Increased cerebral oxygen extraction capacity in patients with Alzheimer’s disease

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Background

• Vascular risk factors are suspected to play a role in the etiology of Alzheimer’s disease.
• Recently, a model that relates capillary dysfunction to the development of AD was proposed [1]. The model predicts that increased capillary dysfunction leads to increased oxygen extraction in order to support the metabolic requirements of the brain tissues.
• In this study we investigated the brain oxygen extraction capacity (OEFmax) in AD patients and controls using dynamic susceptibility contrast (DSC) magnetic resonance imaging (MRI).

Methods

• Subjects:
  • 18 (13 females) patients with clinically suspected possible or probable AD verified by ICD-10, DSM-IV, and NINCDS-ADRDA (MMSE: 24.5±2.7, age: 72.9±5.1)
  • 19 (8 females) cognitively normal (MMSE ≥ 28) age-matched (age: 67.1±6.4) healthy controls
• Imaging:
  • 1.5T GE Signa LX scanner, gradient echo EPI with i.v.-bolus injection (5 ml/sec) of 0.1 mmol/kg gadobutrol (Gadovist® M, Schering). 16 axial slices imaged at a spatial resolution of 1.9x1.9x0.5mm
  • 3D T1-weighted (T1w) with a spatial resolution of 0.9x0.9x1.5mm and a reconstruction matrix of 256x256x116.
• Modeling:
  • OEFmax maps, modeled under the assumption of a fixed tissue oxygen tension, were calculated from the perfusion images using a parametric deconvolution method [2-3].
• Parcellation:
  • T1w images were segmented into main lobes, basal ganglia and thalamus using an atlas-based method [5]. The subject-specific atlas was used to calculate regional median OEFmax values.
• Brain atrophy was estimated by cortical thickness [4] and hippocampal volume [5] automatically calculated from the T1w images. Differences between AD patients and controls were determined using a general linear model with age and gender as confounding factors.

Conclusion

• Increased OEFmax was detected in the temporal, parietal and frontal lobes of AD patients compared to controls. These findings are consistent with the capillary dysfunction hypothesis of AD [1]. The widespread cortical atrophy and smaller hippocampal volumes in the AD patients suggest pathologies of late Braak stages. Further studies should address the causal relation between elevated OEFmax and atrophy.

References

5. Eskildsen and Østergaard, MICCAI 2006.