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Case study

Short- and long-term neurobehavioral effects of lumbar puncture and shunting in patients with malabsorptive hydrocephalus after subarachnoid haemorrhage: An explorative case study

Bernd-Otto Hütter *, Joachim-Michael Gilsbach

Department of Neurosurgery, RWTH Aachen University, D-52057 Aachen, Germany

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ABSTRACT

Background: The neuropsychological effects of lumbar puncture and shunting in terms of cognitive functioning and quality of life were analyzed prospectively in four patients with malabsorptive hydrocephalus who became symptomatic in the chronic state after aneurysmal subarachnoid haemorrhage (SAH).

Methods: A comprehensive battery of neuropsychological tests was applied to four patients before and shortly after lumbar puncture and six months later. In three of them a shunt has been inserted, one patient was treated by repeated lumbar punctures. In addition, the patients completed a quality of life and a depression questionnaire before lumbar puncture and after shunting. The data were analyzed using single-case methodology.

Results: Hydrocephalus was associated with pronounced cognitive deficits in terms of functions of attention, short- and long-term memory, concentration and motor fine-coordination but not with a general mental deterioration. Quality of life and affect were also substantially impaired. Neuropsychological tests of fronto-cortical cognitive capacity, motor fine coordination and reaction time proved to be sensitive for the short-term effects of lumbar puncture. Memory functions and the capacity of divided attention needed more time for regeneration and improved substantially after shunt implantation.

Conclusions: We found a complex pattern of cognitive improvement after lumbar puncture and shunting. Furthermore, our results also show a typical cluster of cognitive deficits associated with malabsorptive hydrocephalus including motor dysfunction. These preliminary findings should be confirmed in larger patient samples.

1. Introduction

Malabsorptive hydrocephalus (MH) is a frequent late complication of subarachnoid haemorrhage (SAH) developing in 10–43% of the patients [1]. In patients with normal pressure hydrocephalus (NPH) the indication for shunting is dependent on the clinical improvement of the patient after lumbar puncture (LP) [2]. In contrast, little is known as of yet about the neuropsychological consequences of LP and shunting in patients with MH after SAH [3]. It is not clear which neuropsychological functions are particularly sensitive for changes of higher cerebral functions due to intracranial pressure. The present study was performed to explore the immediate cognitive changes after LP and the long-term course of cognitive functioning and quality of life in patients with MH after SAH.

2. Patients and methods

2.1. Patients and procedure

The inclusion criteria were as follows: the age at the time of haemorrhage was 18–65 years; increased intracranial pressure caused by acute MH in the postacute or chronic state not later than one year after aneurysmal SAH; no further neurological and/or psychiatric disease and any additional severe internal illness; a good neurological result (GOS = I) according to the Glasgow Outcome scale [4] at discharge; good german language competency. Informed consent could be obtained from five of seven patients fulfilling the required criteria during the study period. One additional patient refused further participation at the study. Severity of SAH

* Corresponding author at: Department of Neurosurgery, Clinical Neuropsychology Division, University Hospital Essen, University Duisburg-Essen, D-45122 Essen, Hufelandstr. 55, Germany. Fax: +49 201 723 5909.
E-mail address: otto.huetter@uk-essen.de (B.-O. Hütter).

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was classified according Fisher [5] while the clinical state of the patients on admission was rated according to Hunt & Hess [6]. The first neuropsychological examination was performed immediately before LP, a second 30–45 min after the release of cerebrospinal fluid (CSF) and a follow-up about half a year later. In addition, quality of life and depression were assessed at the time of the first neuropsychological examination and at follow-up.

2.2. Neuropsychological tests used

Handedness was determined by the Edinburgh Interview [7]. Speed of motor fine-coordination in both hands was measured by the Finger Tapping test [8], concentration capacity by the test d2 [9]. The memory scale of the German intelligence test IST was used to examine verbal long-term memory [10]. The German version of the Recurring-Figures and the Recurring-Words test was employed for measuring figural and verbal short-term memory [11,12]. The Benton test served to examine visuoconstructive capacity [13]. Further, by means of three tasks of a computerized neuropsychological testing battery (TAP) [14] reaction time, alertness, divided attention and selectivity were assessed. In addition an alertness score was computed [14]. The examination of divided attention demands the simultaneous pursuit of two different tasks [14]. The Go/NoGo test is a task of selectivity, a fronto-cortical cognitive function [14]. Finally, we used the Mini-Mental State [15] exam. For the memory tasks parallel versions for the different examinations were used.

