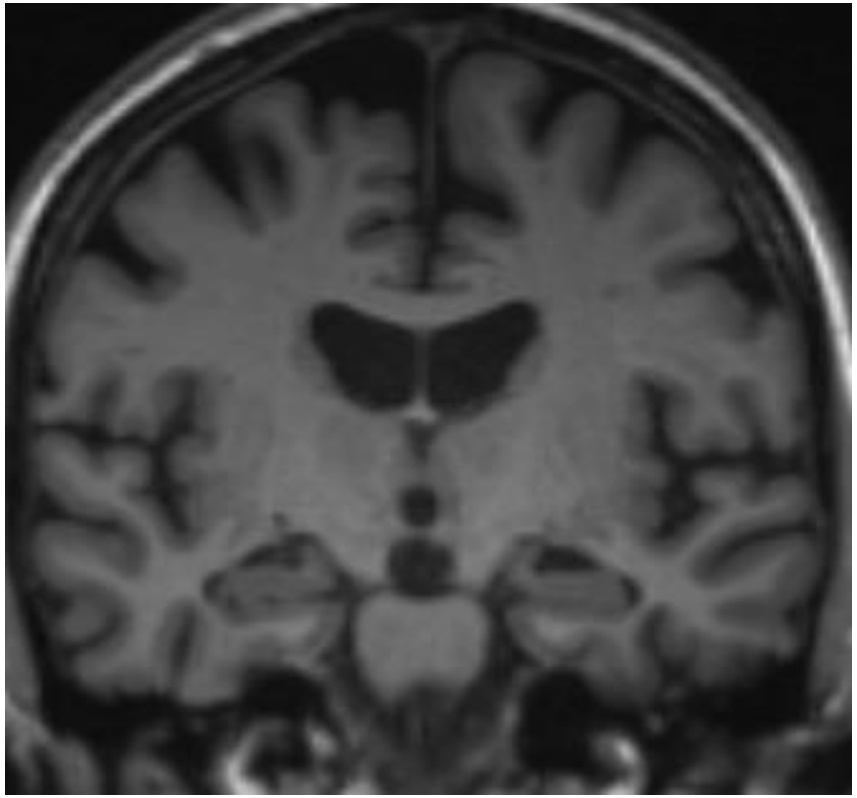
USZ

Initial imaging at clinical presentation



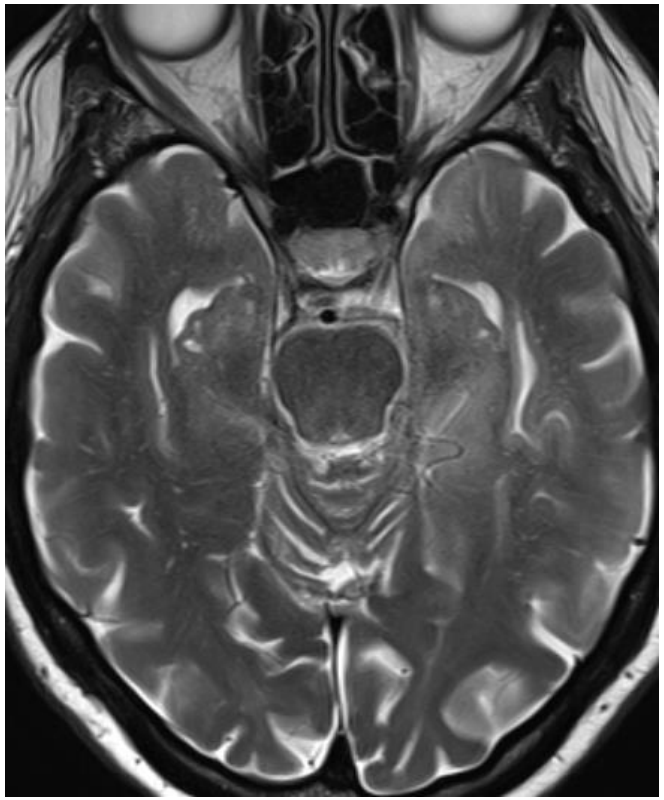
T1 Gd tra

USZ



T1 cor

USZ



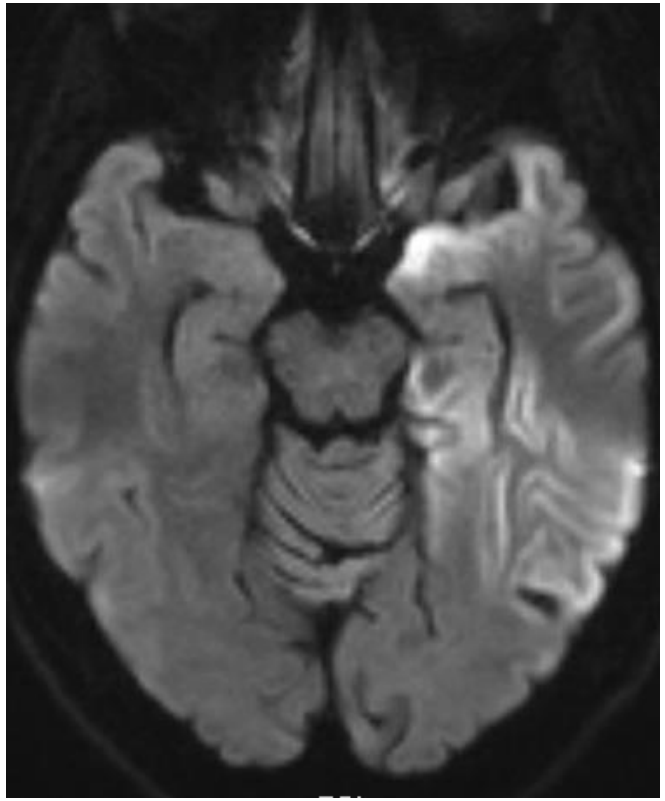
T2 tra

USZ

Continuation of medical history and clinical findings one month later

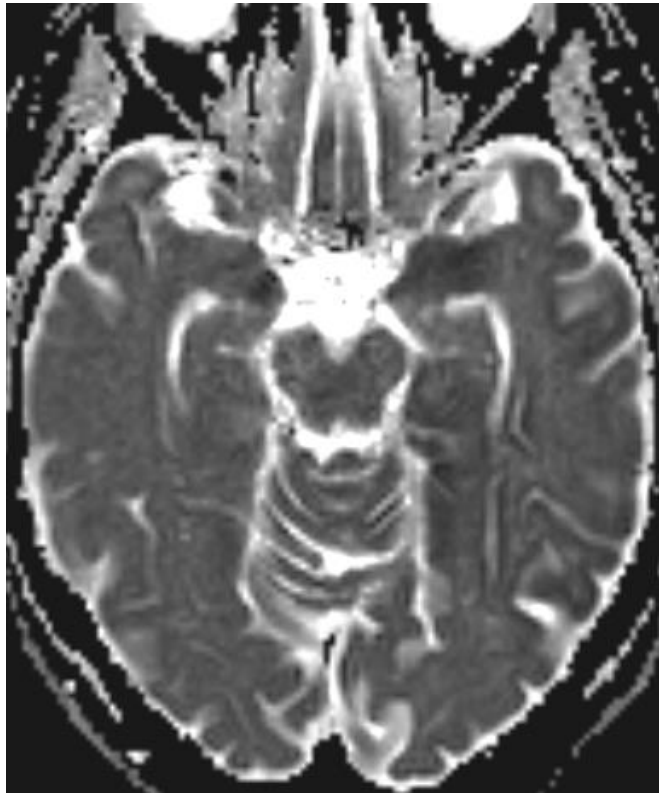
- Increasing cognitive decline (memory loss)
- EEG: normal
- Tumor search: negative
- Labs: no signs of inflammation
- LP: positive oligoclonal bands, negative for viral and bacterial agents, negative for Anti-NMDA and Anti-VGKC
- MRI?

