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Finally, open loop control of intracranial pressure in hydrocephalus

Harold L Rekate

In the recent paper by Farahmand *et al*[1] a new fully implantable telemetered intracranial pressure monitoring device (Raumedic AG, Helmbrecht, Germany) is used to study changes in intracranial pressure that occur in various positions and with various valve settings. The patient population studied here included 15 adult patients with 'communicating hydrocephalus' who underwent ventriculoperitoneal shunting using a Strata valve (Medtronic Inc, Goleta, California, USA).

With the development of adjustable valves for the treatment of hydrocephalus and effective devices to prevent severely negative intracranial pressure from siphoning, it has become possible to make intracranial pressure (ICP) and ICP dynamics normal for nearly all patients despite the fact that they cannot absorb the cerebrospinal fluid (CSF) naturally. The problem of defining exactly what is meant by "normal intracranial pressure dynamics" is controversial. To this point it could only be studied in an intensive care unit setting. Beginning in the late 1970s the problem of tailoring the shunt to the needs of the individual was recognised and the possibility of including an intracranial pressure sensor and a control mechanism for CSF flow was pursued by a study funded by National Aeronautics and Space Administration to study closed loop control of intracranial pressure in hydrocephalus. While there were prototypes of implantable pressure sensors produced and theoretical constructs for adjustable valves studied at that time, the technology was not far enough advanced to be practicable.[2]

The patients studied here were primarily suffering from normal pressure hydrocephalus. The system therefore did not include changes in the anatomy of the patient's central nervous system. There would always be CSF in the ventricle and therefore the physical principles at work were the function of the valve, the physics of the intracranial compartment (Monro-Kellie hypothesis), the pressure of the peritoneum and the hydrostatic forces brought on by changes in position. Using the valves the ICP was brought down in all positions and in all settings.

Having this technology is very exciting but would likely be even more valuable to the younger populations of patients who are shunted. In a study of the self-reporting database of patients with hydrocephalus developed by the Hydrocephalus Association, 73% of patients with shunts between the ages of 18 and 45 received their shunts before the age of 1 year. Of these 40% suffer from severe chronic daily headaches. While the severity of these headaches cannot be accurately assessed by use of the database it is clear that the presence of a shunt over decades carries a high cost in quality of life.[3] Matching careful monitoring of ICP with ability to change the function of that valve will normalise CSF dynamics and may well improve quality of life for many productive young people. Telemetry for patients with shunts and difficulties with shunts is a major advance in understanding that has great potential to improve the lives of many patients.

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