2.3. Analysis of neuropsychological test scores

In order to ascertain the individual level of cognitive capacity, the test scores were compared to the published age-adjusted test norms. A deficit is indicated if the test score reaches or underscores a value two standard deviations below the mean of the test norms. The Benton test has individual cut-off values to indicate a deficit [13]. However, because of a wide range of normal scoring in the Finger Tapping test, the computation of test norms and their application is not useful [8]. This measure is quite sensitive to detect intraindividual change [8] but has the drawback that critical difference scores cannot be computed as well as test norms [16,17].

2.4. Examination of quality of life

Quality of life was examined by the Aachen Life Quality Inventory (ALQI) [18]. The ALQI was developed for the use in patients with brain damage. It contains 117 items in 11 subscales, which enable the calculation of 11 subscale impairment scores, a sum score of total impairment (Total score), a psycho-social (Social score) and a physical summary score (Physical score). The ALQI consists of a self-rating and a parallel proxy-rating version.

2.5. Assessment of depression

Depression was measured by the Beck Depression Inventory (BDI) for self-administration and by the Hamilton Depression Rating scale [19,20]. In the BDI a raw score of >10 and in the Hamilton Depression Rating a raw score >9 was regarded as an indication for the presence of a depressive disorder.

2.6. Statistics – the single case methodology

In order to confirm statistically the differences between the test scores of each individual patient, the critical cut-off values were computed according to Huber [17]. All statistics needed for this single-case statistical procedure were taken from published test norms. All cut-off values gathered by this procedure represent critical differences significant at a type-1 error level of $p < 0.05$ with two-sided testing [16,17]. In single-case studies these procedures allow the statistical confirmation of differences found in parallel tests or in the case of repeated measurement [16,17].

3. Results

3.1. Case 1 patient K.A.

A 54 year-old right-handed female (Edinburgh = +93) had sustained SAH from a ruptured aneurysm of the right middle cerebral artery (MCA). On admission the patient was in a Hunt&Hess grade III. The preoperative cerebral computed tomography (CCT) showed a right-frontal intracerebral haemorrhage and a thin layer of intraventricular blood in both lateral ventricles (Fisher grade 4). The aneurysm was clipped two days after the bleeding. Two days after surgery, the patient developed a psycho-organic syndrome and vasospasm. Three weeks later, the patient was discharged home without any neurological or psychiatric disturbances. A CCT scan performed three months later revealed a right frontal hypodense lesion of 2×3 cm and no further abnormalities. Eight months later, she was readmitted to the neurosurgical department because of cognitive slowing, memory disturbances, disorientation, gait disturbances and urinary incontinence. The Mini-Mental State score was 23. In addition to the known right frontal substance defect, a CCT scan showed a distinct dilatation of the ventricle system, interpreted as a substantial MH. The CSF pressure was 27 cm H_2O and 35 ml liquor were drained. Neuropsychological examination was performed before and after LP. On the day after the insertion of a ventriculo-atrial shunt, the mental symptoms, gait disturbances and the urinary incontinence became rapidly less severe and resolved completely in the further course. Four months after shunt insertion when the neuropsychological follow-up examination was performed, magnetic resonance imaging (MRI) demonstrated the correct position of the shunt, a slight symmetrical enlargement of the lateral ventricles and modestly increased periventricular signal intensities. Table 1 gives the neuropsychological data of this patient.

3.2. Case 2 patient T.C.

A 53 year-old right-handed (Edinburgh = +100) male patient suffered SAH following the rupture of an anterior communicating artery aneurysm (ACoA). He was in a Hunt&Hess grade IV on admission. On CCT scan a frontobasal SAH with intraventricular blood in the posterior horns of both lateral ventricles was seen (Fisher grade 4). The postoperative course was uneventful. A mild psycho-organic syndrome resolved rapidly after surgery. Daily TCD investigations showed no signs of vasospasm. The patient was discharged six days after SAH to another hospital with no neurological deficits or dysfunctions. A CCT scan performed 4 weeks later gave evidence of a small frontal hygroma and slightly enlarged lateral ventricles but no parenchymal focal lesions. One year later, the patient was admitted to the neurosurgical unit because a CCT scan demonstrated a ventricular widening accompanied by cognitive slowing, memory problems, tiredness, gait disturbances and urinary incontinence. The Mini-Mental State examination revealed a score of 21. The CSF pressure was 30 cm H_2O and 15 ml CSF were drained. After implantation of a lumbo-peritoneal shunt, the clinical state improved rapidly. Four days after shunting, he could return home in a good clinical condition. Table 2 gives the neuropsychological test results of this patient. The follow-up exam was performed 28 weeks after shunt insertion.