Editorial

Influence of protein, red blood cell count, and surgical site on shunt performance following aneurysmal subarachnoid hemorrhage

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The manuscript by Rammos et al. in this issue of the Journal of Neurosurgery is an important contribution to the neurosurgical literature because it challenges 2 assumptions that are commonly made by practicing neurosurgeons: 1) that placement of a ventriculoperitoneal (VP) shunt in the presence of an elevated protein level or red blood cell (RBC) count increases the risk of subsequent shunt malfunction; and 2) that proximal VP shunt catheter placement at the same site as a previous external ventricular drain (EVD) carries a higher risk of infection than placement at a new, “clean” site.

The authors retrospectively reviewed 80 patients with hydrocephalus following aneurysmal subarachnoid hemorrhage (SAH) who underwent conversion of an EVD to a VP shunt. The VP shunt placement was performed at a mean of 14.1 days (range 3–45 days) after EVD placement, regardless of the presence of an elevated cerebrospinal fluid (CSF) protein level or RBC count. The proximal VP shunt catheter was placed at the same site and through the same track as the previous EVD, which was removed at surgery immediately prior to placement of the permanent ventricular catheter. There were no reported shunt infections and there was a low shunt malfunction rate (3.8%) over a mean follow-up period of 2 years. These findings are important because they have the potential to influence the current practice of many neurosurgeons.

Prior to addressing the important issues raised by the authors regarding protein level, RBC count, and surgical site, it is worthwhile to discuss briefly the indications for shunt placement in this patient population. It is well known that hydrocephalus can resolve spontaneously over several weeks in some of these patients, particularly when hydrocephalus develops slowly over the few days subsequent to the onset of SAH. Although the authors of this series reported an extremely low complication rate, the best way to avoid shunt complications is not to place one at all, and therefore every effort should be made to prove that permanent CSF diversion is required prior to placement of a VP shunt. Regarding their surgical indications for shunt placement, the authors only state that conversion of an EVD to a permanent VP shunt was considered “if progressive elevation of the EVD drip chamber and/or EVD clamping resulted in increased ventricular size or neurological deterioration.” In their reply to this editorial, it would be worthwhile for the authors to comment further on their surgical indications. Specifically, was intracranial pressure (ICP) measured in these patients? Were increases in ventricular size associated with elevations of ICP? Were shunts placed for minor increases in ventricular size in the absence of symptoms or elevated ICP? If an initial attempt to wean a patient from the EVD failed, did the authors immediately place a shunt in the patient or did they wait a few days and try to wean them from the EVD again?

Regarding CSF protein levels at the time of shunt placement, it should be noted that the spectrum of protein levels in this study was very wide, ranging from 17 to 516 mg/dl. The mean protein level was 124 mg/dl, which is certainly elevated compared to the expected value in ventricular CSF (25.6 mg/dl in the largest study of normal volunteers). However, the notion that an elevated CSF protein level increases the risk of shunt complications has already been called into question by Brydon and colleagues, who reported in a prospective study that an elevated CSF protein level was not associated with an increased risk of shunt failure. Even in premature infants with posthemorrhagic hydrocephalus, who often have protein levels 10-fold higher than the mean protein level in this study, at our institution we currently do not view an elevated CSF protein level without evidence of infection as a reason to delay permanent shunt placement. We are thus not surprised that elevated CSF protein levels in some patients in this series did not result in a higher than average rate of shunt complications.

The perioperative RBC count in CSF (mean 14,204/mm$^3$ and median 4600/mm$^3$) was considerably elevated in patients in this study, which also did not result in an increased rate of shunt malfunction. This is an important finding, because it is contrary to a previous study, cited by the authors, which demonstrated that a perfusate containing ≥ 0.25% blood often causes blockage and malfunction of shunt valves. It should be noted that the lowest percentage of whole blood in the tested perfusates, 0.25%, contains ∼ 10,000 RBC/mm$^3$, not 5–10 RBC/mm$^3$ as stated by the authors in the Discussion. Regardless, one would intuitively expect that shunt placement without waiting for CSF to clear further would result in an increased risk of shunt failure due to blood products.
Editorial

clogging the valve or proximal catheter. The fact that the shunt malfunction rate was very low in this series is noteworthy and may lead neurosurgeons to feel more comfortable placing shunts in this patient population without waiting for a lower RBC count. As the authors mention, a certain proportion of patients with hydrocephalus after aneurysmal SAH may not be permanently shunt dependent, so it is possible that RBC products did cause shunt malfunction in some patients; this was not clinically important because these patients already had become shunt independent spontaneously. Thus, the authors’ comfort in placing VP shunts in patients with elevated RBC counts should not be extended to patients with hydrocephalus from causes other than aneurysmal SAH without additional study.

