

# **The adjustable shunt valve in the treatment of adult hydrocephalus**

## **Effect on complications, intracranial pressure and clinical symptoms**

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av

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This thesis is based on the following studies, referred to in the text by their Roman numerals.

- I. Farahmand D, Hilmarsson H, Högfeldt M, Tisell M. Perioperative risk factors for short term shunt revisions in adult hydrocephalus patients.  
*Journal of Neurology, Neurosurgery and Psychiatry, 2009. 80(11): p. 1248-53.*
- II. Farahmand D, Qvarlander S, Malm J, Wikkelsö C, Eklund A, Tisell M.  
Intracranial pressure in hydrocephalus: Impact of shunt adjustments and body positions.  
*Submitted to Journal of Neurology, Neurosurgery and Psychiatry, 2014.*
- III. Sæhle T, Farahmand D, Tisell M, Eide PK, Wikkelsö C.  
A randomized controlled double-center trial on shunt complications in idiopathic Normal Pressure Hydrocephalus treated with gradually reduced or “fixed” pressure valve settings.  
*In revision, Journal of Neurosurgery, 2014.*
- IV. Farahmand D, Sæhle T, Eide PK, Tisell M, Hellström P, Wikkelsö C.  
A double-blind randomized trial on the clinical effect of different shunt valve settings in idiopathic normal pressure hydrocephalus.  
*Submitted to Journal of Neurosurgery, 2014.*

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## ABSTRACT

**Background:** Hydrocephalus causes impaired gait, balance, cognition and continence, all of which can be reversed by shunt treatment. Adjustable valves are commonly used in the shunt treatment of hydrocephalus but randomized controlled trials (RCT) are scarce. The aim of the present thesis was to evaluate adjustable valves in the treatment of hydrocephalus.

**Patients and Methods:** In Study I, 450 hydrocephalus patients undergoing primary shunt insertion were followed over 10 years to investigate the short-term perioperative risk factors of shunt surgery. In Study II the relationship between intracranial pressure (ICP) and ICP wave amplitude (AMP), valve settings and body positions were studied in 15 hydrocephalus patients. During the shunt operation an intraparenchymatous ICP-sensor was simultaneously inserted and ICP/AMP analyzed with the shunt ligated and when opened at different opening pressures and body positions. A double-centered RCT was conducted in studies III and IV, including 68 patients with iNPH. The patients received a ventricular shunt and were randomized into two groups; in one group (20-4) the valve was initially set to 20 cm H<sub>2</sub>O and gradually reduced to 4 cm H<sub>2</sub>O over the course of the 6 month study period. In the other group (12), the valve setting was kept at a medium level of 12 cm H<sub>2</sub>O during the whole study period. In study III the time to and type of complications and overdrainage symptoms were recorded. In Study IV clinical variables were continuously compared between the two groups.

**Results:** In total, 538 patients were included and the six month shunt revision rate was 19 %. Fifty-four percent of the patients received adjustable valves. Both adjustable valves and right frontal placement of the shunt were associated with a lower shunt revision rate, but not independently. ICP and AMP decreased significantly when the shunt was opened but the difference in ICP between the highest and lowest valve settings (*in vivo*) was smaller than previous measurements *in vitro*. Gradual reduction of the valve setting from 20 to 4 cm H<sub>2</sub>O neither improved clinical outcome nor the complication rate, compared to a fixed valve setting at 12 cm H<sub>2</sub>O. The clinical improvement was seen within 3 months postoperatively.

**Conclusions:** Gradual reduction of the valve setting from a high to a low level neither improved the clinical outcome nor the complication rate, compared to a fixed valve setting at medium level. The pressure window in an adjustable valve is narrower *in vivo* than *in vitro*. ICP in the upright position is significantly different from the supine position. Right frontal shunt placement and the use of adjustable valves were associated with a lower shunt revision rate, but a coincidence of these two variables was found.

Key words: *Hydrocephalus, Shunt surgery, Shunt complications, Intracranial pressure, Pressure hydrocephalus.*

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