P2-430:

PET Imaging Based Clearance Slope, FASTT2 MRI-based Parenchyma CSF fraction, and DTI-based ALPS-index

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Background

Glymphatic clearance is important to maintain brain health, which depends on two interconnected fluid systems: the novel glymphatic system and the traditional well-characterized CSF system[1]. There are several imaging tools have been developed to evaluate the glymphatic function in the human brain, however each method providing only a limited perspective into glymphatic system[2]. A proper imaging tool should consider both circulation pathway of the bulk CSF flow, and a complex PVS network parallel to the microvascular structure. We developed and tested an imaging package including vCSF, CSFF, and DTI-ALPS, to investigate the ventricular CSF turnover rate, perivascular CSF flow and brain parenchymal CSF fraction.

Methods

A total of 22 subjects (F=16, M=7, NL=17, MCI=5) age from 63 and 82 years (mean=69.3, std=5.1). PET MK6240 was acquired for lateral ventricle CSF clearance measure[3] (vCSF), and MRI FASTT2 and DTI was acquired for CSF fraction[4] (CSFF) and diffusion tensor imaging along perivascular spaces[5] (DTI-ALPS) index, respectively. Precisely, vCSF was calculated as the slope of 10 to 30min lateral ventricle TAC normalized by 1-4min whole brain AUC. CSFF was fitted using three compartment model with 6 TEs = 0, 7.5, 17.5, 67.5, 147.5, 307.5 ms. DTI-ALPS was calculated by

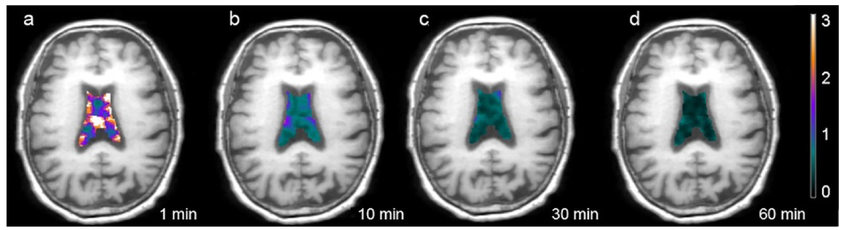
$$ALPS = \frac{mean(D_{x,proj}, D_{x,assoc})}{mean(D_{y,proj}, D_{z,assoc})}$$

where Dx, Dy and Dz are the diffusivity along x-, y- and x-axis, and the projection, association regions.

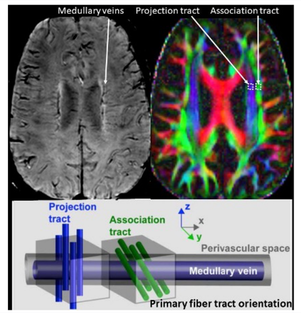
Results

Figure 1 (A)-(C) show vCSF, DTI-ALPS and CSFF, respectively.

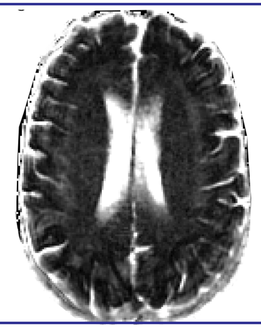
(A) vCSF



(B) DTI-ALPS



(C) CSFF



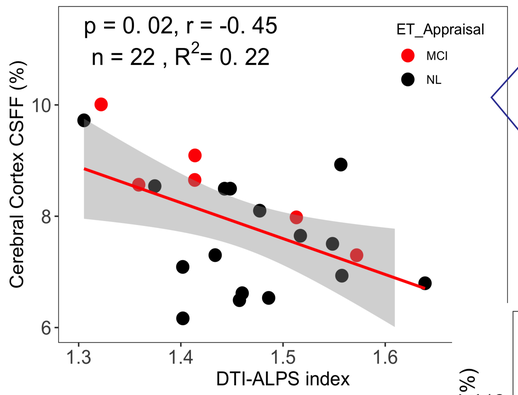
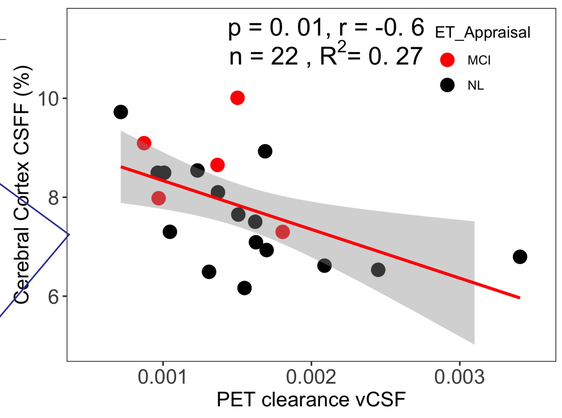


Figure 2 shows parenchymal CSFF negative correlates with DTI-ALPS.

*Note that 4 NL subjects with high CSFF and low DTI-ALPS are amyloid positive.

Figure 3 shows ventricular CSF turnover rate (vCSF) negatively correlates CSFF.



Discussion

The results showed that brain parenchymal CSF fraction (CSFF) associate with ventricular CSF turnover rate (vCSF) and perivascular CSF flow diffusivity (DTI-ALPS). The DTI-ALPS is an index of the diffusivity of CSF in the PVS along the medullary veins. A higher DTI-ALPS means a higher CSF diffusivity in PVS. CSFF is an indicator of glymphatic fluid stasis, reflects the brain parenchyma PVS load. Result in Figure 2 implies that the CSF stasis associates with the low diffusivity of CSF in PVS. Recent study showed the lower the b-value, the higher molecular mobility can be detected. It implies the DTI-ALPS could reflect the high speed PVS flow[6]. The greater the glymphatic stasis (CSFF) the slower the flow along perivascular spaces (DTI -ALPS), suggesting link between increased cerebral CSFF and fluid outflow from the brain. The ventricular CSF turnover rate can be used to estimate the CSF transit between ventricles and the brain/glymphatic system. Result in Figure 3 suggest the reduced CSF turnover rate links with increased glymphatic fluid stasis.

Conclusion

Our multimodal imaging analysis showed that an overall picture of the CSF clearance can be achieved and the brain CSFF could serve as an imaging biomarker of brain drainage pathology.

Reference

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