CSF and brain atrophy investigation in neurodegenerative diseases

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Introduction: It is often difficult to differentiate between hydrocephalus(HC), Alzheimer's disease(AD) and vascular dementias(DVx) in which brain atrophy, the cerebrospinal fluid(CSF) volume variation and ventricular dilatation are present, even when 3D MR images are available[1,2]. To illustrate these distinctive aspects, we used MR Imaging to quantify ventricular CSF (CSFv), subarachnoid CSF(CSFs) and the grey/white matter on a pre-defined 2D reference section in patients with these neurodegenerative diseases. Our aim is to present a fast 2D approach to study CSF and brain tissue variation in neurodegenerative diseases.

Materials & Methods: Subjects: 32 elderly patients (age 60 and above) were divided into 3 groups after a comprehensive physical and neurological examination performed by an experienced neurologist: the first group included 11 AD patients, the second 10 HC and the third 11 patients with other cognitive disorders such as MCI and vascular dementia (DVx). **MRI Acquisitions:** All patients underwent brain examination (3T MRI scanner) using a T1-weighted axial flair anatomical imaging with the following parameters: Field of view (cm²) = 24 x 24, matrix = 384x224, slice thickness (mm) = 5, TE/TR = 152/9002, Excitations number = 1.**Image processing and analysis:** A common reference plane intersecting the anterior horn and the body of the lateral ventricles was defined for all patients(Figure1), then used to calculate the CSF in the subarachnoid space(CSFs), in the lateral ventricles (CSFv), and the grey/white matter(GW), by applying a region-growing segmentation on this reference section using MIPAV software[3] (4 -5 minutes/patient) (Figure2). CSFv, CSFs in the cerebral sulcus and the third ventricles were then subtracted from the total brain area to assess the grey/white matter. Afterwards, means of each region were compared between the three groups using Wilcoxon's test.

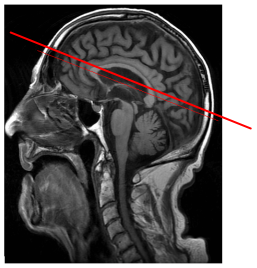

Figure 1. Sagittal T1-weighted image showing the reference plane intersecting the anterior horn and the body of the lateral ventricles.

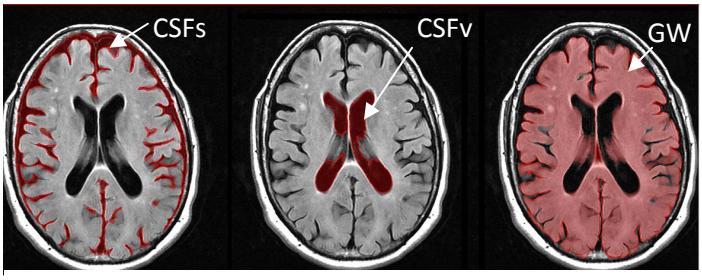

Figure2. Region-growing segmentation of the CSFs (left), the CSFv (middle),and the grey/white matter (right).

Results: A significant increase in the CSFv($p<0.01$) and a decrease in the CSFs($p<0.01$) are detected in hydrocephalus patients, while AD patients presented the highest CSFs and the lowest GW ($p<0.001$ for both measures). A percentage of the distribution of CSFv, CSFs and GW in the brain is also calculated (Table 1). The highest percentages of CSFv and GW were found in HC patients (14 and 80 %), whereas AD patients had the highest CSFs (21%).

Areas	DVx	HC	AD
CSFv(cm²)	14	24	14
CSFs(cm²)	19	9	34
GW(cm²)	117	149	94
Distribution (%)			
CSFv	9	14	9
CSFs	12	5	21
GW	75	80	68

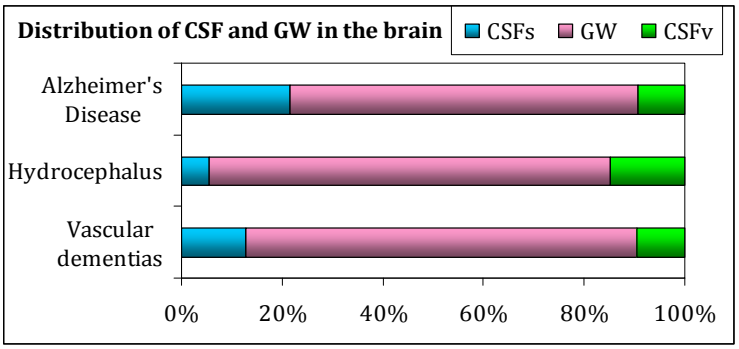

Table1. Segmented areas in the different disease groups (left), and the percentage of distribution of CSFv, CSFs and GW in vascular dementias, hydrocephalus and Alzheimer's disease patients (right).

Discussion and conclusion:

Flair is a quick and commonly used 2D sequence in clinical practice and post-processing. During the last European radiology congress, it has been shown that the ventricular CSF volume was highly correlated with the ventricular CSF area as shown in figure1 [4]. Areas in table1 were expressed in ratios to avoid morphological differences in the brain which, according to our point of view, are not much taken into account in the 3D voxel-based morphometry.

In conclusion our method has shown that significant CSF and brain tissue distribution exists in the different investigated neurodegenerative diseases, and a 2D approach can be added to the standard clinical protocol in order to help improve the differential diagnosis.

References: **[1]** *Hajime Kitagaki, Etsuro Mori, Kazunari Ishii, Shigeru Yamaji 1998* **[2]** *Condon et. alLancet 1986;*
[3] http://*mipav.cit.nih.gov/*
[4] *CSF ventricular volume and flow investigation in neurodegenerative diseases ESMRMB congress 2011- 571*