Intracerebral Hemorrhage With Severe Ventricular Involvement
Lumbar Drainage for Communicating Hydrocephalus

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Background and Purpose—The objective was to analyze the feasibility of a lumbar drainage (LD) for a communicating malresorptive hydrocephalus in patients with supratentorial hemorrhage (intracerebral hemorrhage) accompanied by severe ventricular involvement (intraventricular hemorrhage) who required an external ventricular drain (EVD).

Methods—In this retrospective study, 16 patients received an EVD and concurrent LD and were compared with 39 historical patients treated with EVD alone. The duration of required EVD and need for permanent ventriculoperitoneal-shunt were analyzed.

Results—LD was inserted after 12 (4 to 18) days. In LD-treated patients, the LD was capable to replace repeated EVD exchanges, resulting in a shorter EVD-duration (12 versus 16 days) compared with patients treated with EVD alone. The overall duration of extracorporeal cerebrospinal fluid drainage was longer (16 days EVD versus 21 days EVD+LD) and the frequency of ventriculoperitoneal-shunt lower (18.75% versus 33%; P<0.03) in LD-treated patients.

Conclusion—Our data suggest that LD is safe and feasible for treatment of nonpersistent communicating hydrocephalus after intracerebral hemorrhage. After adequate treatment of the occlusive hydrocephalus using an EVD in the acute phase, LD discloses an alternative for further extracorporeal cerebrospinal fluid drainage. (Stroke. 2007;38:183-187.)

Key Words: communicating hydrocephalus ■ intracerebral hemorrhage ■ intraventricular hemorrhage ■ lumbar drainage ■ therapy ■ treatment

Insertion of an external ventricular drain (EVD) is a common and lifesaving procedure in intracerebral hemorrhage (ICH) patients with severe intraventricular hemorrhage (IVH) and consecutive occlusive hydrocephalus. However, EVD frequently needs to be exchanged because of infections, persistent obstructive hydrocephalus, or because of a communicating (ie, malresorptive) hydrocephalus caused by impairment of the Pacchioni granulations by ventricular hemorrhage. In these cases, a permanent ventriculoperitoneal-shunt (VP-shunt) is usually indicated. However, in patients with a communicating hydrocephalus, sufficient extracorporeal cerebrospinal fluid (CSF) drainage could be achieved by insertion of a lumbar drainage (LD), thereby replacing the EVD and extending the time for recovery of the Pacchioni granulations. Our objective was to evaluate the feasibility and potential benefits of LD in ICH patients with communicating hydrocephalus.

Methods

Patient Selection
Between the years 2000 and 2005, clinical data of all ICH patients were collected prospectively in a database (n=811). For this study, all patients with spontaneous primary supratentorial ICH were identified who required an EVD because of occlusive hydrocephalus caused by severe IVH (n=89). We further excluded those patients who received intraventricular fibrinolytic therapy for clot lysis (n=28). Between the years 2000 and 2003, patients were treated only with an EVD for extracorporeal CSF drainage (n=45; in the following, referred to as group I). According to an institutional protocol established since 2004, all consecutive patients received an additional LD (n=16; in the following, referred to as group II).

Imaging Data
ICH was diagnosed immediately after hospital admission by CT. Hematoma volume (cm³) was calculated using the formula for ellipsoids (ABC/2). The site of the ventricles affected was noted using the Graeb score. Hydrocephalus was determined by enlargement of the lateral ventricles on CT on admission or follow-up CT after 24 (mean 23±6.1) hours. Hydrocephalus was evaluated by measuring the bicaudate index (considered present when it exceeded the 95th percentile for age) and the mean temporal horn diameter.

Clinical Management
The Glasgow Coma Scale for each patient was scored before intubation. If the patient was admitted to our institution breathing spontaneously, the Glasgow Coma Scale was scored on admission, otherwise we recorded the Glasgow Coma Scale as scored by the emergency physician outward.

