Artificial intelligence for early detection of Alzheimer's disease on structural MRI

Goals

Within the Alzheimer's disease (AD) spectrum, the preliminary stage of mild cognitive impairment (MCI) often precedes the onset of AD dementia. Prompt identification of MCI patients at heightened risk of progression is critical for clinical intervention. AD typically evolves from a preclinical phase marked by biomarker deviations, through MCI, culminating in overt AD dementia. Notably, an estimated 10–15% of MCI-diagnosed patients annually advance to AD dementia. Uncovering factors that propel MCI towards AD is imperative for accurate clinical forecasting and guiding the selection of appropriate interventions. We propose leveraging AI-enhanced brain volumetry to discern brain regions instrumental in distinguishing between MCI likely to develop into AD (MCI-AD) and MCI that will not (MCI-nonAD), potentially assisting AD phenotype classification.

Materials and methods

A total of 193 patients who sought consultation for MCI were included in the study. As part of their clinical assessment, these patients received brain MRIs, cerebrospinal fluid (CSF) and serum biomarkers analyses, and PIB PET-CT scans. Additionally, a cohort consisting of 12 AD patients and 14 healthy controls, matched by age and gender, was also incorporated into the study. All brain MRIs were processed using automated AI software designed to estimate absolute and relative brain volumes and brain percentiles in comparison to a healthy population. MCI patients were categorized as having an AD phenotype if at least one biomarker tested positive for AD. The brain regions characteristic of AD were compared across groups using multivariate regression.

Results

Significant differences were identified in two specific regions. MCI-AD patients exhibited notably lower temporal cortex volumes compared to MCI-nonAD patients, with

percentiles of 15 versus 22, respectively, and the difference was statistically significant (P=0.03). Inversely, the ventral diencephalon volume was substantially lower in MCI-nonAD patients than in MCI-AD patients, with percentiles of 27 versus 48, respectively, and this difference was highly significant (P=0.003, see Figures 1-2). Although hippocampal volume was significantly reduced across all groups in comparison to healthy controls, with percentages of intracranial volume (ICV) at 0.58% versus 0.48% (P=0.008), no significant volume differences were observed between the MCI groups. These findings emphasize the ventral diencephalon and temporal cortex as critical regions for differentiating between MCI-AD and MCI-nonAD.

Conclusions

Identifying MCI patients who are progressing to AD facilitates earlier intervention, potentially enhancing management. Utilizing AI-assisted volumetry can aid radiologists in distinguishing MCI-AD from other causes of MCI. To confirm the clinical relevance of these findings across broader populations and to determine appropriate thresholds, larger trials are necessary.

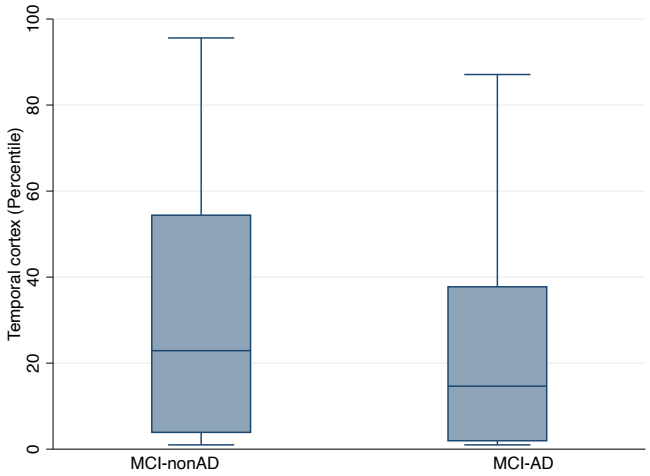

Figure 1. Temporal cortex percentile in MCI patients

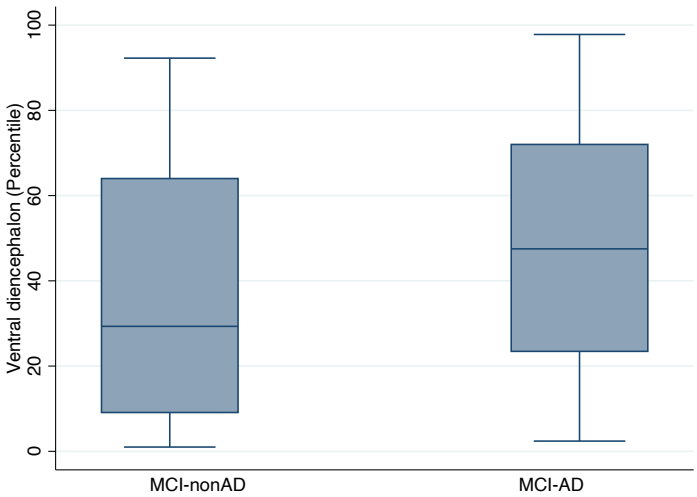

Figure 2. Ventral diencephalon percentile in MCI patients