Same patient, one month later



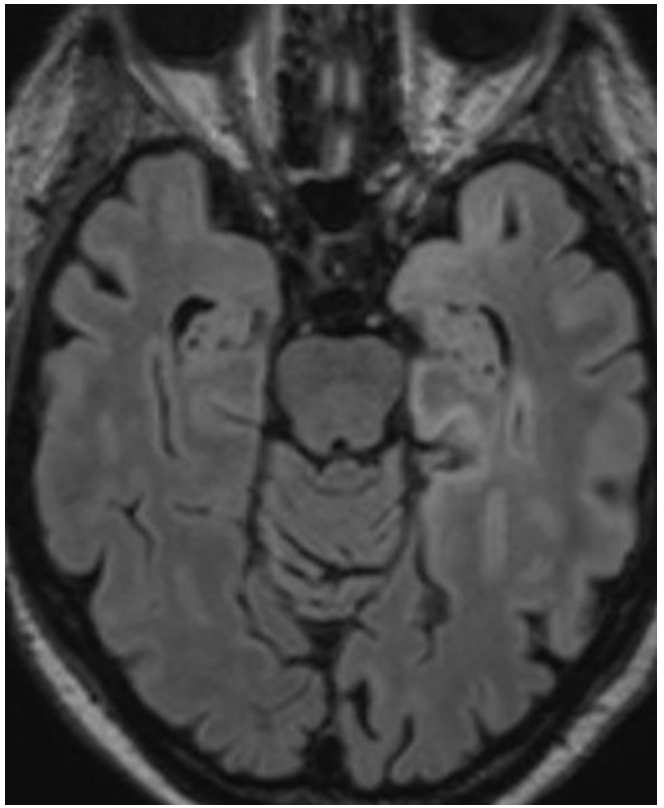
DWI tra

USZ



ADC tra

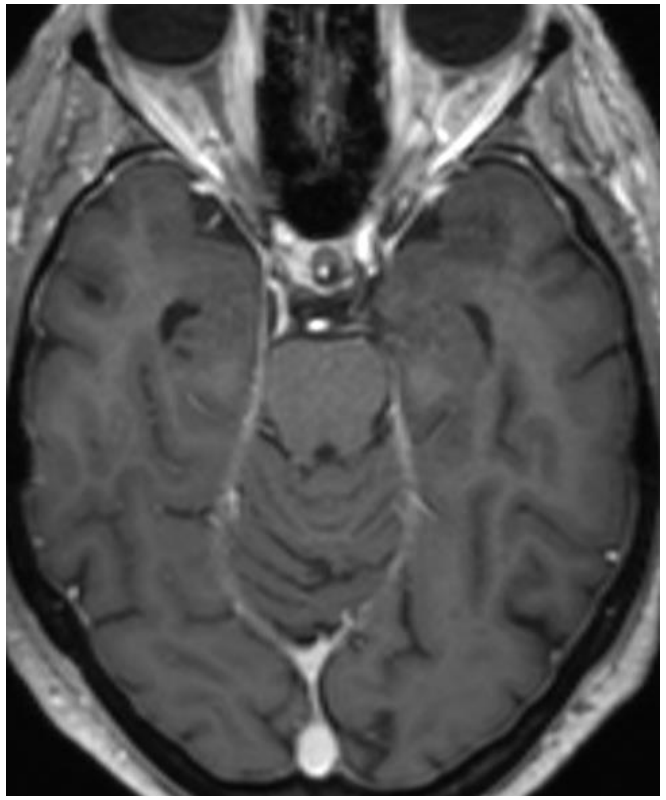
USZ



3D FLAIR tra

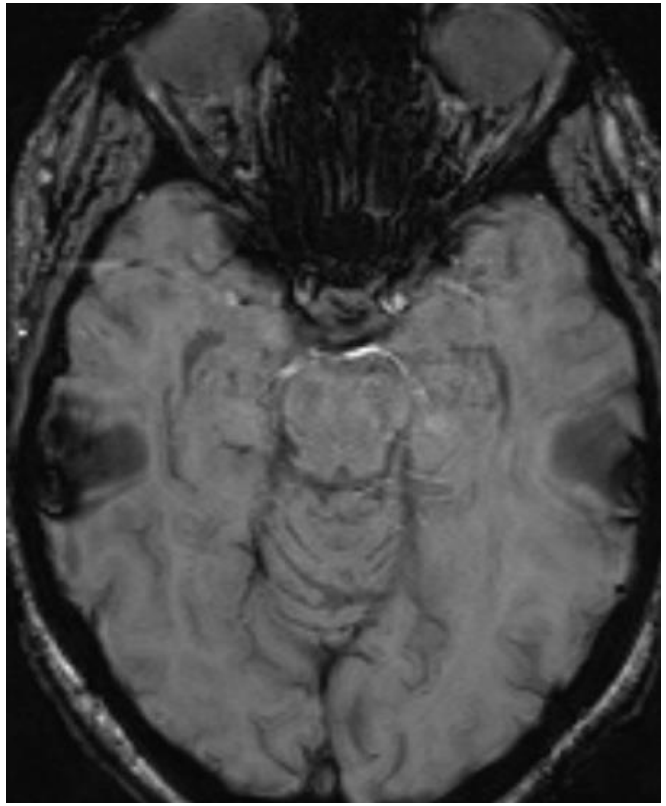
USZ

Same patient, one month later



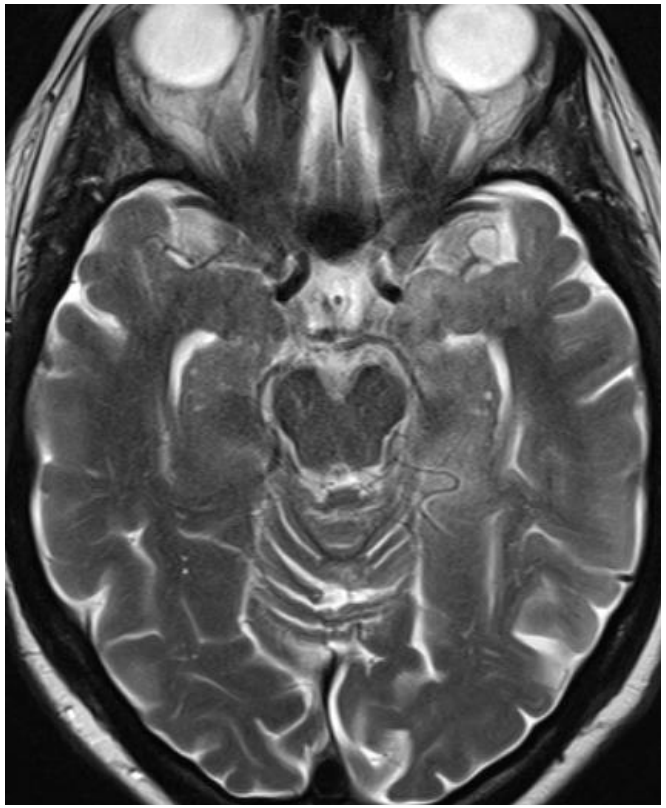
T1 Gd tra

USZ



SWI tra

USZ



T2 tra

USZ

Further CSF-analysis

- Real-Time Quaking-induced Conversion: Prion aggregates in 4/4 CSF-replicates
- In combination with progressive neurological syndrome: **most likely CJD** (cannot distuinguish between fCJF and sCJD)

Which statement is false?

A) Early imaging hallmarks for CJD are areas of persistent cortical diffusion restriction, later with T2 hyperintensity

B) Diffusion restriction in CJD often includes the caudate nucleus, putamen and thalamus

C) Diffusion restriction in the limbic cortex can be seen in herpes encephalitis, limbic encephalitis, CJD, seizure and stroke

D) Presence of cortical hemorrhage and fulminant Gd-enhancement suggests herpes encephalitis

E) CJD is a terminal illness which progresses more rapidly than herpes encephalitis

Swiss Federation of Clinical Neuro-Societies

Case-based session

Dr. Johanna Lieb[1]

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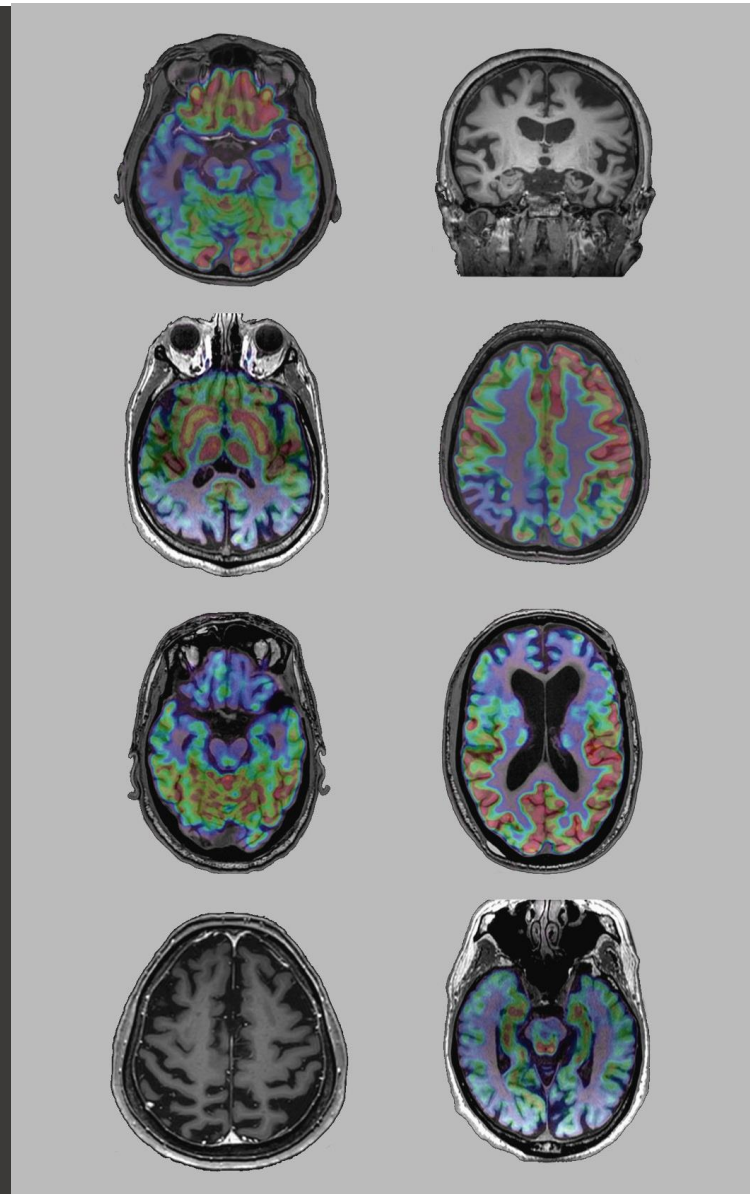
SFCNS Neuroimaging Course

