Acta Neurochir (2000) [Suppl] 76: 559–562

Clinical Experiences with the Dual-Switch Valve in Patients with Normal Pressure Hydrocephalus

F. S. Zeilinger[1], T. Reyer[2], U. Meier[1], and D. Kintzel[2]

[1] Department of Neurosurgery, Unfallkrankenhaus Berlin mit berufsgenossenschaftlicher Unfallklinik, Germany
[2] Department of Neurosurgery, Krankenhaus im Friedrichshain, Germany

Summary

In patients with normal pressure hydrocephalus (NPH) we compared the postoperative results reference to the implanted valve type.

In 117 patients diagnosed with normal pressure hydrocephalus there was placement of 47 Cordis Standard valves (CSV), 20 Cordis Orbis Sigma valves type I (OSV) and 50 Miethke Dual-switch valves (DSV). Ninety-five patients (36/19/40) were re-evaluated. Normal pressure hydrocephalus was graduated according to the results of the intrathecal infusion test in an early and late stage. There were no statistical differences in mechanical and infective complications between the different valve types. We found significant differences in overdrainages and subdural hematomas. Two patients (6%) with a CSV, 3 patients (16%) with an OSV and 1 patient (3%) with a DSV developed clinical symptoms due to this.

The course of disease in patients with NPH is influenced by the stage of disease – degree of cerebral atrophy – and also by the implanted valve type. The great amount of overdrainage complications and subdural hematomas in the Cordis Orbis Sigma valve group may be an argument against this valve. Our clinical experiences with the Miethke Dual-switch valve show that this hydrostatic valve may be advantageous for patients with NPH.

Keywords: Normal pressure hydrocephalus; shunt operation; hydrostatic valve; overdrainage.

Introduction

Despite emerging knowledge in valve regulated shunt therapy for treatment of hydrocephalus internal, there are still biomechanical problems caused by an unphysiological construction of the valves. This is reflected in the high number of available devices with more than 195 different valves, which can be subdivided into three construction types. The first group, the so called differential pressure valves, have a fixed opening pressure which is related to the horizontal position of the patient. The programmable valves allow a non-invasive adjustment of the opening pressure but they also bear the problem that they do not take the posture of the patient into account. The third group are hydrostatic valves which aim to reduce the flow through the shunt when the patient moves into the upright position [1, 15, 16].

Conventional differential pressure valves have the disadvantage in patients with a normal pressure hydrocephalus (NPH) that they open abruptly when the patient moves into the upright position and therefore induce a negative pressure on the brain.

Patients and Methods

117 patients with normal pressure hydrocephalus were treated by a ventriculo-peritoneal shunt insertion in the Department of Neurosurgery of the hospital Berlin-Friedrichshain from May 1982 and in the Department of Neurosurgery of the Unfallkrankenhaus Berlin from September 1997 through March 1999. In 47 patients we implanted a Cordis-Standard valve, in 20 patients a Cordis-Orbis-Sigma valve type I, and in 50 patients a Miethke Dual-Switch valve (Fig. 1). Ninety-five of these patients (39/19/40) were thoroughly re-investigated. The signs of each patient were classified according to the clinical grading of Kiefer and Steudel, and we compared the course of disease after surgery and catamnesia at an average of 7 months, with our created NPH-Recovery-Rate [13].

$$\text{NPH-R-R} = \frac{\text{Clinical grading preoperative} - \text{postoperative}}{\text{Clinical grading preoperative}} \times 10$$

Comparison of the internationally established Black grading scale for shunt assessment [2] and our NPH-Recovery-rate is illustrated in Table 1. The indication for shunt implantation was made according to the clinical signs and the results of the intrathecal infusion test with measurement of a pathological, increased resistance [7, 11, 12]. The resistance to cerebrospinal fluid outflow (R_{out}) is the main criterion for grouping patients into those with normal pressure hydrocephalus and those with cerebral atrophy. A further differentiation into early stage (NPH without atrophy) and late stage (NPH in association with atrophy) is made by measuring the compliance (C_p) – this being a secondary criterion (Fig. 1). Patients whose outflow resistance was in the physiological range were diagnosed for cerebral atrophy. The mathematical fundamentals, the standardized investi-

