Cerebrospinal Fluid Research

Oral presentation

Interaction between hydrocephalus shunt and pressure waves

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Background

The majority of contemporary hydrocephalus valves are designed to introduce a low resistance to flow into the cerebrospinal fluid (CSF) drainage pathway. This, according to mathematical models, and clinical observations may influence the magnitude of ICP waveform. On the other hand, exaggerated waves of ICP may influence drainage through the shunt. We attempted to review these phenomena systematically both in clinical practice and laboratory.

Materials and methods

From our database of nearly 1600 pressure recordings (both infusion tests and overnight ICP monitoring) in patients routinely diagnosed for hydrocephalus we selected 35 patients in whom CSF infusion study was repeated before and after shunting. The relationship between pulse amplitude and mean ICP was compared between patients with functioning (121) and blocked shunt (127). We discussed recordings from three patients with unusually strong respiratory wave. In laboratory we studied six constructions of medium-pressure valves. Valves have been mounted in the testing rig, perfused with deionised water with a rate of 0.3 ml/min and proximal pulsating pressure of different amplitude (from 2 mm Hg to 30 mm Hg peak to peak) and frequency (70 cycles/min to 10 cycles/min) were superimposed.

Results

Although, in NPH, mean ICP not always decreases after shunting, baseline pulse amplitude of ICP significantly decreased from median (range): 2.5 (0.2; 5.9) mm Hg to 1.4 (0.3;4.1) mm Hg; $p < 0.0051$. In three patients with functioning shunts and high amplitude of respiratory pattern, baseline pressure was negative (from -2 to -7 mm Hg). The relationship between pulse amplitude and ICP was stronger in patients with blocked shunts ($R = 0.48$; $p < 0.03$; slope 0.14) than in patients with properly functioning shunt ($R = 0.057$; $p = 0.765$). In the laboratory, the mean operating pressure decreased in all valves when simulated amplitude of respiratory and heart pulsations increased. The rate of this decrease was dependent on type of the valve (variable from 2.5 to 5 mm Hg per increase in peak-to-peak amplitude by 10 mm Hg). The decrease was not related to the frequency of the wave.

Conclusion

The shunt's operating pressure, which determines the mean ICP in shunted patients may be influenced by the dynamics of a patient's ICP waveform. Shunt, in turn, has an ability to reduce dynamics in pressure waves. Decrease in pulse amplitude of ICP pulse waveform may be a marker of proper shunt drainage.