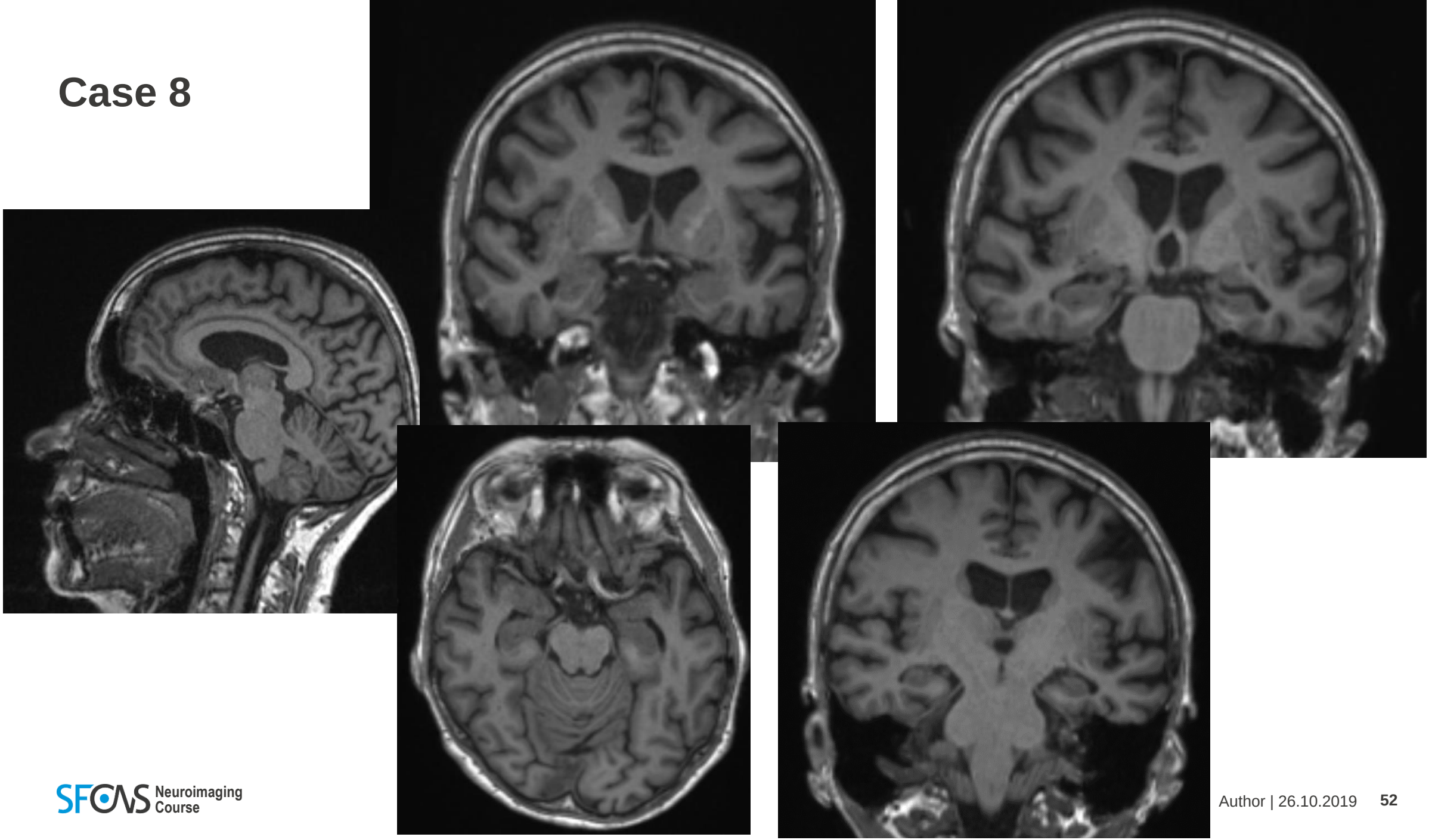
1st Module: Imaging Neurodegeneration



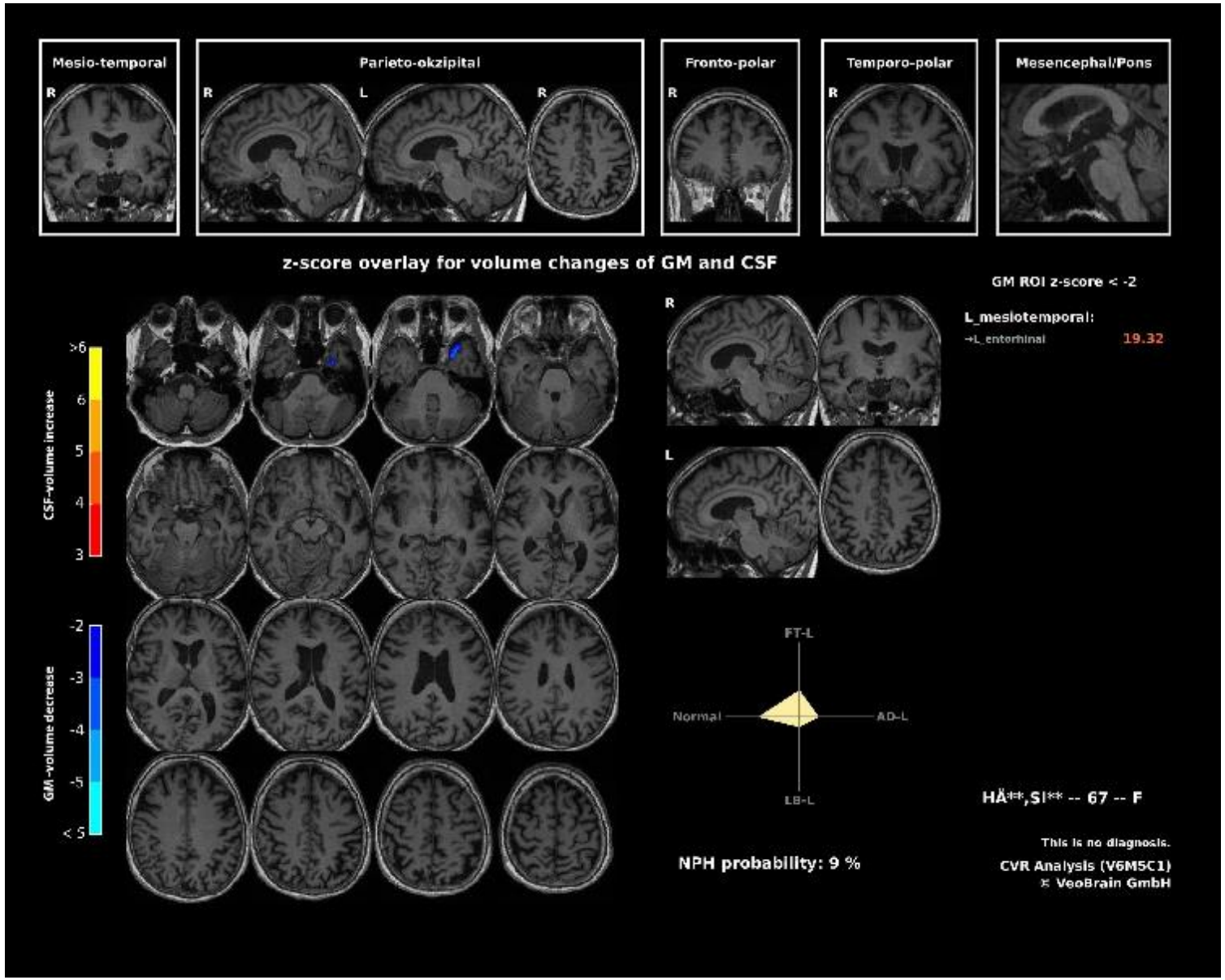
Case 8

- 67y female
- Language difficulties (difficulties finding the right words) for about 12 months
- MMS 23/30
- No psychiatric disorder

Case 8



Case 8


Mesio-temporal
Parieto-okzipital
Fronto-polar
Temporo-polar
Mesencephal/Pons
R
L
z-score overlay for volume changes of GM and CSF
GM ROI z-score < -2
L_mesiotemporal:
→L_entorhinal 19.32
CSF-volume increase
>6
6
5
4
3
GM-volume decrease
-2
-3
-4
-5
< -5
FT-L
Normal
AD-L
LB-L
HÄ**,SI** -- 67 -- F
NPH probability: 9 %
This is no diagnosis.
CVR Analysis (V6M5C1)
© VeoBrain GmbH

Question for Case 8 - Which statement is correct?

A) MRI normal, Morphometry normal, Pattern recognition normal

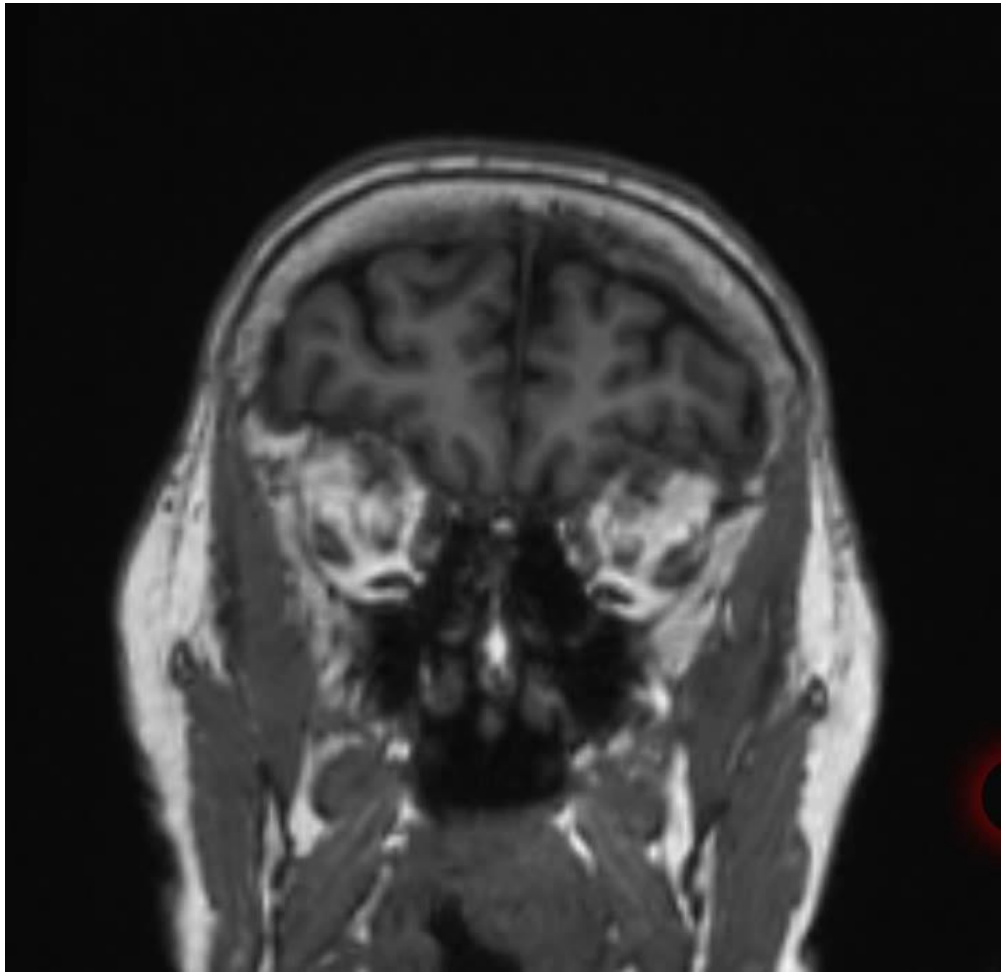
B) MRI normal, Morphometry slightly abnormal, Pattern recognition confused

