RSNA Press Release

Choroid Plexus Volume Linked to Alzheimer's Disease

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At A Glance

- Higher volume of an important structure in the brain—the choroid plexus—is linked to Alzheimer's disease.
- Researchers performed brain MRI on 532 participants at various stages of cognitive impairment.
- Choroid plexus measurement on MR can potentially help identify more vulnerable patients who need earlier treatment.

OAK BROOK, Ill. — Increased volume of an important structure in the brain called the choroid plexus is linked to greater cognitive impairment and Alzheimer's disease, according to a new study published in the journal *Radiology*.

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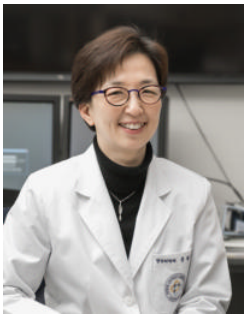

Won-Jin Moon, M.D., Ph.D.

The choroid plexus is a network of blood vessels, connective tissue and cells found in spaces of the brain called ventricles. The plexus plays an important role in brain health. It is a gateway for immune cells from the blood to the brain. As the primary site for the production of cerebrospinal fluid, it is crucial to clearing waste products and toxic proteins from brain cells. This role is particularly important in the case of Alzheimer's disease. Recent research suggests that disease progression is related to the accumulation of abnormal proteins called amyloid and tau and subsequent degeneration of the nerves.

"Researchers believe impaired clearance rather than overproduction of abnormal amyloid and tau is responsible for Alzheimer's disease," said study senior author Won-Jin Moon, M.D., Ph.D., professor of radiology and chairperson of the Department of Radiology at the Konkuk University School of Medicine in Seoul, Korea. "Thus, we assume that the abnormal status of choroid plexus is linked to the failure of clearance leading to waste and toxic protein accumulation in the brain and failure of immune surveillance leading to neuroinflammation."

Little is known about the choroid plexus' imaging profile in cognitive impairment.

To learn more, Dr. Moon and colleagues performed brain MRI on 532 participants at various stages of cognitive impairment. Of the 532 participants, 132 underwent permeability imaging using dynamic contrast-enhanced MRI.

Choroid plexus volume and permeability were associated with the severity of cognitive impairment on brain MRI. Choroid plexus volume was greater in those with Alzheimer's dementia than in those without. Higher choroid plexus volume was negatively associated with memory. It also had negative effects on executive function, a wide-ranging set of mental skills governing things like self-control and planning.

"Our study found that the enlarged choroid plexus volume is independently associated with increased cognitive impairment," Dr. Moon said. "We found no relationship between choroid plexus volume and amyloid pathology but a clear relationship between the choroid plexus volume and cognitive impairment severity."

The study results point to new possibilities for MRI's role in the diagnosis of Alzheimer's disease.

"I think our findings on the choroid plexus can suggest it as a new potential MR imaging surrogate for an impaired clearance system and neuroinflammation," Dr. Moon said.

Other potential clinical applications include helping researchers develop new target drugs or treatments for clearance failure and neuroinflammation. Eventually, choroid plexus measurements could help speed treatment to those who need it most.

"If we combine choroid plexus volume and hippocampal volume in a screening stage, it may help us better discriminate the more vulnerable patients from the less vulnerable ones," Dr. Moon said.

The researchers plan to follow up with a longitudinal study. They will explore changes in choroid plexus volume over time as the disease progresses.

"Choroid Plexus Volume and Permeability at Brain MRI within the Alzheimer Disease Clinical Spectrum." Collaborating with Dr. Moon were Jong Duck Choi, M.D., Yeonsil Moon, M.D., Ph.D., Hee Jin Kim, M.D., Ph.D., Younghee Yim, M.D., and Subin Lee, Ph.D.

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For patient-friendly information on brain MRI, visit *RadiologyInfo.org*.

