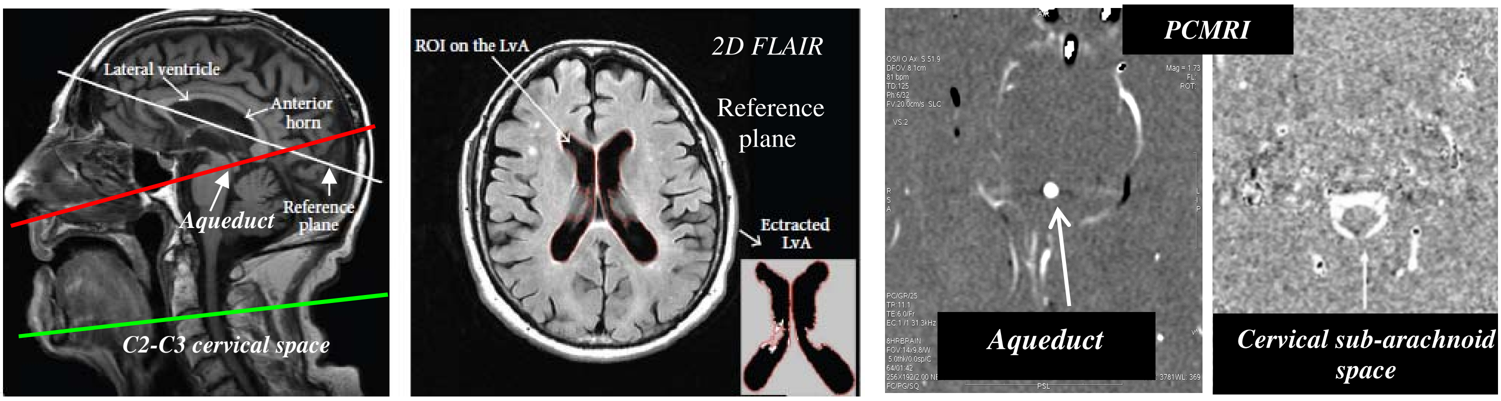
Relationship between Cerebral Ventricles dilatation and Cerebrospinal Fluid oscillations

Bader Chaarani[1], Cyrille Capel[2], Jadwiga Zmudka[3], Joel Daouk[1], Anthony Fichten[2], Catherine Gondry-Jouet[4], Roger Bouzerar[1], and Olivier Balédent[1]
[1]*Department of Imaging, Amiens University Hospital, Amiens, Somme, France,* [2]*Department of Neurosurgery, Amiens University Hospital, Amiens, Somme, France,* [3]*Department of Geriatrics, Amiens University Hospital, Amiens, Somme, France,* [4]*Department of Radiology, Amiens University Hospital, Amiens, Somme, France*

Introduction: It is still not well elucidated if cerebrospinal fluid (CSF) oscillations amplitude can be associated with ventricle dilatations. One of the common features of such diseases revealed by MR neuroimaging is the dilatation of the lateral ventricular system. Recent studies (*El Sankari et al. 2011*) have shown that CSF flow investigation at the aqueductal and cervical levels could help also to differentiate between these brain disorders, particularly between Alzheimer's disease (AD) and adult chronic hydrocephalus (ACH). However, it remains unclear whether this can be related to altered ventricular volumes or to other pathological aspects. The aim of this study is to determine if ventricular dilatation is correlated with the cerebrospinal fluid flow at the aqueductal and cervical levels in neurodegenerative diseases.

Materials and Methods: 45 elderly patients suffering from AD (19), ACH (13), and vascular dementia (VaD) (13) underwent MR, after signing an informed consent, including axial FLAIR-T2 weighted, and Phase-contrast MR imaging (PC-MRI) sequences for CSF flow at the aqueductal and C2-C3 cervical levels. A common reference plane intersecting the lateral ventricles was used to calculate the lateral ventricles' area (LvA) on 2D images. Aqueductal (ASV) and cervical (CSV) stroke volume (CSF displaced through the acquisition plane during a cardiac cycle) were calculated on PCMRI as mean of the integration of the positive and negative parts of the CSF curves using a flow image processing software (http://tidam.fr/).

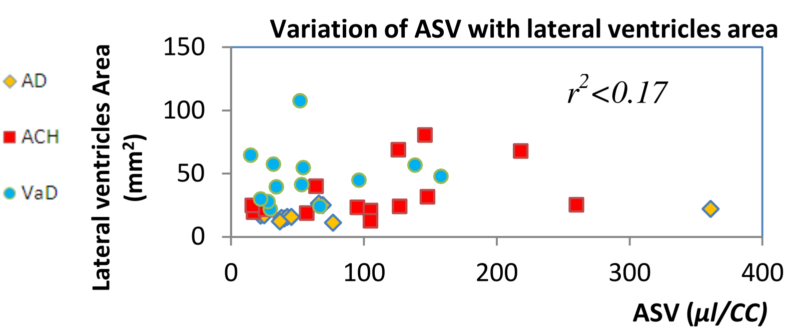


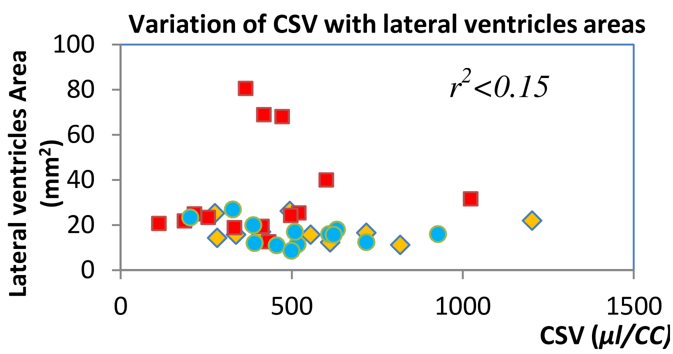
MR Parameters	*FLAIR*	*PCMRI*
FOV (cm^2)	*24x24*	*14 x14*
Matrix	*384x224*	*256 x128*
Slice thickness (cm^2)	*5*	*5*
TE(ms)	*152*	*7*
TR(ms)	*9002*	*15*
Nex	*1*	*1*

	AD	*ACH*	*VaD*	*Total*
ASV (mean±SD)(µl/CC)	*76 ± 60*	*108 ± 72**	*62 ± 46*	*82±63*
CSV (mean±SD)(µl/CC)	*551 ± 264*	*417 ± 222**	*524 ± 193*	*493±230*
LvA (cm^2)	*18±4*	*34±21**	*16±5*	*23±16*
Correlation ASV/LvA (r^2;p)	*0.12;0.09*	*0.17; 0.13*	*0.01;0.15*	*0.15; 0.14*
Correlation CSV/LvA (r^2;p)	*0.002;0.34*	*0.02; 0.19*	*0.15; 0.1*	*0.01; 0.3*

(*) = significant difference compared to other groups (p<0.05)

Results: The largest LvA were observed in ACH patients, with significant difference compared to AD and VaD (table above). Significant higher ASV and lower CSV values were found in ACH patients. On the other hand, no significant correlations were detected between ventricles and stroke volumes ($R^2 \leq 0.17$; $p>0.05$).





Discussion: The LvA were used as an index of ventricular dilatation following a previous study in which we showed that the ventricular volume measured on 3D images is significantly proportional to the 2D reference plane we used *(Chaarani et al 2013)*. The cerebrospinal fluid fluctuations in neurodegenerative diseases seem to be ruled by a highly complex system and may depend on many physiological parameters other than simple ventricular morphology: the difference in CSF pressure in the third and fourth ventricles, the aqueductal geometry and the heart rate *(Greitz et al.1992).*