Magnetic Resonance Queckenstedt fs Test: A Preliminary Results

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[Target audience] This presentation is targeted at those interested in phase contrast magnetic resonance imaging (PC-MRI) and cerebrospinal fluid (CSF) flow dynamics.

[Purpose] Queckenstedt's test is a clinical procedure used to diagnose spinal stenosis. The test is performed via a lumbar puncture, and the opening pressure is measured. Both the jugular veins are then compressed by hands, which leads to a rapid increase in intracranial pressure in normal anatomical structures. However, if stenosis is present in the spine, there will be a damped, delayed response in the lumbar puncture indicating a positive Queckenstedt's test[1]. The change in pressure is caused by the increased intracranial venous volume produced by compressing jugular veins. An increase in the CSF pressure indicates a change in the CSF flow dynamics. If the CSF flow changes can be observed while compressing jugular veins, MR flow measurement could be an alternative of Queckenstedt's test which needs lumber puncture. The purpose of this study is to measure the change in the CSF flow dynamics using PC-MRI when both jugular veins are compressed (Figure 1).

[Methods] PC-MRI using a 1.5-Tesla clinical scanner with a two-dimensional gradient echo sequence was performed in 6 healthy volunteers. The acquisition parameters were TR/TE = 12.3/4.7 ms, flip angle = 20°, slice thickness = 10 mm, field of view (FOV) = 20 × 20 cm with a matrix size of 256 × 128, number of slices = 1, and velocity encoding parallel to slice direction = 20 cm/s. The region of interest (ROI) was placed in the aqueduct of the midbrain by one observer. The maximum and mean velocities (cm/s) as well as the CSF stroke volume (mL) were measured twice each under jugular vein compression (push) and while at rest (release). The push and release values obtained were compared using paired t-test.

[Results] Significant differences were observed between the flow measurements of push and release ;release vs. push, maximum velocity, 2.40 ± 0.70 cm/s (mean ± standard deviation) vs. 1.47 ± 0.30 cm/s ($p = 0.0002$); mean velocity, 1.09 ± 0.36 cm/s vs. 0.72 ± 0.12 cm/s ($p = 0.0010$); stroke volume, 2.82 ± 0.87 mL vs. 1.98 ± 0.44 mL ($p = 0.0040$). The typical flow curves are illustrated in the Figure 2.

[Discussion] Changes in midbrain aqueduct pressure may be caused by changes in blood vessel capacity as a result of heart beats. Since the cranial capacity remains constant, a change in blood vessel capacity causes a change in the CSF space capacity. This volumetric change leads to an increase in CSF space pressure, thereby elevating the flow in the aqueduct of the midbrain. Therefore, a decrease in the CSF space pressure during jugular vein compression will result in a decrease in the CSF flow in the aqueduct of the midbrain.

[Conclusion] We successfully measured the changes in CSF flow dynamics using PC-MRI when both jugular veins were compressed.

[References]

1. Pearce JM. Queckenstedt's maneuver. J Neurol Neurosurg Psychiatry 2006;77:728.

Figure 1

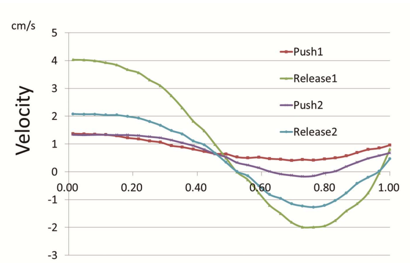

Figure 2

Figure 1

Both the jugular veins are compressed by hands.

Figure 2

CSF flow curves measured in the aqueduct of the midbrain. Compared with the release graph, the amplitude in the push graph is small. These graphs show that the CSF flow is bidirectional, and the bidirectional flow decreases when both jugular veins are compressed.