Images (JPG, TIF):

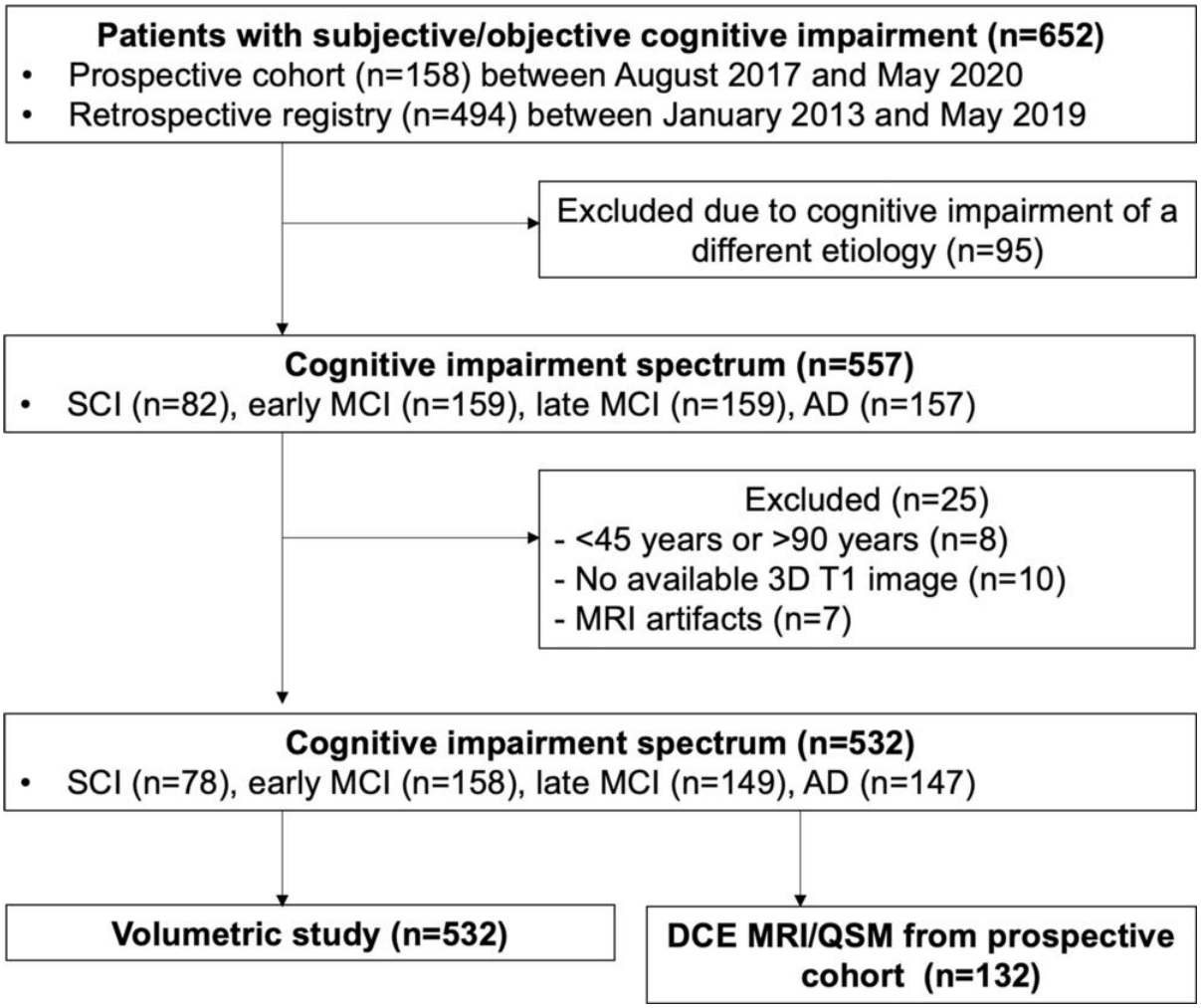

Figure 1. Flowchart of patient selection. AD = Alzheimer disease, DCE = dynamic contrast-enhanced, MCI = mild cognitive impairment, QSM = quantitative susceptibility mapping, SCI = subjective cognitive impairment, 3D = three-dimensional.
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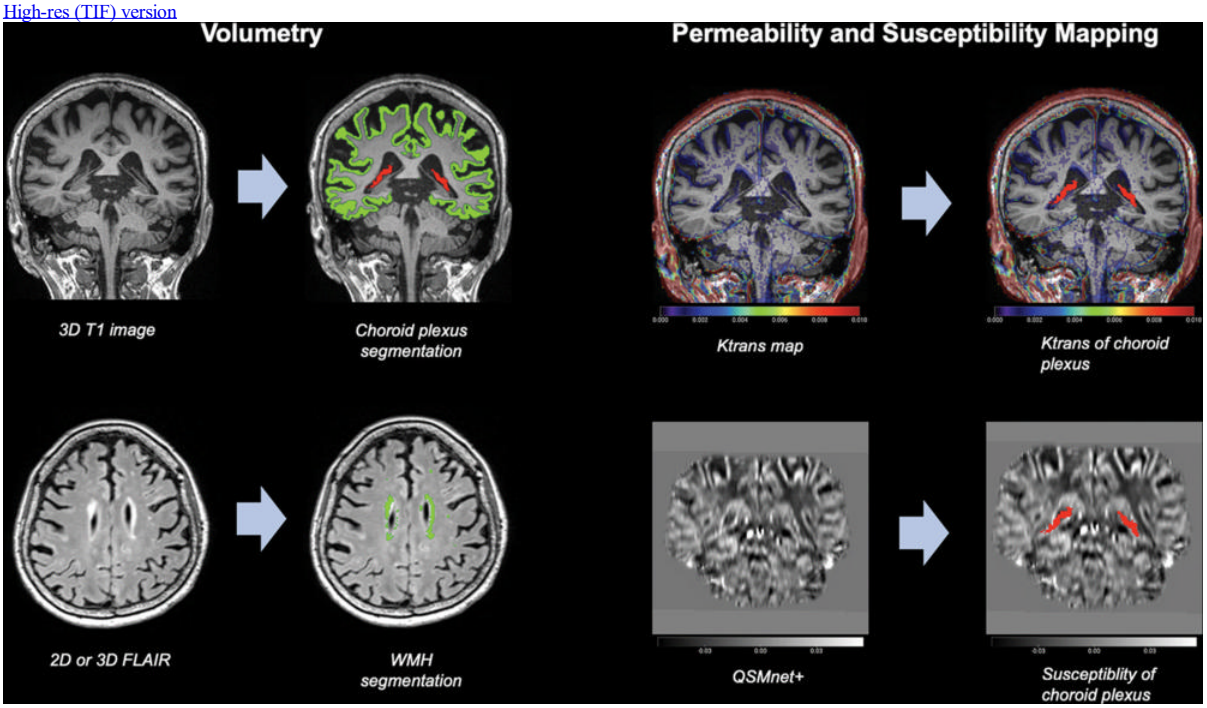

Figure 2. MRI processing steps. For volumetry (left), choroid plexus (CP) volume (red) and cerebral cortex volume (green) are segmented from T1-weighted volumetric images by using an automatic volumetric software (Inbrain) based on the FreeSurfer 6.0 platform (upper row). White matter hyperintensity (WMH) volumes (green) are also segmented from three-dimensional (3D) or two-dimensional (2D) fluid-attenuated inversion-recovery