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Stroke is available at http://www.strokeaha.org
EVD Management (Group I)

EVD management was performed according to an institutional protocol. The EVD was inserted ipsilaterally and rostrally to the hematoma as soon as occlusive hydrocephalus was diagnosed. CSF was routinely controlled for ventriculitis and total protein. The EVD was clamped if intracranial pressure (ICP) was \(< 20 \text{ mm Hg for } 24 \text{ hours and removed after another 24 hours after performing control CT with absence of enlarging ventricles, otherwise reopened. The EVD was routinely exchanged after 8 (median 8; range 4 to 13) days in cases of persisting hydrocephalus, as well as in cases of infection, dislocation, or insufficient drainage because of obstruction.}^2 \text{ In cases of persistent communicating hydrocephalus (which was defined as } \geq 4 \text{ futile attempts to clamp the EVD), VP-shunts were indicated before insertion of a third EVD (ie, before the second EVD exchange).}

EVD and LD Management (Group II)

In the hyperacute phase, EVD management was as described above. According to a protocol starting in 2004, LD was initiated in patients in whom in the course of treatment, a persistent hydrocephalus was evident, but CT analysis revealed a complete clearing of the third and fourth ventricle from blood clots. Thereupon, a communication

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**Figure 1.** Median duration of EVD, median overall time of extracorporal CSF drainage, and frequency of VP-shunts (in %) for both groups.
between inner and outer CSF spaces was assumed, and we hypothesized a sufficient extracorporal CSF drainage using an LD. Although the EVD remained open, a silicon catheter was introduced through a 16-gauge curved tip needle (Tuohy typ) into the subarachnoid space at the L3-4 level and connected to a sterile collecting system fixed at a drainage height of 5 to 15 cm above the foramen of Monroe. During the transitional period of opened EVD and LD, only a slow CSF drainage by LD was tolerated to avoid a pressure gradient and, although implausible, to minimize risk of transforaminal herniation. During lumbar CSF drainage, EVD was clamped and was only reopened when ICP increased or the follow-up CT showed evidence of enlarging ventricles. If the EVD had to be opened, clamping the LD was subsequently tried once per day. As soon as there was no rise in ICP for >24 hours (although EVD remained closed, and LD was open) and no enlargement of ventricles was observed on CT, the EVD was removed. After the EVD was removed, attempts to clamp the LD were performed every second day, and control CT was done routinely. The LD was routinely exchanged according to the above-described criteria for EVD. VP-shunts were placed after 5 futile attempts of clamping the LD.

To avoid bias, those patients of group I with persistent occlusive hydrocephalus who showed filled-out third and fourth ventricles (at the chronologically comparable time point to that of insertion of LD in patients of group II) were excluded from the control group I (n=6). Fifty-five patients remained for final analysis (39 patients with EVD alone [group I] versus 16 patients with EVD and LD [group II]).

**Statistical Analysis**

We performed the Shapiro–Wilk test to analyze the distribution of the data. Normally distributed data are expressed as mean±SD and were compared using the unpaired t test. Other data are expressed as median and range and were compared with nonparametric tests. $\chi^2$ and Fischer exact were used to determine associations between variables categorized. A value of $P \leq 0.05$ was considered statistically significant.
Results

Demographic and neuroradiologic characteristics are shown in the Table. Median Graeb scores on admission were similar in both groups. Patients of group II received the LD after a median of 12 (4 to 18) days after admission; the median duration of LD was 9 (3 to 12) days. The Graeb scores at the time point of LD insertion in patients of group II were also similar to the chronologically comparable CT scans of group I.

Patients of group I required EVD longer than patients with additional LD (median 16 [8 to 24] versus 12 [5 to 25] days; Figure 1 [histograms show the exact frequencies for both groups]; Figure 2A and 2B). The overall duration of continuous extracorporeal CSF drainage was longer in LD-treated patients (median 16 [8 to 24] versus 21 [9 to 28] days; Figure 1 [histograms show the exact frequencies for both groups]; Figure 2C and 2D). VP-shunts were placed after a median of 18 (14 to 24) days in group I and 22 (18 to 25) days in group II. The frequency of VP-shunts was significantly lower in patients with LD (13 of 39 versus 3 of 16; \( P < 0.03 \); Figure 1). CSF infection rates were 10.2% in group I and 6.25% in group II. EVD needed to be replaced because of obstruction in 2 patients of group I and in 1 patient of group II. The LD needed to be replaced once in 1 patient of group II because of catheter removal. There were no complications such as subdural hematoma or herniation in either group.

