brain MRI for neuropsychiatrists: what do you need to know

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MRI is challenging
- symptoms non specific
- MR findings are subtle and equivocal
- normal aging vs pathology
- go towards or away particular differential
- putting all together
MR images

- T2 images: water-white-two
- T2: pathology
- T1: anatomy
- White in T2 images: abnormal, but non-specific
- For neurodegenerative disease: FLAIR (dark CSF, white pathology of the brain)
  FLAIR: fluid attenuated inversion recovery
MRI of the brain

- T1, T2 (anatomy, pathology)
- dark CSF (FLAIR)
- DWI: ischemia, CJD
- T2 *, SWI: signs of hemorrhage
- non contrast MR Angiography
  (imaging of willis-aneurysms)
- contrast enhanced brain MRI
- i.v. contrast MR-Angiography
  (carotid and vertebral arteries)
non contrast MR angiography: MRA (Time Of Flight)

- no iv contrast
- non invasive technique
- flow measurement
- wall of artery?
- detection of aneurysm
diffusion imaging (DWI and ADC)

- functional information (diffusion restriction)
- cytotoxic edema (as opposed to vasogenic)
- infarction and demyelination
- CJD
T2* and SWI

- susceptibility of iron
- microbleeds
- standard imaging protocol
T2*  bleeding in cavernoma  SWI
MR safety

✓ implants
✓ pace-maker
✓ heart, ear devices etc
✓ renal insufficiency (NSF)
✓ gadolinium deposition in the brain
MRI of the brain: artifacts

- CSF pulsations
- vessel pulsations
- calcifications
- implants (i.e. metallic)
location, location, location...
brain MRI: location of lesions

intra-axial

extra-axial
what do I expect from MRI

✓ exclude lesion (congenital, tumor, etc)
✓ depict neurodegeneration (atrophy, white or gray matter changes etc)
✓ depict changes due to medication, abusus etc
✓ evaluate the location of depicted changes
✓ do the MRI findings correlate with the clinic? (correct interpretation of what is seen!)
interpretation of findings
LET'S MAKE BETTER MISTAKES TOMORROW
systemic approach

- corpus callosum (sagittal T1)
- midbrain shape & size (midbrain to pons ratio)
- medial surfaces (frontal, parietal, occipital lobe)
- hippocampal volume (swelling vs volume loss)
- CSF spaces, sylvian fissure, ventricular size
- general sulcal and gyral size (regional atrophy)
- appearance of WM, basal ganglia, midbrain...
- MR imaging findings and clinical diagnosis
volume + or -?

- atrophy vs swelling (what is normal?)
- +: limbic encephalitis (typically bilateral, but asymmetric)
- -: mesial temporal sclerosis (atrophy and hyperintense signal)
herpes encephalitis
<table>
<thead>
<tr>
<th>Grade 0</th>
<th>no cortical atrophy</th>
<th>closed sulci of parietal lobes and cuneus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>mild parietal cortical atrophy</td>
<td>mild widening of posterior cingulate and parieto-occipital sulci</td>
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<tr>
<td>Grade 2</td>
<td>substantial parietal atrophy</td>
<td>substantial widening of the sulci</td>
</tr>
<tr>
<td>Grade 3</td>
<td>end-stage ‘knife-blade’ atrophy</td>
<td>extreme widening of the posterior cingulate and parieto-occipital sulci</td>
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</table>
Alzheimer dementia

✓ parietal and temporal cortical atrophy
✓ disproportionate hippocampal volume loss and entorhinal cortex
✓ exclude other causes of dementia
Scheltens-Skala: medial temporal lobe atrophy score

- Width of the choroid fissure
- Width of the temporal horn of the lateral ventricle
- Height of the hippocampus
voxel-based volumetry of hippocampus

Hippocampus

Koronare Schichten des Hippokampus

Rechts Links

Ausschnitt [1] Normal 76 Jahre

Graue Substanz im Hippokampus
Gesamtvolumen: 3.8 ± 0.3 ml

Weisse Linie: Rand der Hippokampus-Maske

Farbig markierte Bereiche:
Graue Substanz reduziert (alterskorrigiert):
\( p < 0.05 \)

multi-infarct dementia (vascular dementia)