Regarding the site of shunt placement, the authors report no cases of shunt infection despite placement of the proximal catheter through the same incision, bur hole, and ventricular catheter track as the previous EVD. Although to our knowledge there are no previous studies comparing infection rates for shunts placed at the same site as a previous EVD to those placed at a new site, many neurosurgeons assume that a fresh site carries a lower risk of infection. At least for patients with aneurysmal SAH, this publication certainly challenges that assumption. Although using the previous incision and bur hole is faster than using a new site and may not increase the risk of infection, it is our opinion that the authors state too emphatically that doing so “minimizes the operative risks of hemorrhage and catheter malpositioning.” These assertions, although reasonable, are not proven either by this manuscript or by any previous publication to our knowledge, and therefore, until further evidence develops, using either the previous site or a new site should both be considered reasonable options. There may be situations, such as asymmetrical lateral ventricles or asymmetrical intraventricular hemorrhage, in which placement of a catheter contralateral to the EVD should be strongly considered. Moreover, without further evidence, the results of this study should not be applied to other patient populations, such as infants, who have higher baseline shunt infection rates.

The authors also place a significant weight on the use of antibiotic-impregnated shunt catheters, even stating in the introduction to their article that the “old dilemma” regarding surgical site and shunt infection risk “may not be relevant anymore” with the use of such catheters. Several retrospective studies have shown decreased shunt infection rates when a cohort of patients with antibiotic-impregnated catheters is compared to an older cohort without these catheters. However, other recent studies have shown no difference in infection rates at all when comparing such groups. The study by Zabramski et al. that is cited by the authors was a randomized prospective trial of EVD catheters whose results should not be extrapolated to the placement of permanent shunt systems. We strongly echo the conclusion of Kan and Kestle that “any recommendation for or against the use of antibiotic-impregnated systems... requires a prospective, blinded, randomized-controlled trial with adequate power.”

In conclusion, the authors are to be congratulated for performing an important study that may influence the practice of neurosurgeons treating patients who develop hydrocephalus after aneurysmal SAH. From the results of this study it follows that, if the need for permanent CSF diversion has been established, elevated protein and RBC counts are not contraindications to proceeding with shunt placement. This finding may expedite the mobilization of patients out of intensive care units and thereby enable aggressive physical therapy in a more timely manner and also lower hospital costs. It should also be concluded that placement of a VP shunt at the same site as a previous EVD does not appear to increase the risk of shunt infection in this patient population. It should not be concluded that placement of a shunt at the same site is definitively preferred, but rather that it is a reasonable option. Moreover, without further investigation, none of the results of this study should be applied to patients with hydrocephalus due to causes other than aneurysmal SAH.

References

Response

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We thank Drs. Sandberg and Heros for their very thoughtful and thorough analysis of our study. The senior author (G.L.) learned this practice of placing a VP shunt in patients with aneurysmal SAH through the same EVD track and regardless of the RBC and protein counts during his fellowship at the Barrow Neurological Institute. It appeared that the rate of shunt malfunction or infection was not increased, so we decided to study it in a more systematic manner.
Despite a multitude of studies describing prognostic risk factors for the development of shunt-dependent hydrocephalus in patients with SAH, there are no stringent or rigorously tested clinical or imaging criteria for permanent shunt placement in this patient population. Our primary but not universal method of assessment for possible shunt dependency has been temporary clamping of the EVD already in place after a baseline CT scan. If the patient develops symptoms and/or signs attributable to hydrocephalus, we reopen the EVD to drainage, and shunt implantation is considered. In the absence of symptoms/signs of symptomatic hydrocephalus, we obtain a repeat CT scan to assess for changes in ventricle size. Patients are considered for VP shunt placement if an increase in ventricle size is demonstrated between the initial and subsequent scans. After EVD clamping, we usually do not monitor or measure ICP, but most of our decisions are based on clinical and radiological findings.

In practice, numerous exceptions exist to this simplified decision-making process. For example, in young patients with no focal or significant cognitive deficits, we try as much as possible to avoid a VP shunt and may decide to give it “another try.” Conversely, in elderly patients after SAH we have had a very low threshold to consider VP shunt placement, based on the assumption that CSF reabsorption is already borderline in this patient population and less amenable to “EVD wean.” Similarly, in patients with neurological impairment we have had a very low threshold to place a VP shunt, based on the assumption that another “challenge” in these patients could impair and/or delay their ability to recover from their deficit. This low threshold to perform a VP shunt insertion has resulted in a shunt placement rate close to the high range of that reported after aneurysmal SAH. This may have favorably and indirectly influenced the low rate of shunt malfunction observed in this series.

We agree that the conclusions of this study cannot be extended to other patient populations. Over the years, we have used this same strategy in adult patients with head injury and intraparenchymal hemorrhage with intraventricular extension who are in need of a VP shunt. We have not included those patients in the present analysis, to keep the study focused on a well-defined and homogeneous patient population. Definitely, conclusions derived from this study cannot be extrapolated to pediatric patients with hydrocephalus.

In conclusion, we agree with Drs. Sandberg and Heros that the results of this study offer an alternative option to current dominant neurosurgical practices. We have shown that patients with aneurysmal SAH who are deemed candidates for permanent shunt implantation can safely undergo insertion of the devices by using the same surgical track as for the previously placed EVD, and regardless of CSF protein and RBC contents. We believe that this practice avoids other potential surgical complications and shortens the duration of intensive care unit stay in this sensitive population of patients. (DOI: 10.3171. JNS.2008.109.12.0998)