Discussion

In acute ICH patients with ventricular involvement and occlusive hydrocephalus, prompt CSF drainage by ventriculostomy is the current treatment of choice.5 In cases of persisting malreabsorptive hydrocephalus and the need for repeated EVD changes,
placement of VP-shunt is usually indicated. The pathophysiology of a communicating malresorptive hydrocephalus after IVH is still not fully understood, but dysfunction of the CSF reabsorbing Pacchioni granulations of the arachnoida caused by mass effect of the ventricular blood clots and thus de-equilibration of the physiological workflows of the arachnoida seem to be major factors.4

This study provides first insights in the feasibility and potential benefit of LD in persistent communicating hydrocephalus. In our series, LD was indicated in ICH patients with IVH who required further extracorporeal CSF drainage because of persistent hydrocephalus and who showed complete clearing of the third and fourth ventricle and thus in whom a communicating hydrocephalus could be postulated. In patients with this constellation, LD was safe and feasible without evidence of increased risk for axial herniation or increased rates of infection, and it shortened the duration of required EVD. Moreover, the time of extracorporeal CSF drainage could be extended and the frequency of VP-shunts reduced. Two aspects emerge from our data.

First, LD has the capability to replace EVD in communicating hydrocephalus and to reduce the need of EVD exchanges. The efficacy of LD in this setting was confirmed because none of the patients of group II exhibited evidence of increasing ICP (which was controlled by EVD in the transitional period after insertion of LD) or enlargement of ventricles during LD. As a less invasive bedside technique, LD has been shown previously to be beneficial in patients with refractory intracranial hypertension9 or in cases of vasospasms after subarachnoid hemorrhage.10 The rationale for the use of lumbar CSF drainage in patients with communicating hydrocephalus consisted in the replacement of EVD and undesirable EVD exchanges, which are associated with the risk of bleeding, iatrogenic repetitive structural damage of brain tissue, infections, subdural hematoma, or symptomatic seizures.1–3,11 We neither observed increased rates of infections nor any side effects related to the lumbar CSF drainage, especially no signs of herniation, a theoretical risk in cases of excessive drainage of the lumbar CSF spaces, which can be minimized by controlled release of CSF under continuous monitoring of ICP via EVD during the first 24 hours and exclusion of patients with filled out third and fourth ventricles.

Second, the LD enables the extension of time of extracorporeal CSF drainage avoiding an EVD, thereby increasing the period for potential recovery of the arachnoida and reconstitution toward normal CSF resorption. We observed a reduced frequency of final VP-shunts in LD-treated patients. Differences in clinical and radiological characteristics between groups I and II are not likely to contribute to this observation because these parameters were comparable. Possibly, extension of EVD duration might have resulted in comparable frequencies of VP-shunts in group I. However, repeated EVD changes for extending the drainage period (increasing risk of ventriculitis with increasing “length of EVD stay”) are invasive with the risk of anesthesia and surgery and are therefore usually not recommended for persistent malresorptive hydrocephalus.5 For these patients, LD represents a promising option to extend the duration of external CSF drainage with the advantage of fewer side effects.

However, the interpretation of our data are limited. With regard to the second aspect discussed, we compared the LD-treated patients with a “historical” control group, which, however, is in the nature of this nonrandomized retrospective study; the less frequent requirement of VP-shunts might be influenced by a self-fulfilling prophecy.12 Moreover, the data of both groups were obtained retrospectively, and the differences between the groups might be explained by different surgeons with different opinions on when to replace the EVD or to insert a VP-shunt.

In conclusion, LD seems to be a simple, safe, and reasonable alternative to EVD in patients with communicating hydrocephalus after IVH. A prospective controlled study is needed to verify the potential benefits of an LD found in this study. Future treatment strategies such as intraventricular fibrinolysis13 might facilitate clot lysis and thus influence CSF circulation. In these patients, LD might even be inserted earlier and duration of EVD further reduced.

Disclosures

None.

References

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