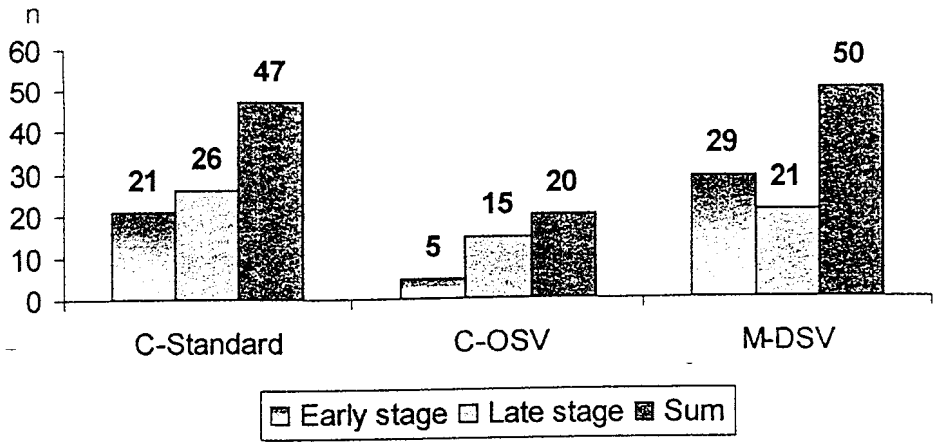

Fig. 1. Valve types versus NPH stage

Table 1. *Black Grading Scale for Shunt Assessment Versus NPH-Recovery-Rate*

Black grading scale for shunt assessment		NPH-recovery-rate
Grading	Description	More/same
Excellent	activity like before	7
Good	slight reduction	5
Fair	gradual improvement	3
Transient	temporary improvement	2
Poor	unchanged or worsened	less than 2

gation procedure, and the indications for the performance of a computer aided infusion test have been described previously [7–13].

Results

In the clinical follow up according to the NPH-Recovery-Rate and using the U-test of Mann-Whitney ($p < 0,01$), we have found a statistically significant improvement in patients with an implanted Miethke-Dual-Switch valve (*) and also catamnestia after a mean time interval of 7 months (**). While differentiating the operative and valve induced morbidity we found no difference in mechanical and infectious complications between the different valve types. Distinct differences exist in overdrainage complications and subdural hematomas (Fig. 3). Four patients (11%) with a Cordis-Standard valve, 5 patients (26%) with a Cordis-Orbis-Sigma valve type I and 2 patients (5%) with a Miethke-Dual-Switch valve had a reduction of ventricular width visualised in the CT scan or MRI. Of those, 2 patients (6%) with Cordis-Standard valve, 3 patients (16%) with a Cordis-Orbis-Sigma valve type I and 1 patient (3%) with a Miethke-Dual-Switch valve exhibited clinical signs. The 3 patients with a Cordis-Orbis-Sigma valve type I developed subdural hematomas and 2 (11%) of them had to be evacuated. One of these patients (5%) died due to a hematocephalus.

