AJNR

Reply:

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AJNR Am J Neuroradiol 2016, 37 (2) E17-E18
doi: https://doi.org/10.3174/ajnr.A4667
http://www.ajnr.org/content/37/2/E17

REPLY:

I appreciate the thorough review and comments on our recent article, "Meta-Analysis of CSF Diversion Procedures and Dural Venous Sinus Stenting in the Setting of Medically Refractory Idiopathic Intracranial Hypertension,"[1] by Dr Noonan. I humbly concede that our meta-analysis of the dural venous sinus stent (DVSS) is not significantly different from the previously published meta-analysis on the topic of DVSS for idiopathic intracranial hypertension (IIH),[2] though another meta-analysis on DVSS was not the goal of the article. The DVSS portion of the article represented only one-third of the focus of the article. The goal of the article was to compare outcomes and complications of DVSS with traditional surgical approaches (CSF flow diversion and optic nerve sheath fenestration) on the basis of the best available published literature and to highlight that the "standard of care" for medically refractory IIH may not be superior to DVSS. To date, no large meta-analysis has been performed comparing surgical intervention with the DVSS in the setting of IIH. The purpose of this article was to challenge the assertion that surgery, rather than endovascular treatment, should be considered as the first-line standard of care for all patients with medically refractory IIH. Therefore, this article represents a significant and unique contribution to the literature.

The major limitation of the article was the retrospective nature and inconsistent data collection, which are inherent with meta-analysis study designs and are further complicated by comparison of different procedures by different operators focusing on different clinical parameters. This limitation was a considerable challenge, and direct comparison of baseline characteristics and follow-up was impossible.

One criticism raised by Dr Noonan was our approach to exclusion/inclusion of particular articles. This was largely driven by the numbers and was arbitrary. DVSS is a relatively new procedure compared with optic nerve sheath fenestration and CSF flow diversion; therefore, significantly less patient data were available. Data regarding DVSS were incomplete and inhomogeneous, given the current lack of standards (selection and follow-up). We chose to exclude any article deemed to have poor or incomplete data. Articles with a single patient were also excluded because they did not significantly add to the power of the study (7 articles with single patients are already well-described in the literature). Larger patient numbers were, in our opinion, worth the effort required to evaluate and standardize the data to help power the study. The 15-patient cohort from Albuquerque et al[3] was included to help power the DVSS subset, despite not providing detailed pretreatment CSF opening pressures, given that the remainder of the data points were documented. Albuquerque et al did report, however, that elevated venous pressures were confirmed in all except 1 patient (18/19 patients).[3] In reference to the comments regarding Table 4, venous sinus stenting, Bussière et al[2] did report CSF opening pressures as a range between 25 and 50 cm H_2O, which was provided in the body of the article under "Materials and Methods." Strict inclusion criteria were not commonly adhered to in the surgical modalities.

http://dx.doi.org/10.3174/ajnr.A4667

Emergent evacuation of a subdural hematoma is not to be taken lightly and may be less common now, given improved catheter technology with use of flexible large-bore guiding catheters such as the Neuron Max catheter (Penumbra, Alameda, California). Subdural hematomas were reported in only 4/136 patients and resulted in no deaths in the DVSS group. Additionally, the major complication rate in this group was significantly lower than that in the surgical alternatives. I humbly contend that most neurointerventionalists would not consider re-stent placement as a complication, but rather a limitation. If we defined "repeat procedure" as a complication, the CSF flow-diversion group would appear even less appealing to physicians and patients because 154/435 patients required an astonishing additional 428 procedures. This was just during the average follow-up period of 41 months in largely young female patients, with an average age of 31.9 years (potentially, additional procedures might be needed for many more years).

Finally, I would agree with Dr Noonan that there is great promise for the DVSS in the setting of appropriately chosen patients with medically refractory IIH. I would propose incorporation of the following before any stent procedure:

1) A multidisciplinary approach (documenting truly medically refractory IIH)

2) CSF studies with elevated opening pressures

3) Careful imaging selection before venography (MR imaging and MRV with and without contrast)

4) Venography confirming stenosis and direct pressure measurements (gradient, $\geq$8 mm Hg) without sedation

5) Intervention by using a careful technique (a triaxial approach by using modern ultra-flexible guiding catheters) and the "conduit technique" to minimize the risk of dural sinus injury[4] and dual antiplatelet therapy minimizes risk of in-stent thrombosis

6) Thorough long-term follow-up including clinical examination (symptoms, papilledema, funduscopic examination) and follow-up CSF pressures.

I sincerely hope this article proves to be a valuable contribution to the literature, ideally serving as a stepping stone to better understand the disease and potentially suggesting a new paradigm in the treatment of patients with medically refractory IIH.

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