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Contemporary shunt technology: 20 years of Cambridge Shunt Lab

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Shunt testing independent on manufacturers provide knowledge that can contribute significantly to improve management of hydrocephalus patient.

Cambridge Shunt Evaluation Laboratory was created 20 years ago. Thanks to financial support from the Department of Health (1993-1998) all shunts in use in the UK were systematically evaluated with “blue reports” printed by the Medical Devices Agency. Later, new devices were tested, as they appeared in public domain.

Fresh shunts (3 samples) were tested in three identical rigs. Pressure flow characteristics and their descriptive parameters, as hydrodynamic resistance, opening, closing and operating differential pressure were measured over minimum duration of one month.

26 models have been tested. The majority of the valves had a non-physiologically low hydrodynamic resistance (from 1.5 to 3 mmHg/(ml/min) which may result in overdrainage both related to posture and during nocturnal cerebral vasogenic waves. A long distal catheter increases the resistance of these valves by 100–200%. Drainage through valves without a siphon preventing mechanism is very sensitive to body posture. Shunts with siphon-preventing accessories offer a reasonable resistance to negative outlet pressure. On the other hand, valves with membrane devices may be blocked by raised subcutaneous pressure. In adjustable devices the settings may be changed by external magnetic fields of intensity above 40 mT (exception: ProGAV, ProSA and Polaris). Most of magnetically adjustable valves produce large distortion of MRI scans.

Bench parameters were used for testing of shunt performance in vivo using infusion tests. Criterion for correctly performing shunt was established. Pressure measured in shunt prechamber during plateau phase of infusion should stay not more than 5 mmHg above level of shunt’s operating pressure plus hydrodynamic resistance of valve multiplied by infusion rate. Such “critical levels” for every shunt and every performance level have been incorporated in ICM+ software. In more than 2000 tests performed in patients exhibiting adverse clinical symptoms with shunts in situ, in almost 1200 cases shunts underperformance was revealed. These patients underwent revisions and in majority improved immediately after surgery.

The behavior of a valve revealed during testing is of relevance to the surgeon and may not be adequately described in the manufacturer’s product information. This information is useful for shunt testing in vivo.