(FLAIR) images by using the same software (lower row). The segmented mask volumes are binary. For permeability and susceptibility mapping (right), permeability values (volume transfer constant [*K*trans] and fractional plasma volume) are obtained from dynamic contrast-enhanced MRI scans by using the Patlak model, and CP permeability values are extracted with use of coregistration of the segmented CP (red) of T1-weighted images to the parametric map using a mutual information-based algorithm (upper row). The color scale bar represents the volume transfer constant (in min21). CP susceptibility measures are generated in an analogous manner. Quantitative susceptibility mapping (QSM) is obtained from multidynamic multiecho images by using QSMnet1 (lower row). The grayscale bar represents susceptibility in parts per million.
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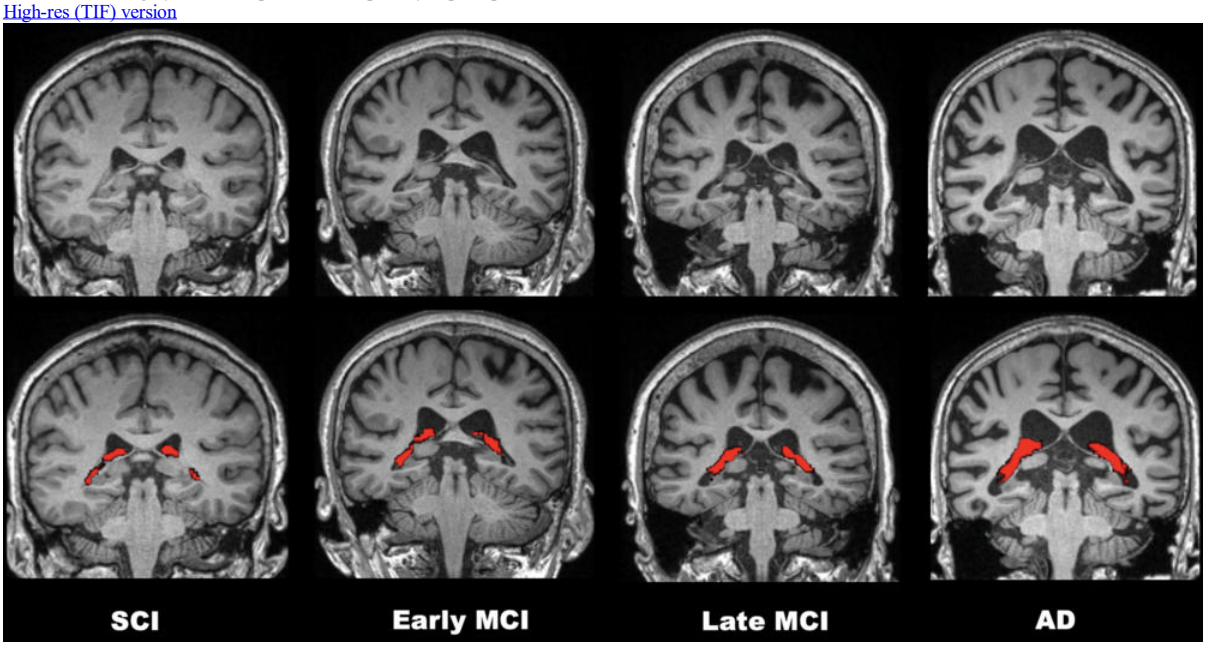

