Study of cerebral hydrodynamics in a control population

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Introduction

The cine phase-contrast MR sequence is the only noninvasive technique for the study of CSF oscillations. It can also be used to quantify cerebral blood flow. Its clinical use for the study of hydrodynamic disorders such as hydrocephalus must be based on reference values using a simple and rapid protocol. The objective of this study was to establish a global investigation protocol compatible with clinical examination in order to establish reference values for intracranial CSF flow and cerebral blood flow.

Material and method

CSF flow and cerebral blood flow were measured in 44 control subjects with a mean age of 27±9 years by a cine phase-contrast MR sequence (1.5 T GE Healthcare version 9). MR imaging comprised morphological sequences for determination of functional planes of section. CSF oscillations were recorded at the cerebral aqueduct, cisterna pontis and C2-C3 subarachnoid spaces (SAS) and a vascular sequence designed to quantify blood flow in the internal carotid and vertebral arteries and the jugular vein was also performed. The cine phase-contrast MR sequence was used retrospectively with peripheral cardiac gating and the following sequence parameters: TR: 30 ms / TE: 12-17 ms / FOV: 60 x 120 mm / Matrix: 256 x 128 / Slice thickness: 5 mm / Tilt angle: 30° / Venc: 80 cm/s for blood flow and 10 or 5 for CSF. The duration of the cine phase-contrast sequence is about 2 minutes per plane of section.

Dynamic flow images were analyzed on dedicated software, developed on site, based on an automatic segmentation algorithm of regions of interest. This post-processing tool allows rapid calculation of flow rate curves on a cardiac cycle and calculation of the main characteristic parameters of a flow curve: oscillatory volume, mean flow, peak flow, as well as temporal information characterizing propagation of the arterial pulse pressure in the various CSF compartments.

Cerebral blood flow was calculated by adding mean vertebral and internal carotid blood flow.

Results

CSF and cerebral blood flow curves are shown on Figure 1.

Total cerebral blood flow was 633±126 ml/min. The venous blood flow measured in the jugular vein was 419±164 ml/min. The ventricular CSF oscillatory volume was 0.056±0.026 ml/cardiac cycle and the subarachnoid CSF oscillatory volume was 0.55±0.15 ml/cardiac cycle.

Propagation of the arterial pressure pulse is shown on Figure 2.

Discussion

This study established the main values characterizing cerebral hydrodynamics in a control population and provided a better understanding of the mechanisms of intracranial volume regulation during the cardiac cycle. Although the sequence parameters were not optimal for precise measurements, they are nevertheless compatible with rapid use of flow sequences in routine clinical practice.

Figure 1

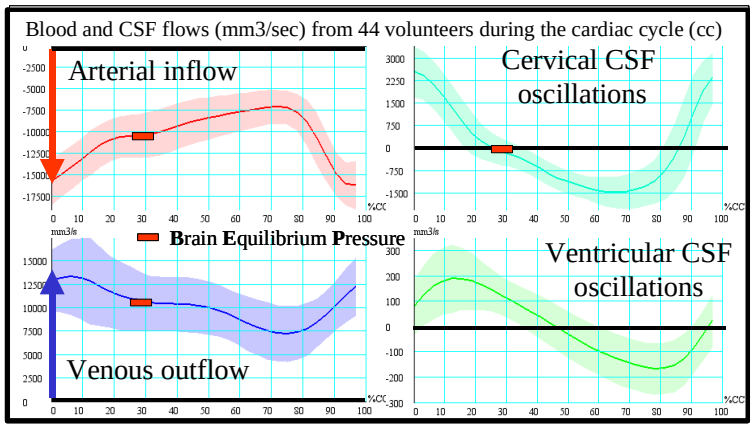

Figure 2