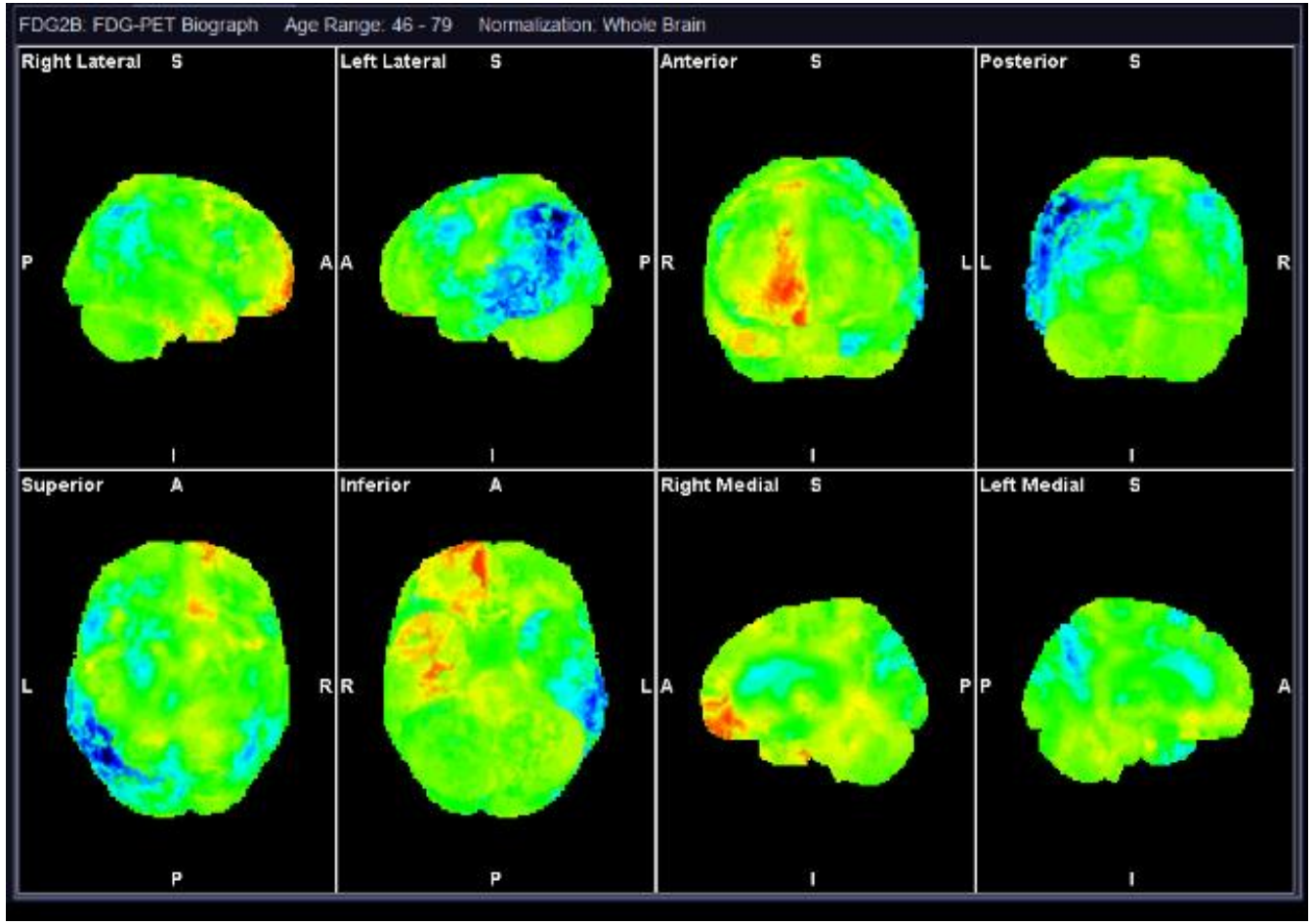
C) MRI slightly abnormal, Morphometry slightly abnormal, Pattern recognition confused

D) MRI, Morphometry and Pattern recognition show hints for AD

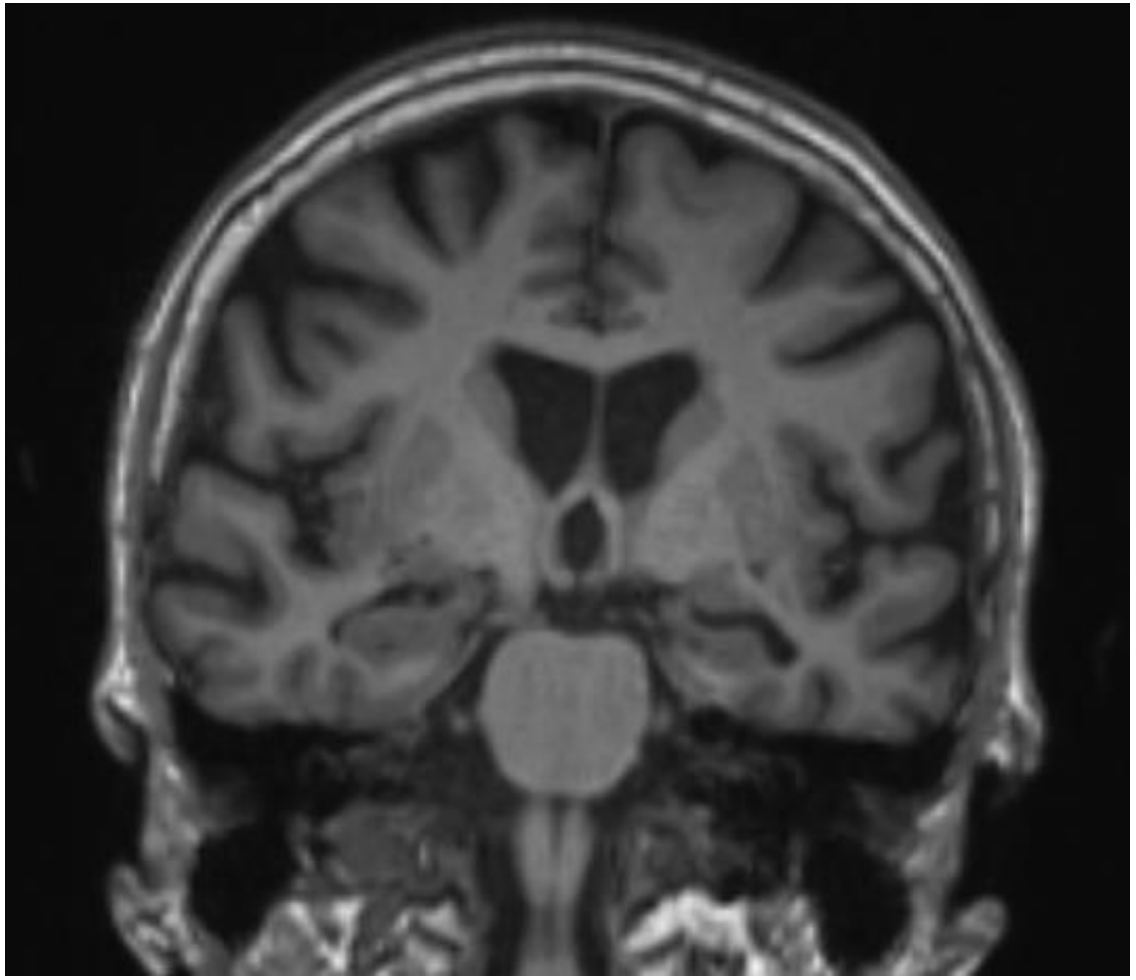
E) MRI, Morphometry and Pattern recognition show hints for FTLD

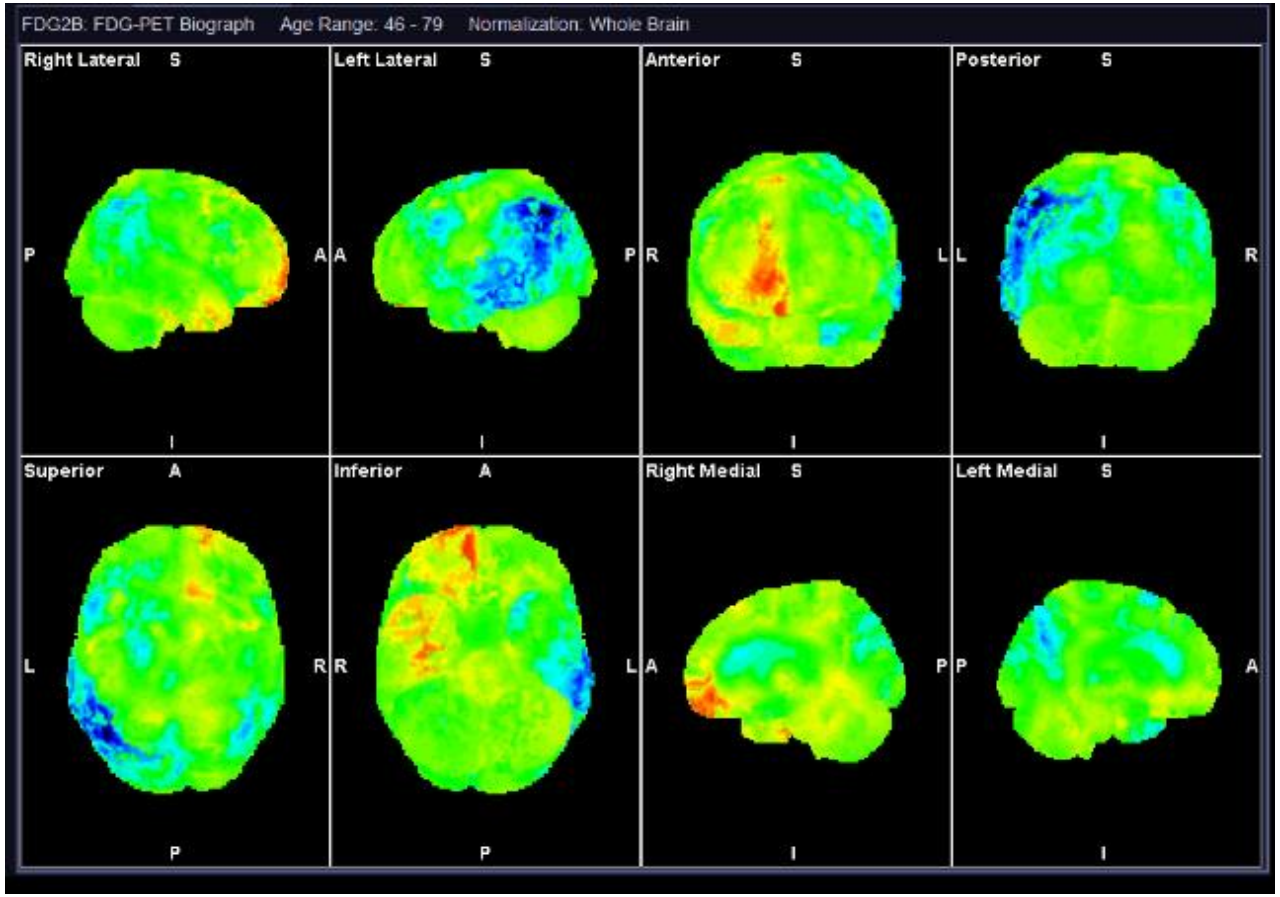
Case 8




FDG2B: FDG-PET Biograph Age Range: 46 - 79 Normalization: Whole Brain
Right Lateral S
P A I
Left Lateral S
A P I
Anterior S
R L I
Posterior S
L R I
Superior A
L R P
Inferior A
R L P
Right Medial S
A P I
Left Medial S
P A I

Case 8




FDG2B: FDG-PET Biograph Age Range: 46 - 79 Normalization: Whole Brain
Right Lateral S
Left Lateral S
Anterior S
Posterior S
Superior A
Inferior A
Right Medial S
Left Medial S