Figure 3. Comparisons of four representative 3.0-T brain MRI scans of choroid plexus (CP) volume (red) according to disease stage over the cognitive impairment spectrum. CP volume is greater in the patient with Alzheimer disease (AD) than in those with subjective cognitive impairment (SCI) or mild cognitive impairment (MCI). All patients were 75-year-old women.
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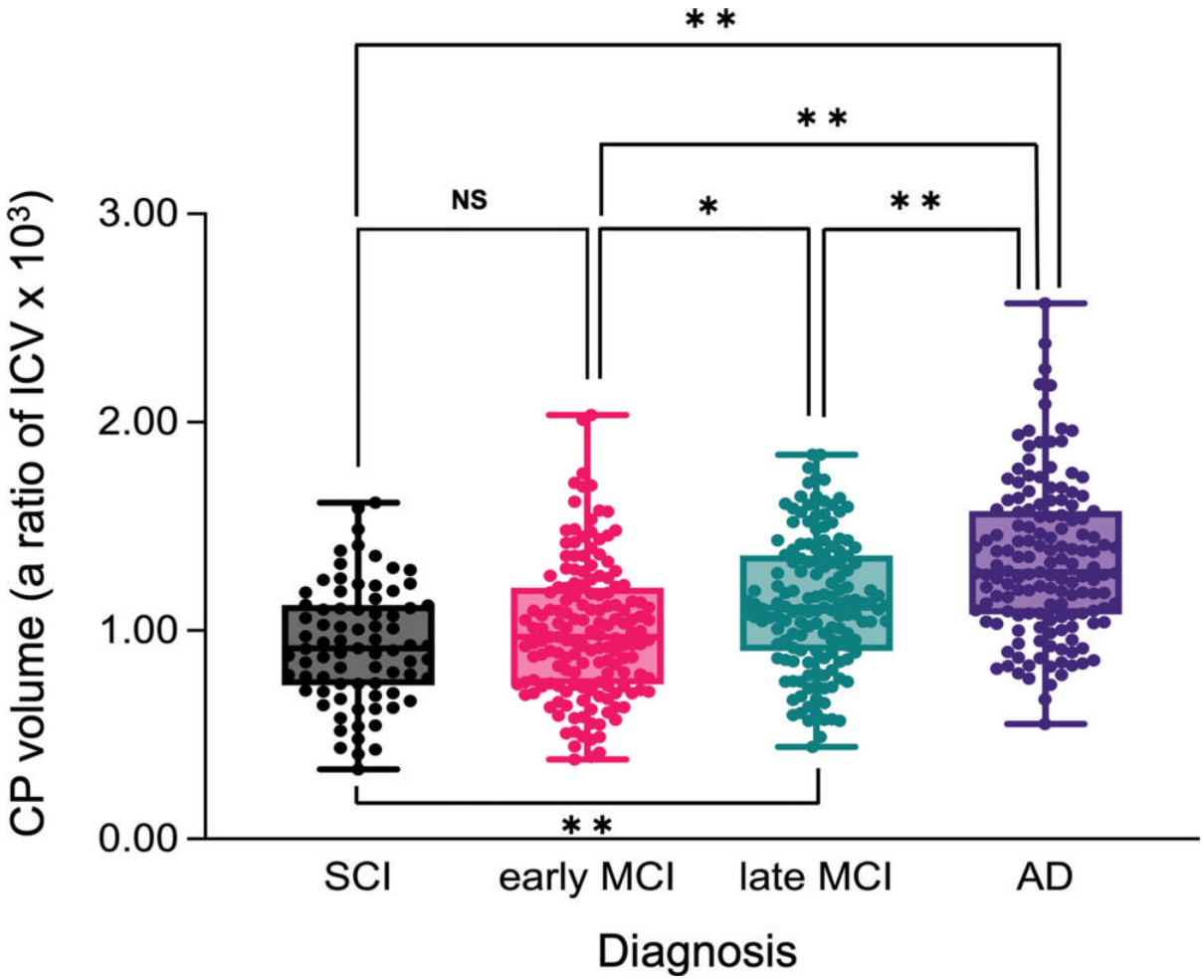

