Dilated perivascular spaces: a hallmark of traumatic injury

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Perivascular or Virchow-Robin spaces (VRS) follow the path of the penetrating arteries as they enter the apical cortex from above or the basal ganglia from below. Macrophages in the VRS are known to initiate and promote immune response to foreign antigens (*1*). Structural MR images depict VRS with a diameters larger than the 1 mm resolution of a conventional 256x256 acquisition protocol. Apical VRS are noted with ~10% frequency in a normal brain of a 20-40 year old person. Enlarged VRS are known to be associated with advanced age, hypertension, and dementia (*2*). A recent study reported increased frequency of large VRS in patients with multiple sclerosis suggesting their role as neuroradiological markers of early inflammatory changes (*3*). Our purpose was to determine the frequency of dilated VRS in human brain after traumatic injury.

Methods

A comprehensive set of structural MR imaging sequences (including MPRAGE and dual echo SE) was performed in 24 patients of mean age 33.6 years (range, 18.1-50.8 years), 10 women, 14 men. Imaging was done within 7 days of traumatic incident in 15 patients. The remaining 9 subjects were studied on the average 3.7 years (range 0.6-13.4) after trauma. The same MR imaging protocol was applied to 17 age-and gender-matched control subjects (mean age 32.8 years, range 18.4-47.8 years, 9 women, 8 men). Segmentation procedures were applied to MPRAGE and T2-weighted sequences, yielding for each person the total cranial cavity volume, brain parenchyma volume, and total CSF volume. On axial T2-weighted sections, above the superior margin of corpus callosum, individual VRS were identified (see inter-observer reliability below) as small punctate areas within white matter, isointense with CSF (arrows in figure 1).

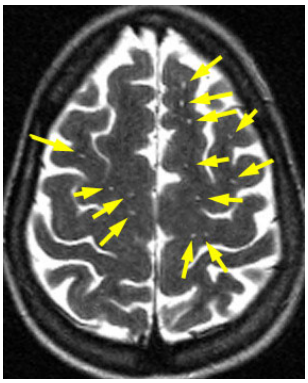

Figure 1

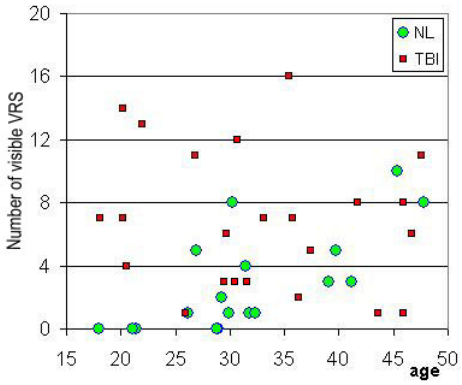

Figure 2

Results

The average (± standard deviation) number of VRS visualized in high-convexity white matter was 7.1±4.6 in patients and 2.4±2.9 in control subjects (t-test, $p<0.0003$). Among normal subjects (but not among injured patients, see figure 2) VRS were associated with age ($R=0.69$, $p<0.001$). Among patients with brain trauma, dilated VRS were neither correlated with brain atrophy nor with the time after injury: 6.6±1.2 in images taken less than one week after injury versus 8.5±1.6 in images taken more than 7 months after. Inter-oberver reliability establishing an excellent agreement of two blinded, idependent readers on the number of dilated VRS, with $\kappa=.996$ (95% confidence interval .985-.998).

Discussion

Striking enlargement of VRS in patients with brain trauma appears to be a new neuroradiologic marker of the injury, easiest to detect on T2-weighted images. Since the dilation is independent on the time since injury, it probably reflects early and permanent brain changes. Experimental brain trauma studies have demonstrated the presence of inflammatory cells (macrophages or microglia) in VRS several days after the injury (*4*). The prolonged accumulation of these cells in VRS might contribute to the pathophysiology of secondary diffuse brain injury.

References

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