Abstract

**Background:** Stenting and flow diversion for aneurysmal subarachnoid hemorrhage (aSAH) requires the use of dual antiplatelet therapy (DAPT).

**Objective:** We investigate whether DAPT is a risk factor for hemorrhagic complication with placement of external ventricular drains (EVD) in patients with aSAH.

**Methods:** Rates of radiographically identified hemorrhage associated with EVD placement were compared between patients who were on DAPT for stenting or flow diversion, and patients who underwent microsurgical clipping or coiling and were not on DAPT by way of a backward stepwise multivariate analysis.

**Results:** 443 patients were admitted for management of aSAH. 298 patients required placement of an EVD. 120 patients (40%) were treated with stent assisted coiling or flow diversion and required DAPT, while 178 patients (60%) were treated with coiling without stents or microsurgical clipping and were not on DAPT. 42 (14%) cases of new hemorrhage along the EVD catheter were identified radiographically. 32 of these hemorrhages occurred in patients on DAPT, while 10 occurred in patients without DAPT. After multivariate analysis, DAPT was significantly associated with hemorrhage (OR: 4.92, 95% CI: 2.45-9.91, p=.0001). 5 hemorrhages (5 of 10 [50%]) were classified as symptomatic in patients not receiving DAPT, while 10 hemorrhages (10 of 32 [31%]) were classified as symptomatic in DAPT patients (p=.4508).

**Conclusions:** Patients with aSAH who receive stent assisted coiling or flow diversion are at higher risk for radiographic hemorrhage associated with EVD placement. Nevertheless, they remain viable options for aSAH patients in an era of evolving endovascular therapeutics.

METHODS

Informed consent was obtained to enter data prospectively into a quality control database for patients presenting to the UIHC between July 2009 and November 2016 with aSAH. All medical records and imaging studies for all patients receiving EVD placement during this time period were retrospectively reviewed.

The standard techniques for EVD placement at our institution have been previously described and were employed throughout this analysis. The patients who underwent stent-assisted coiling or flow diversion received 600 mg clopidogrel and 325 mg aspirin at the time of stent insertion, followed by 75 mg clopidogrel daily and 325 mg acetylsalicylic acid daily postoperatively. DAPT was not discontinued during the perioperative period.

All post-operative CT scans obtained during the index hospitalization were reviewed by a neuroradiologist not involved in the study at the UIHC for clinical purposes. Two blinded attending neurosurgeons further reviewed the CT scans to confirm hemorrhage extent and location. A hemorrhage was deemed EVD-related if it occurred along the ventricular catheter tract. A hemorrhage was classified as symptomatic if it required further surgical intervention, was associated with a temporally related deterioration in serial neurological examination, or caused seizures.

The odd ratios for radiographically identified hemorrhage with respect to the following variables were analyzed with the use of logistic regression: age, sex, EVD approach, antiplatelet therapy prior to admission, presenting Hunt and Hess grade of the aSAH, presenting Fisher grade, and presenting World Federation of Neurosurgical Societies grade. Variables associated with hemorrhage in the univariate analysis (p<.35) were included in a backward, stepwise, multivariate analysis.

RESULTS SUMMARIZED

The patient characteristics, identified hemorrhages, and multivariate analysis results are summarized in the accompanying figures.

- **443 Patients admitted with aSAH, 1309 CT scans reviewed**
- **298 Received EVD**
- **DAPT was significantly associated with increased odds of radiographically identified hemorrhage [OR: 4.92, 95% CI: 2.45-9.91, p=.0001]**
- **5 hemorrhages (5 of 10 [50%]) were classified as symptomatic in patients not receiving DAPT, while 10 hemorrhages (10 of 32 [31%]) were classified as symptomatic in DAPT patients (p=.4508).**

Conclusions

Our analysis confirms that patients with aSAH who are candidates for stent assisted coiling or flow diversion are at higher risk for hemorrhage associated with EVD placement. Despite this risk, the identified DAPT associated hemorrhages do not appear to be of increased clinical significance. Stent assisted coiling and flow diversion for aSAH remain options in an era of evolving endovascular therapeutics.