Figure 4. Box plots of choroid plexus (CP) volumes in patients with different stages of cognitive impairment (n = 532). The CP volume (expressed as the ratio of CP volume to intracranial volume [ICV]) in patients with late mild cognitive impairment (MCI) is higher by 21.4% and 13.0% compared with volume in patients with subjective cognitive impairment (SCI) and early MCI, respectively (P < .001="" and="">P = .01); the volume in patients with Alzheimer disease (AD) is higher by 43.6% and 33.7% compared with that in patients with SCI and early MCI, respectively (P < .001).="" however,="" cp="" volumes="" did="" not="" significantly="" differ="" between="" the="" sci="" and="" early="" mci="" groups="">P = .51). The horizontal line in each box plot indicates the median, and the box corresponds to the IQR. The whiskers indicate minimum and maximum values in the data. * = P < .05="" and="" **="">P < .001.="">P values were corrected for multiple comparisons. NS = not significant.
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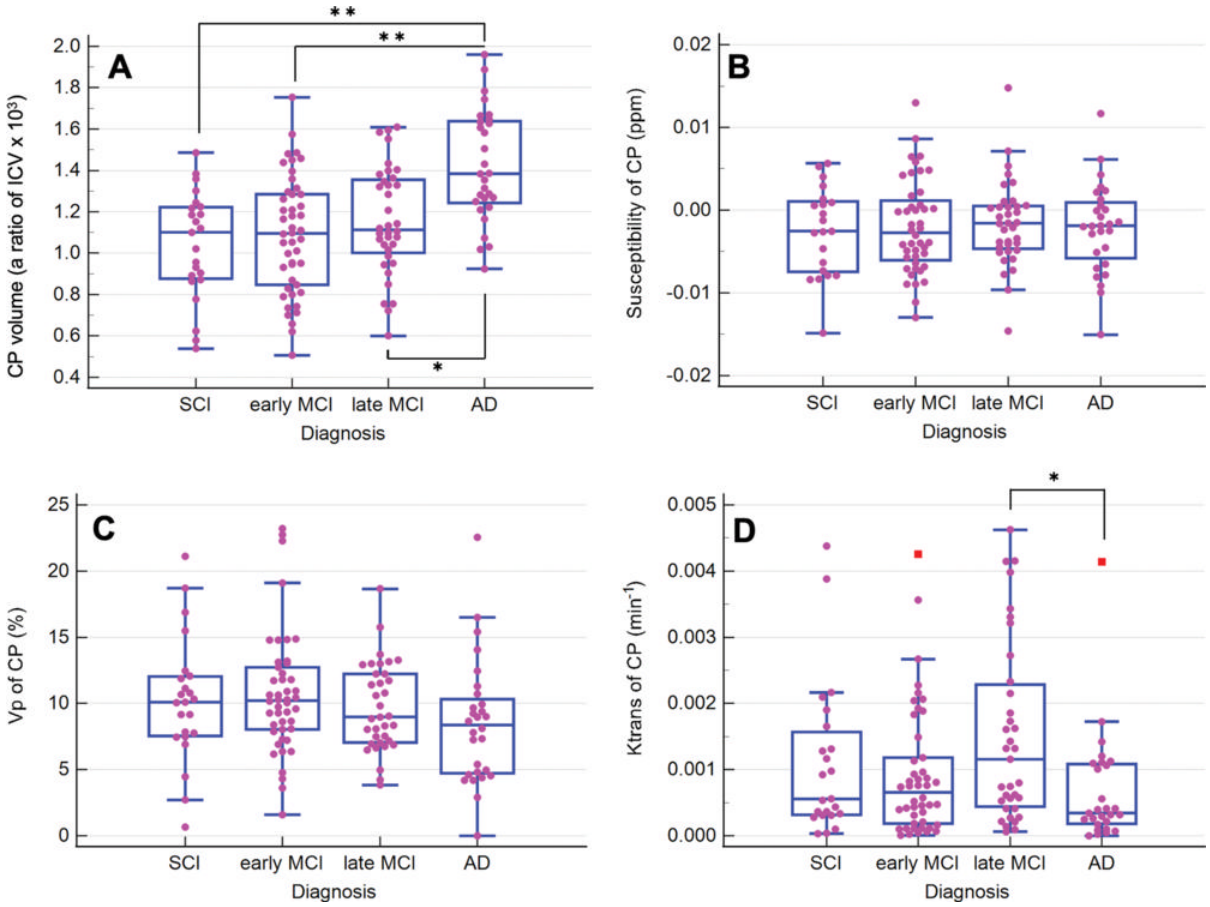

