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Parenchymal CSF Fraction and DTI-ALPS in Brain Aging

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Abstract Text:

Background: The perivascular space (PVS) functions as part of a brain clearance system that drains interstitial fluid and solutes including Aβ and tau from brain parenchyma and is associated with the development of AD. Recent developed imaging tools of cerebral parenchymal CSF fraction (CSFF)[1] and diffusion tensor imaging along perivascular spaces index (DTI-ALPS)[2] provide an insight of the perivascular CSF flow and early PVS pathology in the cerebral cortex. We applied CSFF and DTI-ALPS in an elderly cognitive normal cohort to investigate its value in brain aging.

Method: A total of 27 cognitive normal subjects in this study are within age 57 and 82 years (mean=67.7, std=6.4). We conducted MR FASTT2 scan for CSFF, T1W, T2W for PVS burden, and DTI for DTI_ALPS index. CSFF was fitted using three compartment model with 6 TEs = 0, 7.5, 17.5, 67.5, 147.5, 307.5 ms. PVS burden was calculated by using imaging processing based PVS segmentation on enhance PVS image (T2W/T1W). DTI_ALPS was calculated by mean(Dx_proj,Dx_assoc)/mean (Dy_proj, Dz_assoc), where Dx, Dy and Dz are the diffusivity along x-, y- and x-axis, and the projection, association regions. Multi-variate linear model **Age~1+DTI_ALPS+CSFF** was compared with **Age~1+DTI_ALPS+PVS_burden**.

Result: Figure 1 (a) and (b) show the PVS mask on T2W and CSFF map. Figure 2 shows the scattered plot of linear model between age and PVS burden+DTI_ALPS, which is not significant (p=0.06, R2=0.14). Figure 3 is the plot of the model between age and CSFF+DTI_ALPS, which is significant (p<0.01, R2=0.34).

Conclusion: The preliminary results showed CSFF and DTI-ALPS can better predict brain aging. The conventional PVS burden only measures the MRI visible PVS in brain WM while CSFF can assess micro-scale PVS along small arteriole and capillary in the cerebral cortex, which is closely related to glymphatic system and reflect the PVS function alert at early stage. CSFF and DTI-ALPS could be a potential marker for detecting early stage of dysfunction of glymphatic clearance.

Reference: 1. *Liangdong Zhou, BioRvix:2021.02.01.429067, 2021*. 2. *Toshiaki Taoka, Jpn.J.Radiol. 2022;40:147–58*.3.

Tables and Figures:

Figure1 Aging_CSFF_PVS_brain.png (695.2KB)

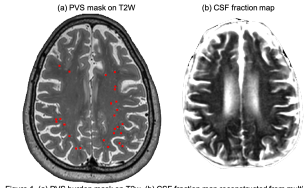

Figure 1. (a) PVS burden mask on T2w. (b) CSF fraction map reconstructed from multi-echo FASTT2 data. Enlarged PVS will elevate CSF fraction not only in white matter but also in gray matter. PVS is only visible in WM. The invisible PVS in cortical gray matter could be more sensitive to the early disease stage.

Figure 2 Aging_PVS_ALPS.png (172.6KB)

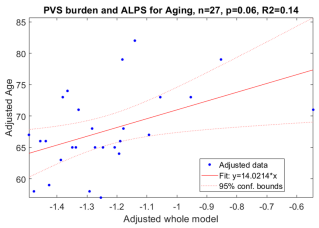

Figure 2. Linear model plot for Age~1+PVS_burden+DTI_ALPS. The model is not significant showing that PVS burden is not sensitive to aging.

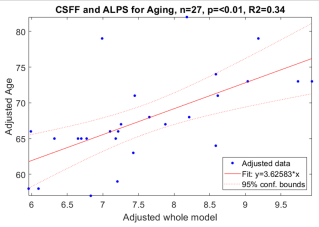

Figure 3. Linear model plot for Age~1+CSFF+DTI_ALPS. The model is significant with a decent R-squared value showing that CSFF is sensitive to aging.

Figure 3 Aging_CSFF_ALPS.png (171.3KB)

Title:
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Do you plan to upload figures or tables to supplement your abstract text?
Yes

Theme:
Biomarkers

Topic:
Neuroimaging

Sub Topic:
Normal brain aging

Learning Objectives:

Use multi-echo MR FASTT2 data to reconstruct CSF fraction map
Establish a better way to predict brain aging using CSF fraction instead conventional PVS burden
Monitor early glymphatic clearance dysfunction using CSFF mapping

Keywords:

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