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CSF pulsation patterns in occlusive hydrocephalus

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Abstract. Fifteen patients with solid and cystic occlusions of the cerebrospinal fluid (CSF) circulation pathways were examined with MRI using an ECG retrogated two-dimensional FISP sequence to determine whether there are certain defined pathological CSF flow patterns in these patients. All patients were clinically still compensated. The results of the measurements of CSF flow velocities at different locations in the CSF system were compared with the results from 8 healthy volunteers. In all patients with occlusive processes of the intraventricular CSF pathways (4 aqueduct stenoses, 1 membranous occlusion of the fourth ventricular outlets, 1 solid tumour at the foramen of Monro and 1 solid fourth ventricular tumour) we observed hyperdynamic CSF pulsation above the lesion. This was transmitted into the spinal canal. Close by a solid occlusion within the aqueduct the flow velocity curve over the RR cycle was typically shifted, resulting in a mirroring of the flow velocity curve compared with normals. In cystic lesions (n = 4) there was transmission of the pulsation wave through the lesion and therefore no mirroring of the flow velocity curve. This technique allows very good delineation of cystic structures in the peripineal region (n = 4), also due to the opposite direction of flow within the cyst compared with the surrounding CSF spaces, depending on the extent of communication.

Key words: CSF flow – Hydrocephalus – MRI

Introduction

Cardiac- and respiration-related cerebrospinal fluid (CSF)-pulsations were investigated by Du Boulay et al. [1, 2] in early studies. These studies with oily contrast agents, which are obsolete today, were invasive. Bradley et al. [3] first reported increased pulsation within the aqueduct in patients with communicating hydrocephalus visible by non-invasive MRI. The known flow effects of MRI [4] are used for MR-angiography in an increasing number of cases. This new method has to compete with intra-arterial X-ray angiography. There is no comparable investigation modality in clinical use for the imaging of CSF-pulsation. The only gold standard in the evaluation of CSF-motion and pulsation is the clinical course of the treated patient. First enthusiastic reports [5-7] were followed by more critical papers [8-10].

Currently there is no reference method in CSF flow investigations. The examinations of patients with communicating hydrocephalus had shown effects on MRI after shunt implantation [11]. Modern methods such as phase contrast imaging will give more detailed velocity information [12, 13]. The potential for cardiac retrogating [14] implies the possibility of an inter-individual comparison of pulsatile CSF-motion.

The purpose of this study was to examine patients with well-defined CSF-pathway disorders to obtain information about the effect of these lesions on the CSF pulsation pattern.

Methods

A total of 15 neurosurgical patients (6 male, 9 female) were investigated by MRI. The mean age was 32.4 years (range 12–70 years). Nine of these patients were operated on for their pathological process and were examined by MRI pre- and post-operatively several times. Two patients had been observed pre-operatively by several investigations within a time period of 1 year. The most common pathology (n = 4) was a stenotic process of the aqueduct or cystic lesions of the peripineal region [4]. A posterior fossa arachnoid cyst or a cystic tumour of the fourth ventricular region was seen in 2 patients each. The other cases were a solid tumour of the fourth ventricle, a solid tumour of Monro's foramen and an occlusion of the fourth ven-
Fig. 1. A septated peripineal region cyst (cavum veli interpositi) has a different (arrow) pulsation velocity and direction visible from phase images (upper right, systolic; upper left, diastolic phase). The loss of communication was demonstrated by cisternography.

Fig. 2. A septated cyst within the cisterna magna has a different pulsation from the communicating part (pulsation phase shift).