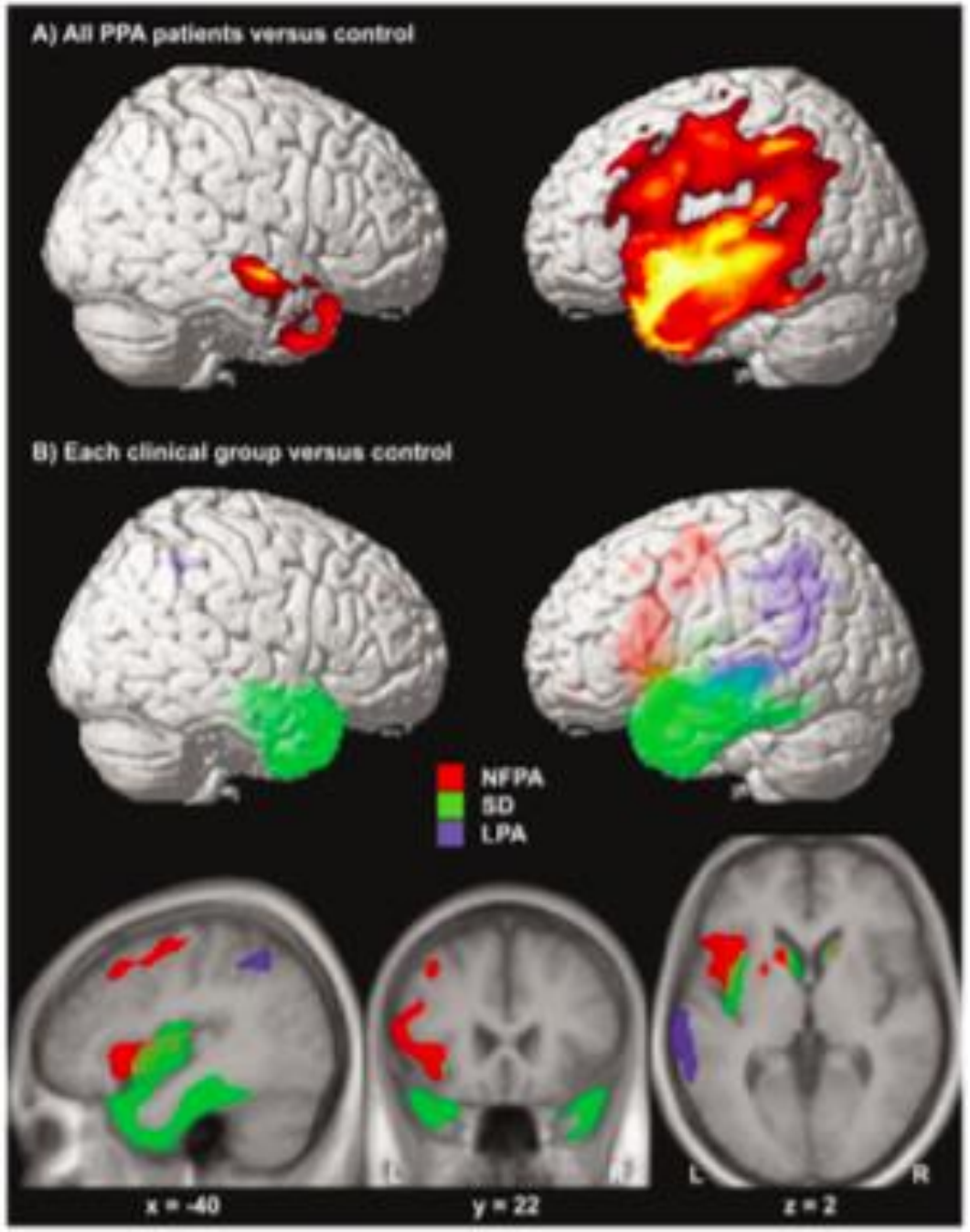
Case 8 – PPA

Primary progressive aphasia

- Semantic dementia
- Logopenic variant PPA (lvPPA, LPA)
- Non fluent PPA (nfPPA, PNFA)

Table 1 **Inclusion and exclusion criteria for the diagnosis of PPA: Based on criteria by Mesulam[32]**

Inclusion: criteria 1–3 must be answered positively
1. Most prominent clinical feature is difficulty with language
2. These deficits are the principal cause of impaired daily living activities
3. Aphasia should be the most prominent deficit at symptom onset and for the initial phases of the disease
Exclusion: criteria 1–4 must be answered negatively for a PPA diagnosis
1. Pattern of deficits is better accounted for by other nondegenerative nervous system or medical disorders
2. Cognitive disturbance is better accounted for by a psychiatric diagnosis
3. Prominent initial episodic memory, visual memory, and visuoperceptual impairments
4. Prominent, initial behavioral disturbance

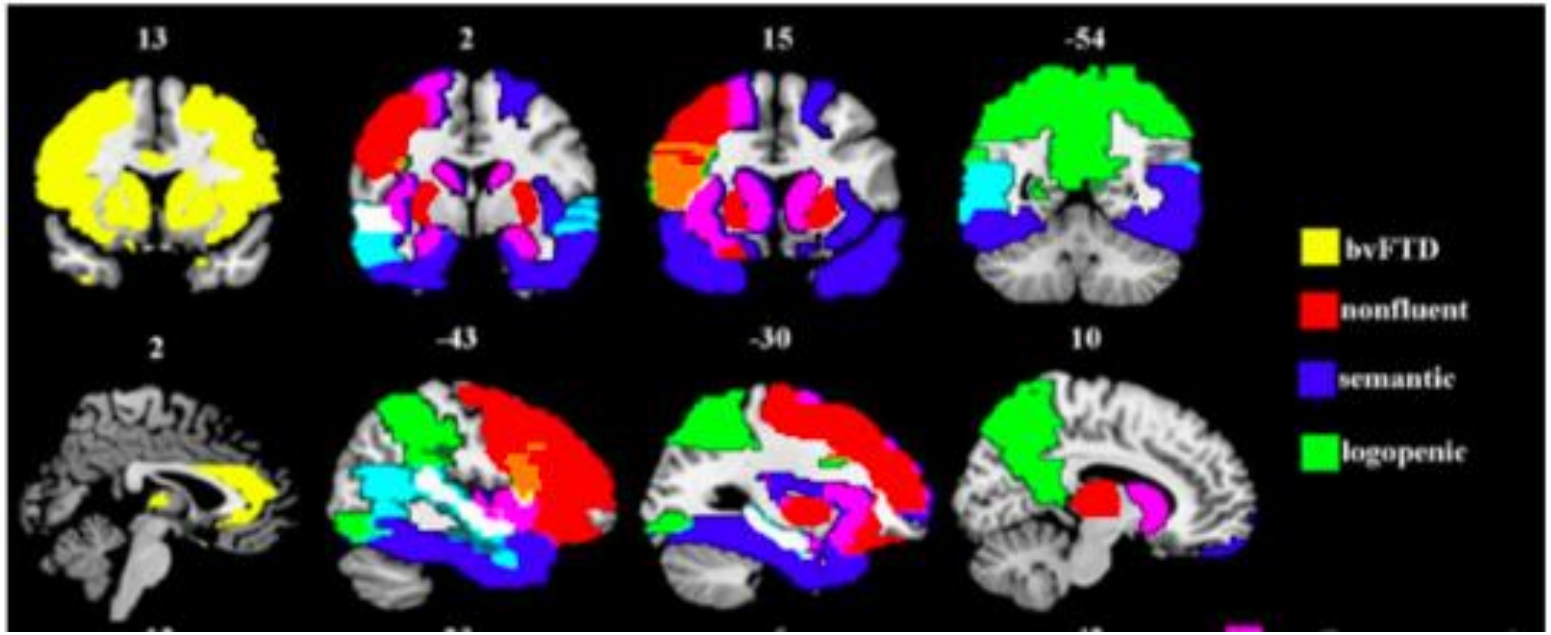


Gorno-Tempini et al. Classification of primary progressive aphasia and its variants; Neurology 2011

Gorno-Tempini et al. Cognition and Anatomy in Three Variants of Primary Progressive; Ann Neurol 2004

FTLD – Frontotemporal Lobar Degeneration (TDP-43)

- **bvFTD** behavioral variant Frontotemporal Dementia
- **SD** Semantic Dementia
- **PNFA** Progressive Non Fluent Aphasia