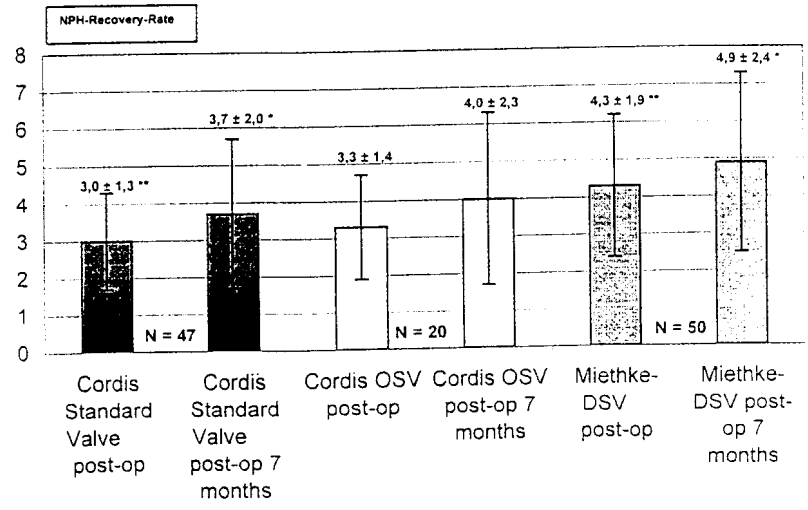

Fig. 2. NPH-recovery-rate versus valve types

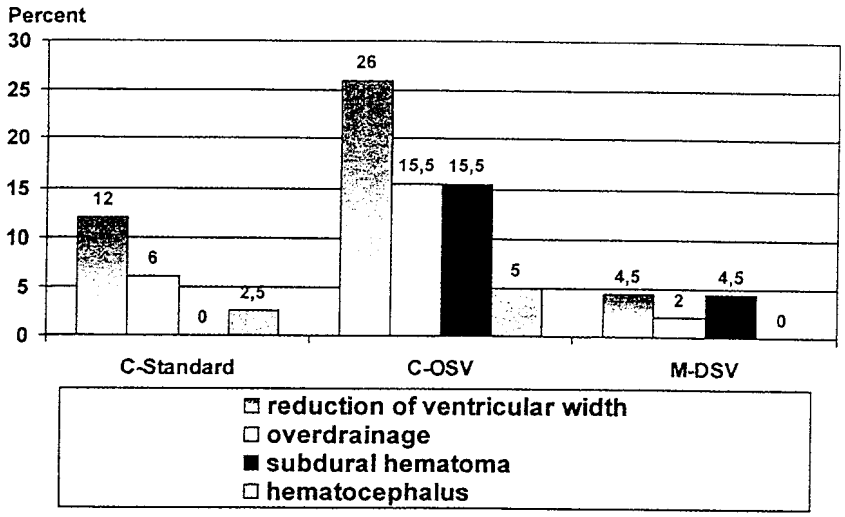

Fig. 3. Complications due to valve related overdrainages versus valve types

Two patients (5%) with a Miethke-Dual-Switch valve developed subdural hematomas, in one of these patients the subdural hematoma was resorbed without accompanying clinical symptoms within one month, and in the other patient we had to remove the shunt (Fig. 3).

Discussion

In patients with an early stage NPH there were 2 (6%) clinically relevant overdrainage complications after insertion of a Cordis-Standard valve (Fig. 3). Trost *et al.* [16] pointed out that many patients tolerate negative intraventricular pressure values which are a matter of fact of the physical characteristics of this valve type. In the Dutch multicentre study [3] there was a statistically significant better postoperative result obtainable with the implantation of low pressure differential pressure valves in comparison with medium pressure valves but this advantage was accompanied by a high overdrainage rate (71% versus 34%). The clinical relevance of the high overdrainage rate was not described in this study but in our opinion, this rate is too high. One reason for the implantation of differential valves is their low price but the costs for treatment of overdrainage complications are much higher. The reasons for the statistically significant better results after insertion of the Miethke-Dual-Switch valve (Fig. 2) are our subtle diagnostic procedures [7–13] and the construction of this valve which takes the changes of the patient's posture into account [14, 15, 16].

The Orbis-Sigma valve aims to regulate a constant flow which depends on the differential pressure acting on the system. This is very important in patients with a late stage NPH in order to avoid overdrainage complication. Unfortunately, we had altogether 5 overdrainages (26%) including 3 chronical subdural hematomas (16%) as complications with this valve type. Also Weiner *et al.* [17] reported about subdural hematomas in patients with NPH after insertion of an Orbis-Sigma valve. In contrast to Czosnyka *et al.* [4], Decq *et al.* [5] found a significantly lower overdrainage rate after Orbis-Sigma valve insertion in contrast to conventional differential pressure valves. These studies were not exclusively evaluating patients with NPH and therefore they cannot completely be compared with our results. According to our results the Orbis-Sigma valve is not appropriate for patients with NPH. The Cordis differential pressure valve bears the disadvantage in patients with a late stage NPH that they induce a suction effect on the brain when the patient moves into the upright position. An anti-siphon device can prevent this problem but the resistance of the system is then increased. In our patients we observed 3 overdrainages (8%) and 2 (6%) of these patients developed clinical signs with this valve type. The Miethke Dual-Switch valve [14] is the first construction which changes between two different valve chambers in parallel depending on the posture of the patient. Two of our patients (5%) with a Dual-Switch valve developed subdural hematomas and one of those exhibited no clinical signs. The more favourable results of the patients with the Dual-Switch valve are evident and are expressed in the criteria of the NPH-Recovery-Rate (Fig. 2).

The course of disease in patients with NPH is influenced by the stage of disease (NPH with or without cerebral atrophy) at the moment of therapy and of the implanted valve type. According to Lee *et al.* [6] an adequate shunt operation offers the chance for an improvement of cerebral blood flow and vasomotor reactivity in NPH patients. The low overdrainage rate with less than 5 percent and the good postoperative results in our opinion are the main aspects that the Miethke Dual-Switch valve represents at the present moment, the best valve in patients for NPH.

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Correspondence: Dr. med. Frank S. Zeilinger, Department of Neurosurgery, Unfallkrankenhaus Berlin mit berufsgenossenschaftlicher Unfallklinik e.V., Rapsweg 55, 12683 Berlin, Germany.