Perivascular spaces in the centrum semiovale automatically assessed in MRI, their association with total brain iron deposition and effect on cognition in the elderly

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Introduction: Recent scientific evidence suggests that brain iron deposition (ID) increases with age mainly via dysfunctional brain iron regulatory mechanisms, which can cause dilation of the perivascular spaces at the centrum semiovale (CSO-PVS) and obstruction of interstitial fluid flow along the intramural periarterial drainage [1]. We examined possible associations of CSO-PVS with brain IDs and cognitive abilities in older people in their early seventies, accounting for age, gender, white matter hyperintensities (WMH) and vascular risk factors.

Materials and Methods: We analysed cognitive, clinical self-reported and MRI data from 486 community-dwelling individuals from the Lothian Birth Cohort 1936 [2], who underwent detailed cognitive testing and multimodal brain MRI at mean age 72.7 years. Brain IDs were assessed automatically following manual editing [3]. Perivascular spaces were also automatically assessed in the centrum semiovale and deep corona radiata supraventricular [4]. We used step-wise general linear modelling and multivariate linear regression for the analyses.

Results: Median (IQR) volume of IDs and CSO-PVS expressed as percentage of intracranial volume were 0.0021 (0.011) and 0.22 (0.13) respectively. The median (IQR) number of CSO-PVS counted per individual were 410 (201). We found strong and negative borderline association (B=-42.31, p=0.041) between volumes of CSO-PVS and IDs, but not between CSO-PVS count and ID volume, probably due to contamination with small WMH (Figure 1). CSO-PVS volume and count had a strong negative interaction effect with age on general cognition (B=1.14, p=0.02) and memory (B=1.61, p = 0.003) but not on processing speed. Multivariate linear regression models that used gender, age, percentage of WMH volume in intracranial volume (ICV) and a combined score of vascular risk factors did not show any association between CSO-PVS (volume or count) and cognition or ID volume.
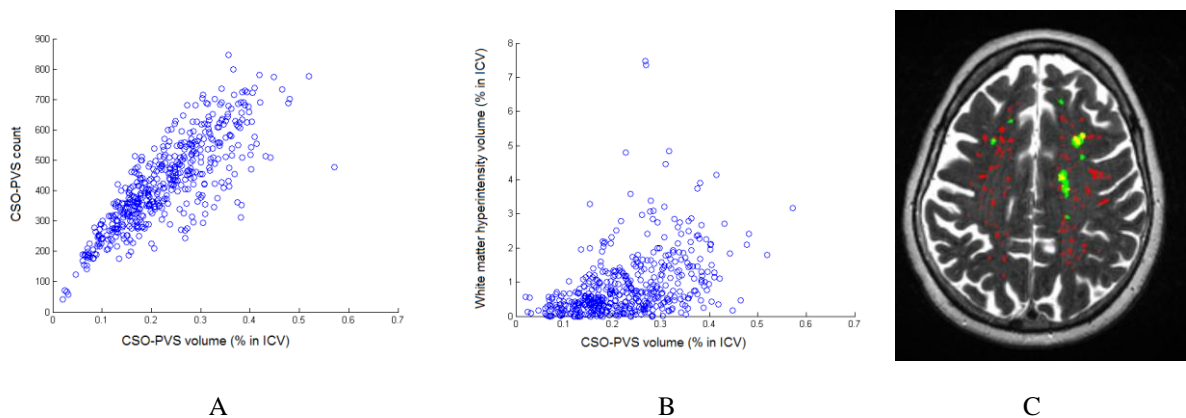

A   B   C

Figure 1. Univariate regression lines between CSO-PVS volume, count and WMH volume (A and B). A: CSO-PVS volume vs. count. As the volume and count increase, both measurements deviate more from the regression line, B: CSO-PVS volume vs. WMH volume. Observe the change in the direction of the association between both measurements as their values increase, suggesting a possible coalescence between both imaging markers that could explain the results obtained. C: A slice showing the PVS (red), WMH (green) segmented and clusters identified as PVS within the WMH mask (yellow).

Conclusions: In community-dwelling individuals it is unclear whether the number of CSO-PVS is associated with the volume of tissue where ID is observed. The CSO-PVS burden could have a negative effect in memory and general cognitive abilities in older age. However, these associations are not generalizable.

References: [1] Ishikawa et al. *J Alzheimers Dis* 2018; 61: 1919-1626. [2] Deary et al. *BMC Geriatr* 2007; **7**: 28. [3] Glatz et al. *Neuroimage* 2015; **105**: 332-346. [4] Ballerini et al. *Sci Rep* 2018; **8**: 2132.