- multifocal infarcts: cortical gray matter, white matter, basal ganglia, pons
- DWI (increased)
- MRA: stenoses
FLAIR imaging in vascular dementia
Fazekas scale 0-3
(deep white matter lesions)

- Grade 1: punctate foci
- Grade 2: beginning confluence
- Grade 3: large confluent areas

FLAIR imaging
DD infarcts-leukoencephalopathy

✓ CADASIL:
  (cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy)

subcortical lacunar infarcts
leukoencephalopathy microbleeds
DD infarcts-leukoencephalopathy

- cerebral amyloid disease: microbleeds: black dots in T2* or SWI hemorrhages of different ages
- subcortical: gray-white junction
Lewy body disease

- normal brain imaging (incl. Hippocampus)
- DD from Alzheimer disease
- DaTscan: abnormal dopaminergic system
frontotemporal lobar degeneration (FTLD)

- anterior fronto-temporal atrophy
- T2-FLAIR hyperintensity in fronto-temporal WM
- in this group: former Pick disease, semantic dementia, primary progressive aphasia, logopaenic variant etc.
Creutzfeld-Jakob disease

- DWI: restricted diffusion (considered as most sensitive sign)
- T2 hyperintensity: basal ganglia, thalamus, cortex, WM
progressive supranuclear pulsy (PSP)

- midbrain to pons ratio: reduced (no=0.24) DD from MSA-P
- humming bird sign: flattening or concave outline of superior midbrain
MRI signs of PSP

- Normal: (convex)
- PSP: (concave)

Midbrain to pons ratio: reduced (no=0.24)
multiple system atrophy (MSA)

✓ C- vs P- (cerebellar vs Parkinsonian symptoms)
✓ hot cross bun sign (hyperintense appearance of pons)
✓ no humming bird (convex upper border of midbrain)
Parkinson disease

- neuronal loss of substantia nigra
- absent swallow tail sign
- loss of „black“ substantia nigra
neuromelanin sensitive MRI

<table>
<thead>
<tr>
<th>Parkinson's disease</th>
<th>Control</th>
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</table>
atrophy midbrain-pons

- Parkinson
- PSP
- MSA

- normal
- midbrain atrophy pons preserved
- atrophy of the pons
corticobasal degeneration

- asymmetric cortical atrophy
  (superior parietal lobule: most constant feature)
- postcentral gyri
- corus callosum
neurodegenerative-like signs

✓ meningioma (anterior cranial fossa)
✓ chronic subdural hematomas
✓ normal pressure hydrocephalus
hydrocephalus (normal pressure, NPH)

✓ ventriculomegaly
✓ sulcal size changes
✓ CSF flow studies
CSF space: tight convexity (NPH) vs widened CSF spaces (atrophy)

Callosal angle: less than 90° in NPH, greater than 90° in atrophy

Periventricular changes: diapedesis vs vascular encephalopathy
Huntington disease

✓ atrophy of caudate nucleus
✓ enlargement of frontal horns of lateral ventricles
chronic subdural hematomas (look at FLAIR imaging)
meningioma

- usually isointense to gray matter
- CSF cleft sign (intra vs extra axial lesion)
- dural Tai sign
- spokewheel appearance of vessels
MRI: made easy

- exclude structural lesions (WM disease and swelling, FLAIR)
- AD signs (hippocampus)
- differential atrophy patterns (FTD, PSP, MSA)
- vascular dementia (and amyloidosis): DWI, SWI
- other (hydrocephalus, Tu, hematomas etc)
- talk with your radiologist...
  (alone is hard, together is better)
Not every presentation is successful!
### MR findings in Dementia

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<th>AD</th>
<th>VaD</th>
<th>FTLD</th>
<th>Lewi*</th>
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<tbody>
<tr>
<td><strong>Hippocampal atrophy</strong></td>
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<td><strong>Temporal atrophy</strong></td>
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<tr>
<td><strong>Frontal atrophy</strong></td>
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<td><strong>Parietal atrophy</strong></td>
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<td><strong>Lacunes</strong></td>
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<td><strong>WML’s</strong></td>
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<td><strong>Strategic infarcts</strong></td>
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