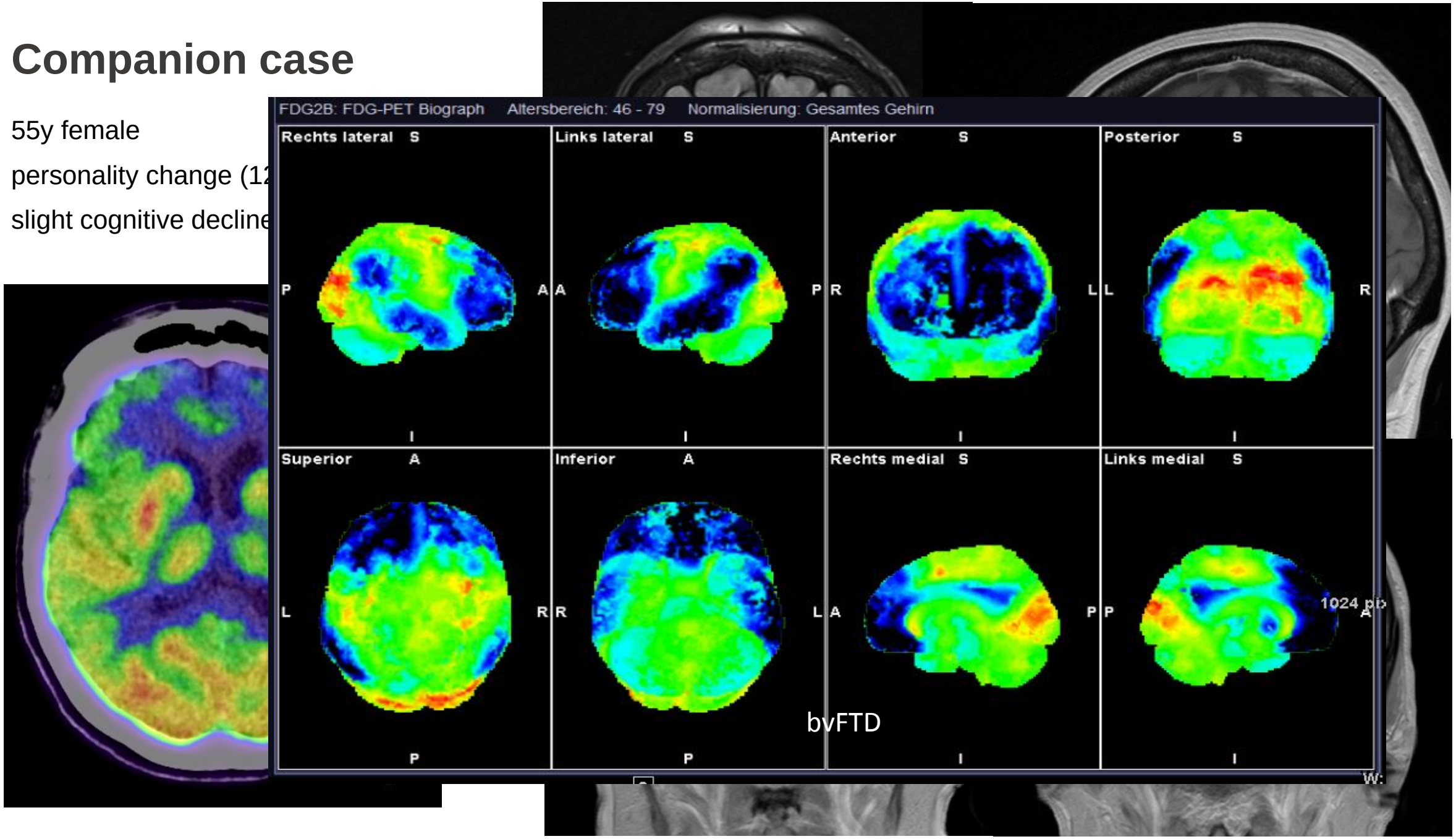


Companion case

55y female

personality change (12

slight cognitive decline



Swiss Federation of Clinical Neuro-Societies

Case-based session

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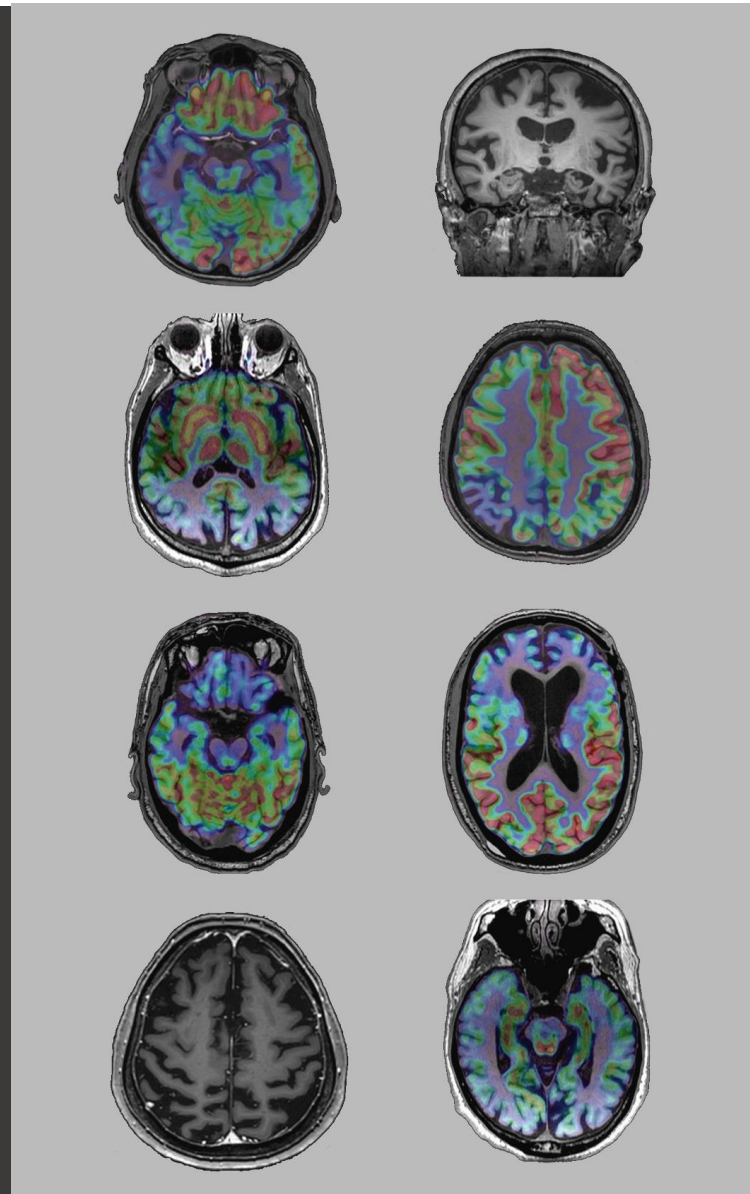
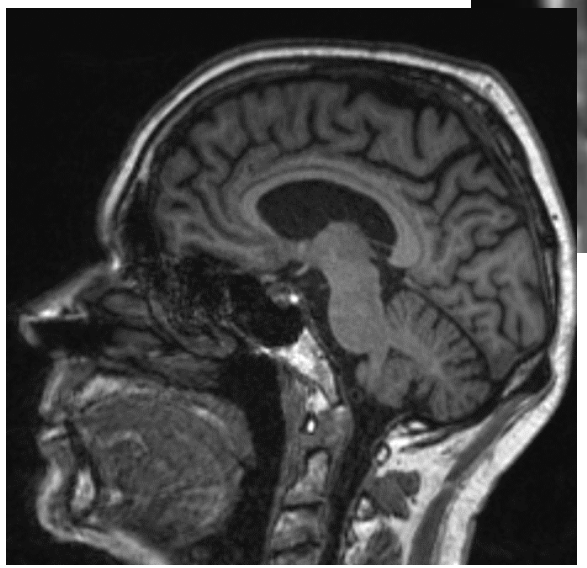
SFCNS Neuroimaging Course

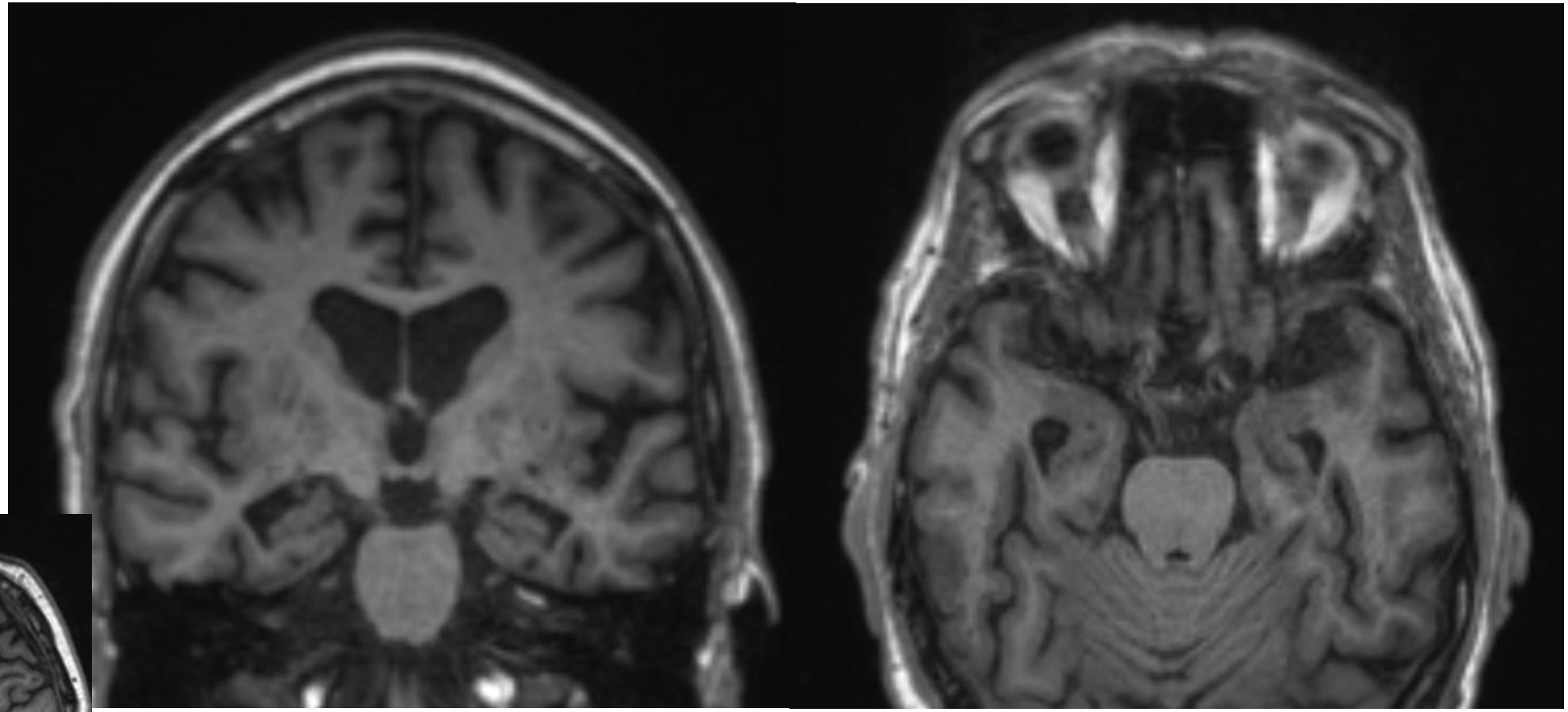
1st Module: Imaging Neurodegeneration



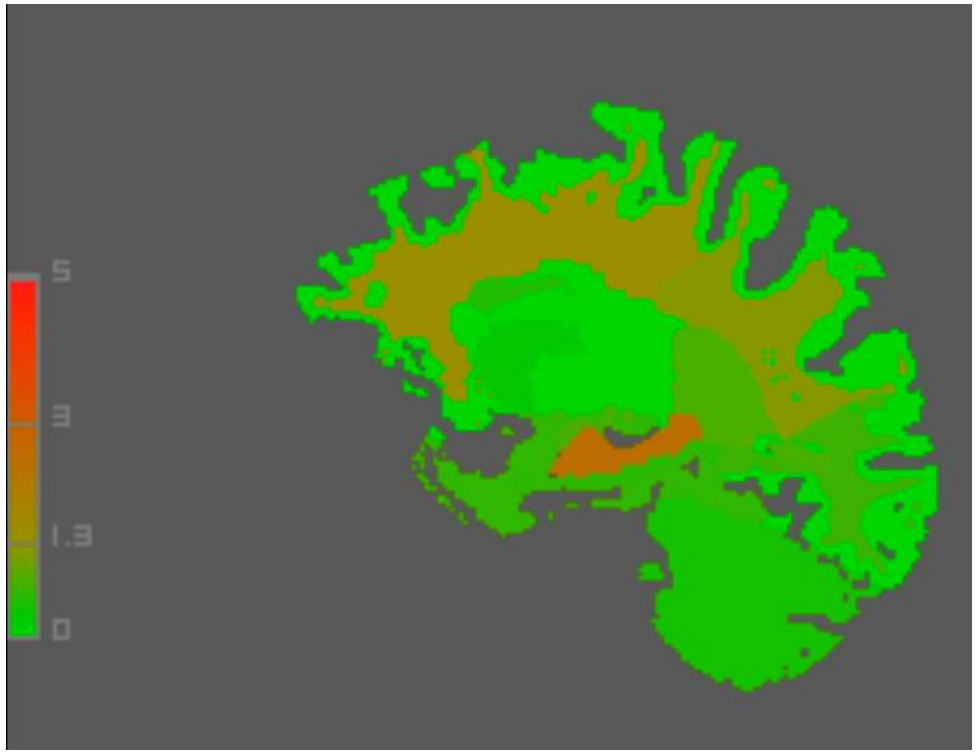
Case 9

- 75y female
- High educational level
- MMS 27/30





Case 9



Brain Morphometry Report - 1/6 SMRVB30A.36

Input Data	t1_mprage_morpho_sag		
Patient Demographics	75yrs	Male	
	Comments	Values	Acceptable Range
Image Quality	acceptable	0.75	[0.00 - 0.82]
Segmentation Quality	acceptable	0.75	[0.70 - 1.00]

