

Principles of testing hydrocephalus shunts in vivo using infusion test

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Objective

Hydrocephalus shunts may fail after implantation. Patients may develop adverse symptoms, which are not always 100% specific for shunt failure, and brain imaging may be not always clear. Our recent study in mixed population (adults and children) showed that in approximately 50% of cases referred to Hydrocephalus Clinic for infusion test to check shunt system patency, blockage (either proximal or distal) or overdrainage is not confirmed. These patients, if revised surgically, would not benefit from surgery.

Methods

Infusion study can be performed via two 25G butterfly needles inserted into shunt prechamber. Almost all shunts with CSF sampling chamber placed before the valve (exception: burr-hole Flow Control Valve) can be tested this way. Free aspiration of CSF is important marker of ventricular inlet patency. One needle is connected to pressure transducer and second to syringe infusion pump with Hartman solution. After 10 minutes of steady state pressure monitoring, infusion starts with the rate of 1.5 or 1 ml/min. Pressure rises until reaching plateau, then infusion is stopped and pressure decreases towards baseline value. Afterwards patient is sat up (in bed or reclining chair) and pressure is monitored minimum for 10 minutes.

Results

Around 2000 tests were performed in years 1993-2017 in shunted patients. Following principles were formulated: 1. Presence of detectable pressure pulse waveform at baseline and through the test is essential marker for patency of ventricular drain. 2. If during the infusion, pressure increases above 'critical threshold' established as shunt opening pressure plus shunt's hydrodynamic resistance times infusion rate plus 5 mm Hg, the valve is judged to underdrain. 3. Normal outflow resistance during infusion test should not exceed 6 mm Hg/(ml/mi) (exception: Orbis Sigma Valve). Cases with normal resistance but baseline pressure elevated above shunt operating pressure plus 5 mm Hg, can result from abnormally elevated abdominal pressure. 4. If during the 'tilting test', pressure decreases below -10 mm Hg initially and then it further decreases gradually, overdrainage is possible.

Conclusion

Infusion test allows avoiding unnecessary shunt revision. Test is safe, with sterile mode of preparation of skin and tubing/needles, rate of infection is less than 1% avoiding unnecessary shunt revision.