Cerebrospinal fluid and brain matter repartition in neurodegenerative diseases

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Introduction: Adult chronic Hydrocephalus (ACH), Alzheimer’s disease (AD) and vascular dementia (VD) are associated with brain atrophy, Cerebrospinal fluid (CSF) dynamics changes and ventricular dilatation [1]. This leads to confusions in the differential diagnosis in a non-negligible part of aging patients presenting one or more of the common pathological features. 3D MR imaging may help improve the differential diagnosis but it can be very time-consuming to acquire and to process, and is very motion and noise sensitive. Hence, we propose a fast and conventional 2D MRI approach to evaluate the CSF and the grey/white matter repartition in healthy (H), ACH, AD and VD patients.

Materials and Methods: After a clinical, neurological and neurophysiological dedicated examination, 43 subjects (mean age: 65±6) were divided into 4 groups: 12 H, 10 ACH, 11 AD and 10 VD, without intergroup age differences. All subjects underwent 2D axial T2*- weighted and axial T2 fluid-attenuated inversion recovery (FLAIR) acquisitions with a 3T MRI scanner.

A common reference plane intersecting the anterior horn and the body of the lateral ventricles was defined for all patients (A). Afterwards, areas of: the ventricular CSF (CSFint), extra-ventricular CSF (CSFext), the grey (GM) and white matter (WM) were assessed on the axial T2* image (B). Then, the transependymal CSF resorption (CSFres) area was measured on the FLAIR image (C). Segmentations were done using a medical image processing software (MIPAV) (2-3 minutes/patient). For each subject, repartition ratios of CSF and grey/white matter within the total slice area were calculated then compared between the four groups.

Results: The highest (p<0.01) CSFint and the lowest (p<0.01) CSFext ratios were detected in ACH, while AD patients presented the largest CSFext and the smallest GM+WM area (p<0.001). The CSFext/CSFint ratio were lower (0.37) in ACH than in the other groups (>1 for the three measurements). The most important transependymal CSF resorption was found in ACH patients.

Discussion and conclusion: Areas were expressed in ratios to avoid morphological differences in the brain. In ACH, there is no matter loss as in AD but a volume redistribution of CSFext towards CSFint compartments. Paradoxically, in our population, CSF volume in ACH and healthy patients is found to be similar, whereas it has increased in the other groups. Preservation of brain matter in ACH could also be considered as an argument for potential recovery of brain functions after CSF treatment (shunt or ventriculocisternostomy). In contrast to ACH, AD and VD patients showed increases in both CSF compartments, and therefore a decreased brain matter surface due to the incompressibility of the tissue. Brain atrophy was most notable in AD patients, as expected. The transependymal resorption was no measurable on the T2*- weighted images, which explains the use of the FLAIR acquisition in order to assess this spinal fluid diffusion modes observed in ACH patients [2]. In conclusion, brain matter and CSF repartition over the brain can be quickly estimated from single 2D MR highlighting morphological differences in these neurodegenerative diseases. ACH seems to result from a CSF repartition disorder whereas AD and VD seem to rather result from a brain tissue loss.