Neuroimaging in Type 2 Diabetes Melitus

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Goals of this presentation

- To outline the use of neuroimaging in Type 2 Diabetes Melitus (T2DM).
- To summarize the results of the most recent studies in this area of interest.
Neuroimaging in T2DM

Recent studies have utilized:

a) structural and functional neuroimaging to explore the brain pathology associated with T2D.

β) have shed light in our understanding of the mechanisms of the brain abnormalities in T2D.
Type 2 Diabetes Mellitus

- Cognitive Deficits
- Brain Structural Changes
  - Cortical & subcortical atrophy
  - Cerebrovascular disease
Types of Imaging
Brain Structural changes

Volume
Structural MRI
Volumetric Differences
Whole brain -Regional
grey/white matter volume

Function
Functional MRI

Connections
Diffusion Tensor Imaging (DTI)
Microstructural changes in the white matter
Structural Brain Changes

- T2D is associated with brain atrophy.
- Brain atrophy rate in patients with T2D is 1-3 times the atrophy rate of normal aging.
- **Blue line**: evolution of brain volumes with age in general population.
- **Red line**: evolution of brain volumes with age in T2D.
- Brain MRI abnormalities are likely to start in pre-diabetic stages (**dotted red line**).

Biessels & Reijmer (2014). Brain changes underlying cognitive dysfunctions in Diabetes: What Can We Learn from MRI? *Diabetes*
Volumetric Differences

The study included a sample of 113 patients with T2D and 51 control subjects.

Brain MRI scans were rated for white matter lesions, cortical and subcortical atrophy, and infarcts.

The results revealed that cognitive impairments in patients with T2D are associated with subcortical ischemic changes in the brain as well as with increased brain atrophy.

The T2D group:

a) had worse cognitive function. This was related with white matter lesions, brain atrophy and the presence of infarcts.

b) had higher number of white matter lesions.

Manschot et al.(2006). Brain Magnetic Resonance Imaging Correlates of Impaired Cognition in Patients With Type 2 Diabetes. *DIABETES*
Volumetric Differences

Meta-analysis included 23 T2D studies \( (n=1364 \text{ patients}) \).

**Aim:** to explore the regional abnormalities in the brain.

Global and regional reductions in brain volume.

- *reduced total brain volume.*
- *reduced grey matter volume.*

Regional reductions were more pronounced in:

- *hippocampus.*
- *basal ganglia.*

*Moulton et al.(2015)*. Meta-analyses of structural regional cerebral effects in type 1 and type 2 diabetes. *Brain Imaging and Behavior*
Brain Pathology

In a sample of 462 persons with T2D.

The aim of the study was to explored how the brain pathology associated with cognitive functions.

T2D was associated with:

a) cortical and subcortical infarcts.

b) higher white matter lesion volume.

c) lower volumes of gray matter.

- Poor cognitive performance was associated with markers of cerebral macrovascular and microvascular pathology and degenerative diseases.

Cognitive functioning and brain volume were assessed twice in 68 patients with no dementia with D2T over a 4-years period.

- Cognitive decline was found in 17 (25%) patients.
- It was associated with a greater increase in ventricular volume and white-matter hyperintensities volume.
- Progressive changes of vascular damage and global brain atrophy were present on MRI.

Brain Atrophy in T2D

Examined regional atrophy in T2D.

Measurements taken for:

a) cerebrovascular lesions (*infarcts, microbleeds, and white matter hyperintensity volume*)

b) brain atrophy (*gray matter, white matter, and hippocampal volumes*)

- Atrophy was present in *gray matter* in temporal, frontal and to a lesser extent with frontal and temporal *white matter* atrophy

- Cortical atrophy in T2D show similar patterns seen in preclinical Alzheimer disease.

Functional Connectivity in T2D

Patients with T2DM presented:

- Reduced functional connectivity between the hippocampus and other brain regions.

- Reduction in connectivity was accompanied by impaired cognitive performance in patients with T2DM in the episodic memory and executive function domains.

Cortical Thickness in T2DM

Compared regional cortical atrophy between 56 patients with T2DM and 30 controls, both globally and regionally.

The results revealed significant differences on:

a) cortical thickness and volume in the hippocampal region.

b) cortical surface and volume in in the middle temporal gyrus.

The effects of T2DM were most pronounced on cortical grey matter in the temporal lobe.

Structural Abnormalities in T2D

Structural brain abnormalities in T2D:

(A) Cerebral atrophy.
(B) White matter lesions.
(C) Lacunar infarct (arrow) in the thalamus.
(D) Microbleed (arrow).

(Koekkoek, Rutten, & De Biessels, 2014. Cognition and Diabetes)
**T2DM and Dementia**

- Brain abnormalities in T2D may increase the risk for a dementia.
- T2D metabolic and vascular abnormalities can contribute to the process of dementia.
- T2D and preclinical Alzheimer disease present the same patterns of cortical atrophy (Moran et al, 2013)
- Cerebral atrophy in hippocampus has been found to be present even in younger patients with T2D.

(Koekkoek, Rutten,& De Biessels,2014)
Conclusion

T2DM is associated:

- Total brain atrophy.
- Regional brain atrophy.
- Macrovascular and microvascular pathology.
- Brain pathology is associated with poor cognitive performance.

- Brain abnormalities can begin to occur early in the pre-diabetic stage.
Thank you for your attention!!!!