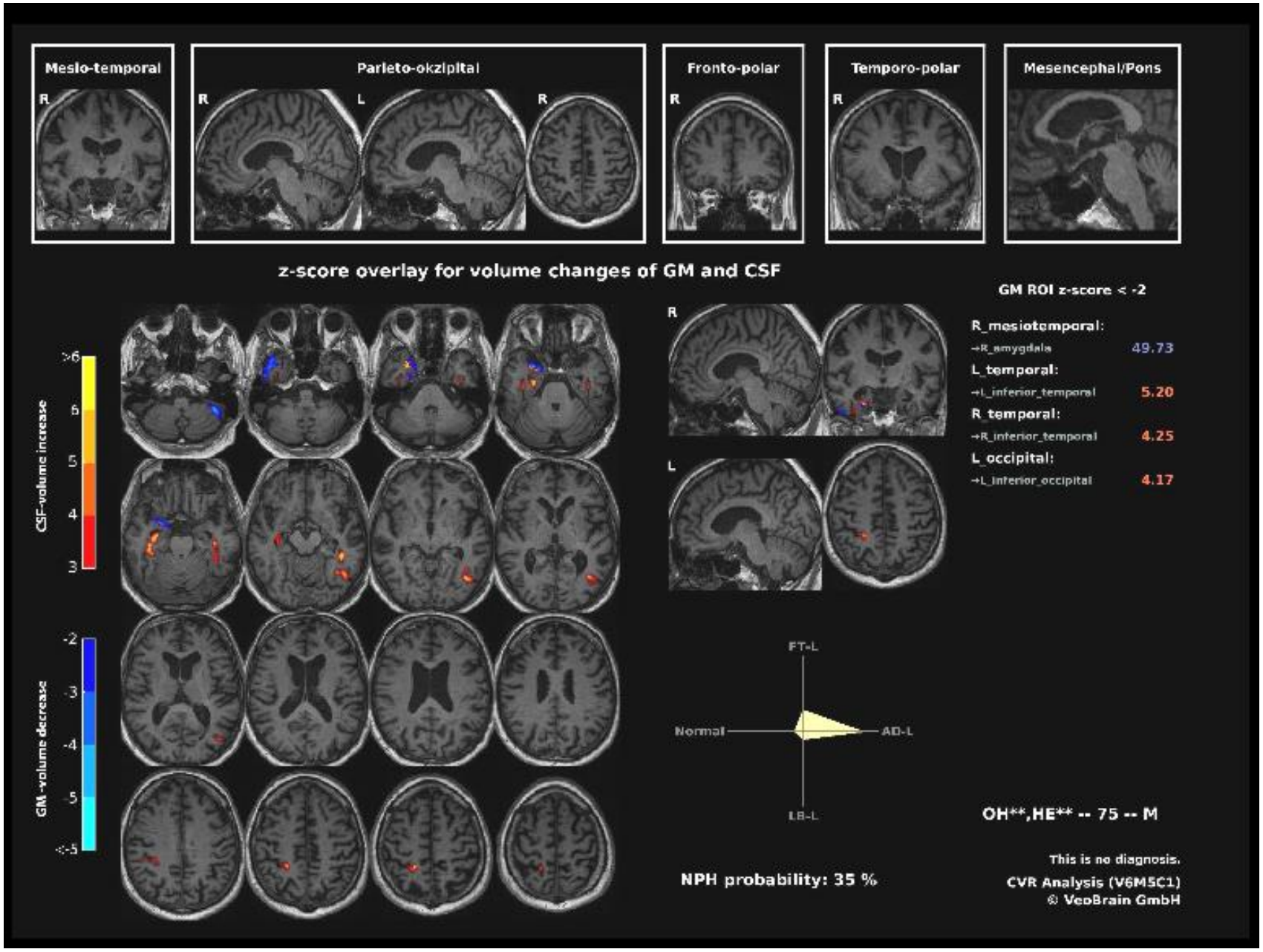
General Info
Input data not consistent with the morphometry protocol guideline. Please check validity of the volumetric results.

Tissue	Absolute[ml]	Normalized^[%]	Normative Range^^[%]
TIV	1380.7		
Brain	960.9	69.6	[66.5 - 74.2]
GM	594.3	43.0	[38.0 - 44.2]
Cortical GM	464.1	33.6	[28.7 - 33.9]
WM	366.6	26.6	[26.6 - 32.1]
WMAb	0.8	0.1	
CSF	419.8	30.4	[25.4 - 33.7]

Brain Morphometry Report - 3/6

Structure	Absolute[ml]	Normalized^[%]	Normative Range^^[%]
Hippocampus	5.0	* 0.36	[0.39 - 0.49]
Hippocampus left	2.7	0.20	[0.20 - 0.25]
Hippocampus right	2.3	* 0.17	[0.19 - 0.25]
Ventricles	58.6	4.24	[1.94 - 5.27]
Lateral ventricle left	28.6	2.07	[0.82 - 2.52]
Lateral ventricle right	25.9	1.87	[0.78 - 2.33]
3rd ventricle	2.5	0.18	[0.13 - 0.28]
4th ventricle	1.6	0.12	[0.13 - 0.26]

Case 9


Mesio-temporal
Parieto-okzipital
Fronto-polar
Temporo-polar
Mesencephal/Pons
R
L
z-score overlay for volume changes of GM and CSF
CSF-volume increase
>6
6
5
4
3
GM -volume decrease
-2
-3
-4
-5
<-5
GM ROI z-score < -2
R_mesiotemporal:
→R_amygdala 49.73
L_temporal:
→L_inferior_temporal 5.20
R_temporal:
→R_inferior_temporal 4.25
L_occipital:
→L_inferior_occipital 4.17
FT-L
Normal
AD-L
LB-L
NPH probability: 35 %
OH**,HE** -- 75 -- M
This is no diagnosis.
CVR Analysis (V6M5C1)
© VeoBrain GmbH

Question for Case 9 – Which impression would you choose for your MRI report?

A) Normal Brain MRI, no signs of neurodegeneration

B) Nonspecific brain atrophy, no tumor, probable neurodegeneration

C) Slight atrophy of medial temporal lobe structures

D) Brain atrophy with moderate atrophy of medial temporal lobe structures above age, suspicious of neurodegenerative process, pattern most likely AD

E) AD

Case 9 – Visual scores, morphometric results, pattern analysis

How we do it:

- 1. visual impression (based on scores and visual analysis of MRI)
- 2. morphometric/volumetric interpretation (normal, abnormal, minor abnormalities, gross abnormalities according to age)
- 3. Pattern: visual pattern, computer-based pattern analysis

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Case-based session

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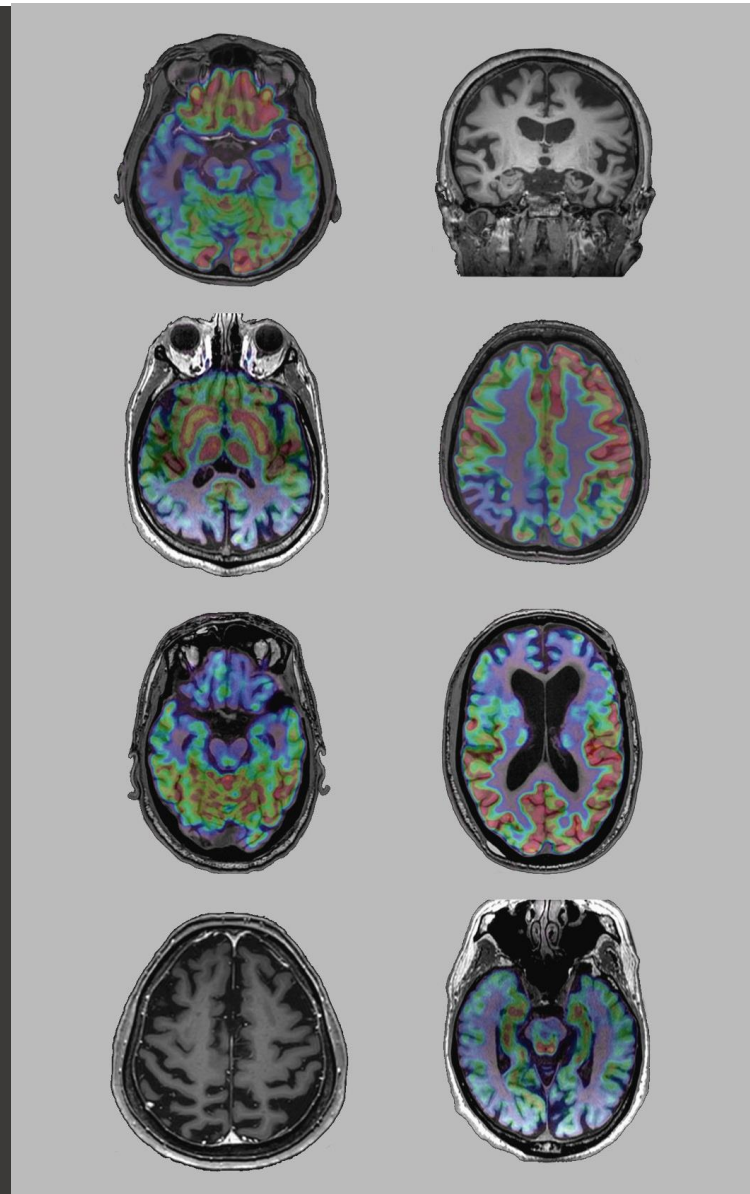
1st Module: Imaging Neurodegeneration