Figure 5. Box plots show **(A)** structural volume, **(B)** susceptibility, and **(C, D)** permeability characteristics of the choroid plexus (CP) in the dynamic contrast-enhanced MRI cohort along the cognitive impairment spectrum (n = 132). Higher CP volume was observed in patients with Alzheimer disease (AD) than in those without dementia, with lower CP permeability (volume transfer constant [K^{trans}]) in patients with AD than in those with late mild cognitive impairment (MCI). Fractional plasma volume (V_p) of CP tended to be lower with worse cognitive impairment status (P = .02, Jonckheere trend test). In contrast, CP susceptibility did not differ between groups (P = .73). The horizontal line in each box plot indicates the median, and the box corresponds to the IQR. The whiskers indicate minimum and maximum values in the data.
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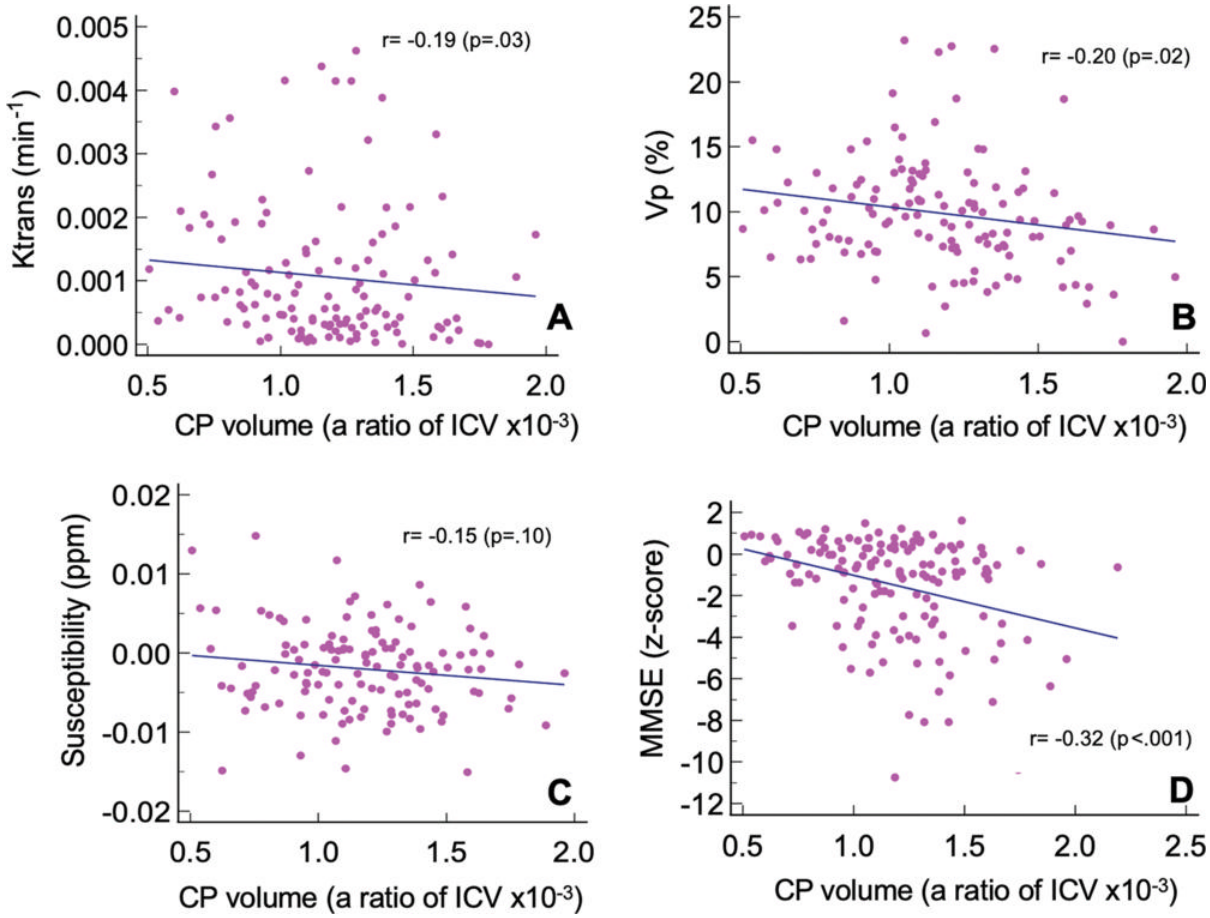

Figure 6. Relationship between the choroid plexus (CP) volume and imaging or cognitive parameters in the dynamic contrast-enhanced MRI cohort along the cognitive impairment spectrum (n = 132). **(A–D)** Scatterplots show significant association of large CP volume with lower volume transfer constant (K^{trans}), lower fractional plasma volume (V_p), and lower Mini-Mental State Examination (MMSE) z-score. The r values are partial correlation coefficients after correction for age and sex. ICV = intracranial volume, ppm = parts per million.
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