Dementia from a radiological perspective

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31st July 2016, Istanbul
• What do we have in imaging toolbox
• Radiological examination of patients with
  • Dementia
  • Our future expectations
AGING

Healthy-successful

NO abnormal neuroimaging (NI) finding

Usual aging

Abnormal NI findings for the AGE

Pathological aging

Increased abnormal NI findings; degenerative
Neurodegenerative Diseases: impact and load on

<table>
<thead>
<tr>
<th>Physical</th>
<th>Social</th>
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<td>Emotional</td>
<td>Financial</td>
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And also *(demotivating)* on radiologist!
Neurodegeneration: progressive

Progressive loss of structure and/or function of neurons in the brain

**COGNITION**
- AD
- LBD
- FTD
- CBD

**COORDINATION**
- SCA
- Freidreich
- Prion

**MOVEMENT**
- PD
- MSA
- PSP
- HD

**STRENGTH**
- ALS
Deregulated Gene and Protein Networks

Inter-Cellular Misfolded Proteins Propagation Across Structural Pathways (prion-like spread)

Neuronal Activity-Dependent Neurodegeneration (inflammation and death)

Gender-related differences AD in women, PD in men

Altogether in act
Network Degeneration Hypothesis

Network-based Diseases

Seeley w. Neuron, 2009. ND diseases target large-scale human brain networks

- Different NDD are associated with spatially distinct atrophy patterns corresponding to structural connectivity and functional network.
Imaging Toolbox in NDD

Conventional CT/MRI

T1W

FLAIR/T2W

T2*/SWI
DWI/DTI

MRS
Functional...BOLD

Molecular
Clinical imaging people with dementia

- To document treatable diseases
  - Hydrocephalus
  - Subdural hematoma
  - Tumor

- To document ‘suggestive’ findings
  - Atrophy pattern
    - Medial temporal lobe atrophy
    - Parietal atrophy
    - Focal frontal-temporal atrophy
  - Brainstem-basal ganglia-cerebellum findings
  - Presence of chronic microbleeds
SUBDURAL HEMATOMA
GLIAL TUMOR
CEREBROVASCULAR DISEASE AND DEMENTIA
AMYLOID ANGIOPATHY
1971, M, AVR-MVR+
NORMAL PRESSURE HYDROCEPHALUS

WWW: Wet Wacky Wobbly

- Gait disturbance
- Dementia
- Urinary incontinence
NPH

- Ventricular dilatation-out of proportionate
- Asymmetric dilatation of sulci
- White matter lesions
PRION DISEASE

Myoclonus, rapid cognitive decline
HIV ENCEPHALOPATHY
ATROPHY
ALZHEIMER DISEASE

- Most common neurodegenerative disease
- Cortical intracellular neurofibrillary tangles
- Extracellular-amyloid (Aβ) plaques
- PET confirmed Aβ accumulation and decreased CSF Aβ

Cohen AD, Klunk WE. Early detection of AD using PiB and FDG PET. 2014, Neurobiology of Disease
ALZHEIMER DISEASE
AD: IMAGING FINDINGS

- Diffuse cortical atrophy
- Prominent in the temporal lobe
- Ventricle, sulcal, total CSF, Sylvian fissure enlargement
- Temporal horns >3 mm %65 +
- Hippocampal-koroid fissure enlargement
- Increased inter-uncal distance
ADVANCED IMAGING

- **MRS**
  
  MI increase (senile plaque accumulation)
  
  NAA loss and volume loss correlated
  
  NAA    AD<MCI<N

- **DWI**
  
  ADC increase
  
  ADC    AD>MCI>N

- **PWI/PET**
  
  Bilateral temporal, parietal
AD: Classical

- Entorhinal..hippocampus.....mesial temp lobe atrophy
- Parietal precuneus atrophy
45 y, F
AD: Temporoparietal
Compared to HC
AD: Posterior variant-Posterior cortical atrophy

Benson’s Syndrome/Visual variant

AD
LBD and CJD
A rare form

- High order visual disturbances
- Apraxia, agnosia and visual hallucinations
AD

- Increased CSF total-tau (t-tau) and phosphorylated-tau181 (p-tau$_{181}$) …NEURONAL DAMAGE

- Resting state network alterations, esp. DMN occur in prodromal AD.

- DMN and executive networks chg
- FMRI chg correspond to neurodegeneration pattern
AD: Resting state fMRI/ DMN

DMN connectivity map derived from PCC shows decreased functional connectivity.
AD: Bioimaging markers?

- CSF: $A\beta_{1-42}$, t-tau and $p$-tau$_{181}$, CSF $\alpha$-synuclein

- Cognitive test results were not correlative to AD related CSF chg

- AD: Decreased CSF $A\beta_{1-42}$, and increased t-tau,$p$-tau$_{181}$, CSF $\alpha$-synuclein

- Connectivity of PCC and other DMN nodes correlated w CSF $A\beta_{1-42}$ in CSF

- Decreased PCC FC correlated well w decreased cognitive scores.

- PCC FC alterations related w disease severity.

Default mode network connectivity is linked to cognitive functioning and CSF $A\beta_{1-42}$ level in Alzheimer’s disease
FRONTOTEMPORAL DEMENTIA
L>R temporal; semantic FTD
Corticobasal Degeneration
Future expectations from imaging

- Identify individuals at risk, preventive medicine
- Identify at prodromal phase, immediate treatment
- Slow down disease progression
- Monitor treatment by imaging
- Risk stratification in patients w dementia before surgery
- Identify personal variabilities in diseases and personal treatment
Special thanks

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