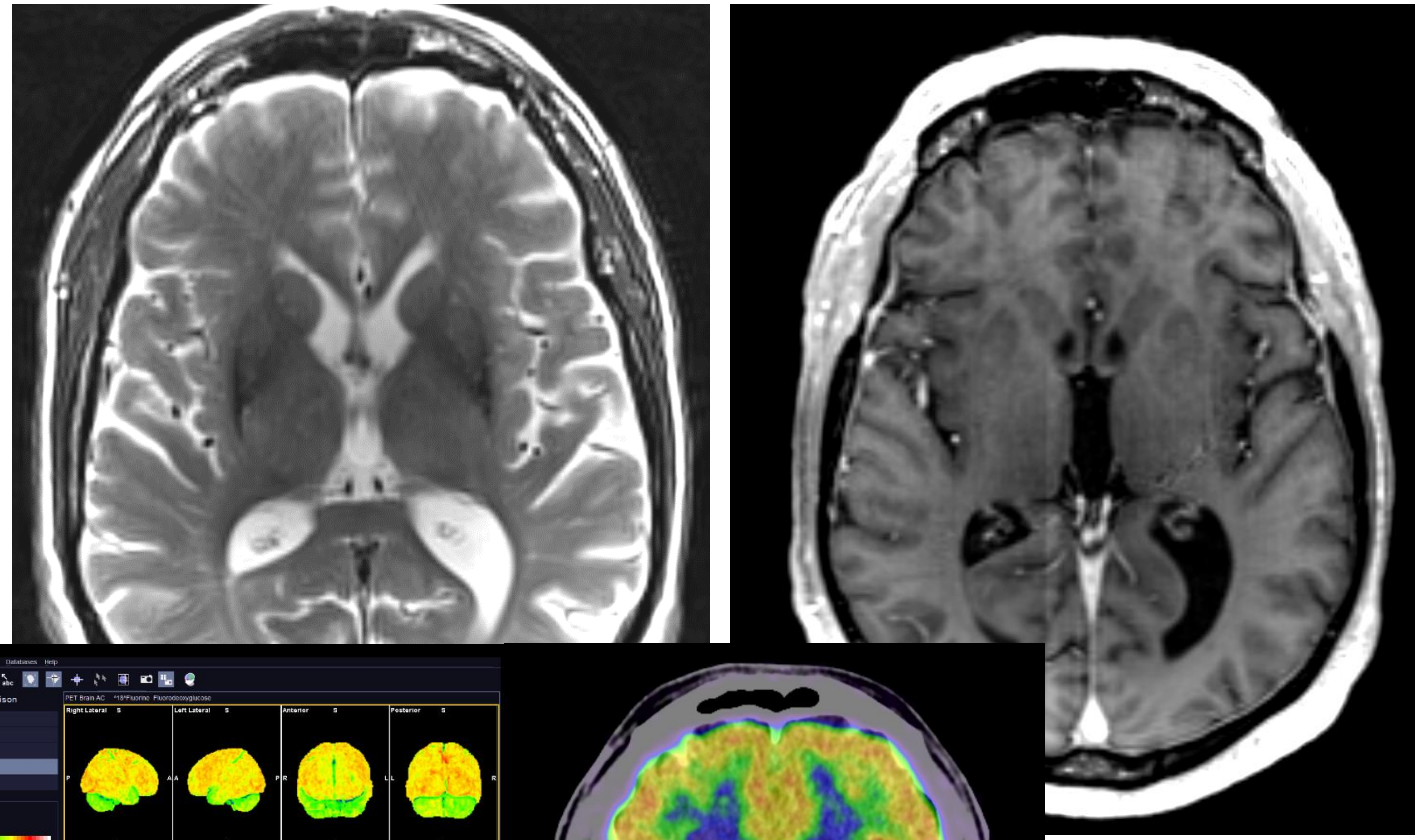


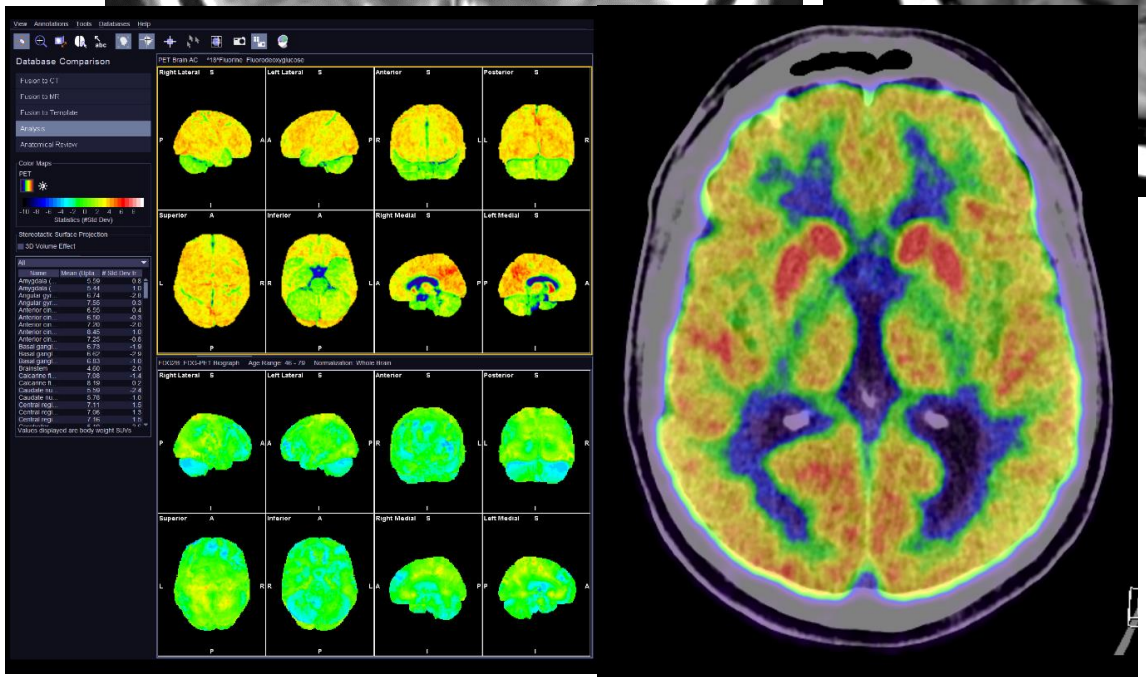
Case 10

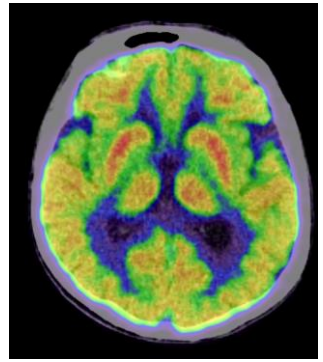
- 70y male
- hypokinetic, rigid parkinson syndrome
- Dopa-non responsive

→MSA-P

- **Low signal in putamen (T2*, T2)**
- **Putaminal rim (hyperintense line)**
- **Putaminal atrophy**





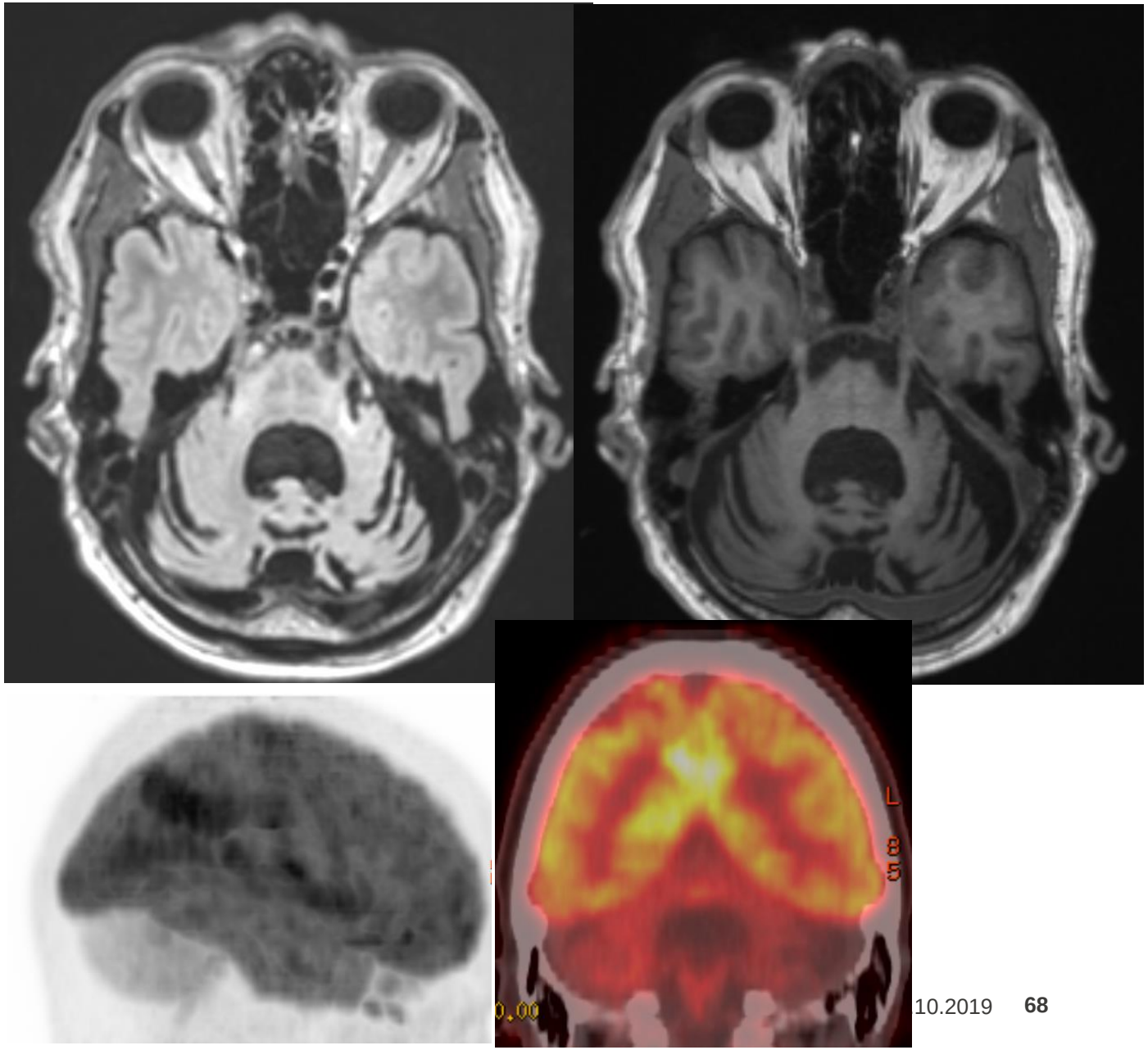


Case 11

- 51y male
- Progressive cerebellar syndrome

→MSA-C

- **hot cross bun sign (raphe pontis)**
- **Cerebellar atrophy incl cerebellar peduncle**
- **Cerebellar hypometabolism**



Case 10 + 11 - Atypical Parkinson Syndromes (APS)

= Clinically patients show Parkinsonian syndromes, but *no drug responsiveness* to Levodopa

- DLB: Dementia with Lewy Bodies
- MSA: Multisystem-Atrophy type „P“ (parkinsonian symptoms)
  Multisystem-Atrophy type „C“ (cerebellar symptoms)
- CBD: Corticobasal Degeneration
- PSP: Progressive Supranuclear Palsy

- APS are difficult but not impossible to detect on structural imaging
- Structural imaging (MRI) is primarily done to exclude ***secondary Parkinsonian syndromes*** (vascular changes/stroke basal ganglia; tumors; NPH)
- ***Atypical Parkinson Syndromes*** can be differentiated with ***FDG-PET-CT*** of the brain