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POSTER PRESENTATIONS

Relationship of grey matter and white matter changes the visibility of perivascular space across normative lifespan

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Background

Perivascular space (PVS), also known as Virchow-Robin space, has been recently recognized as one of the most important components in the glymphatic system of the brain,[1] which is closely related to waste and toxins clearance in the brain. On T1- and T2-weighted images, PVS has similar signal intensities to cerebrospinal fluid (CSF), which are frequently observed in the centrum semiovale (CSO) and basal ganglia (BG) regions. A previous study[2] has shown that PVS increases with age and enlarged PVS was deemed associated with neurodegenerative and vascular abnormalities in the elderly.[3] Although the exact mechanism is still elusive, more evidence showed visible PVS in younger adults or even at the adolescent stage. In this study, we use the human connectome project (HCP) lifespan pilot cohort to characterize the relationship of neuronal tissue to PVS visibility across the normative lifespan.

Methods

T1-weighted (0.8mm isotropic, TE/TR=2.12/2400 ms), T2-weighted (0.8mm isotropic, TE/TR=563/3200 ms), and diffusion magnetic resonance imaging (MRI) (1.5 mm isotropic, dir80) data were used from HCP lifespan pilot project (N=27, F/M: 12/15, age 8-75 years). PVS segmentation in white matter (WM) and BG was performed using the same method described in Sepehrband *et al.*[4] (Figure 1). WM PVS volume fraction was calculated by dividing the total PVS volume by WM volume. Pearson correlation and one-way ANOVA were used for statistical analysis.

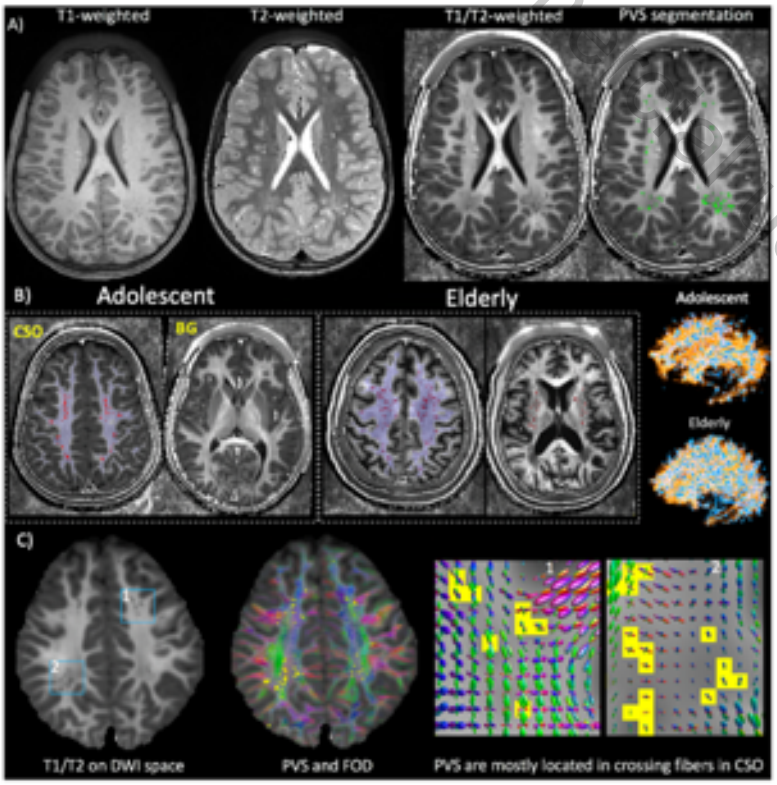

Fig 1. PVS segmentation using A) T1-weighted/T2-weighted ratio images; B) Representative PVS segmentation in CSO and BG of adolescent and elderly brains. C) PVS masks and fiber orientation distribution (FOD) overlaid on T1/T2 images.

Figure 1.

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Results

The grey matter (GM) volume fraction is negatively correlated with WM PVS volume ($p<0.001$, $R^2=0.374$). In addition, we have observed an increase in PVS volume fraction in WM across the lifespan, but there is no significant difference in PVS volume fraction before the age of 55. From an age group range of 8-35 years old, the visible PVS is mostly located in CSO, less PVS is observed in the BG region. However, on the other hand, in the elderly group (age >65 years), high-visibility of PVS is observed both in WM and BG regions.

Conclusions

Across the normative lifespan, PVS appearance is negatively correlated with the GM atrophy index, indicating the potential usage of PVS as a marker of neurodegeneration. In WM, we reported that increased PVS is associated with advancing age, which is consistent with previous reports.[2] Interestingly, we found that in adolescent populations, the PVS occurs mostly in CSO but not in the BG region. In CSO, as shown from fiber orientation distribution analysis, the PVS is mainly located in crossing fiber regions with lower fiber density. However, In BG regions, the PVS occurs in deep GM nuclei (caudate, putamen) and major fiber tracts such as internal capsules or cortical spinal tracts, which are more densely packed compared to crossing-fibers in CSO.

Previous studies have reported that the WM blood flow is inversely correlated with FA,[5] the tightly structured fibers tend to show lower blood flow if compared to loosened ones. The high visibility of PVS in CSO may also be due to more loosened fiber structures, which lead to more axonal spaces for PVS fluid movement.

References

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