

Introduction

External ventricular drains (EVDs) have an important role in the management of neurological disease and are one of the most common neurosurgical procedures. Hemorrhage is a common complication of EVD placement and has recently been recognized to occur more frequently than originally believed. There is also risk of hemorrhage with removal of an EVD, which has not been well described. We investigated the risk factors associated with placement and removal of EVDs at our institution.

Methods

After obtaining IRB approval, a database was created to include all patients who required EVD placement from March 2008 to June 2014 at our institution. A retrospective chart review was completed and all imaging studies during the index hospitalization were reviewed for evidence of hemorrhage on placement and removal of an EVD.

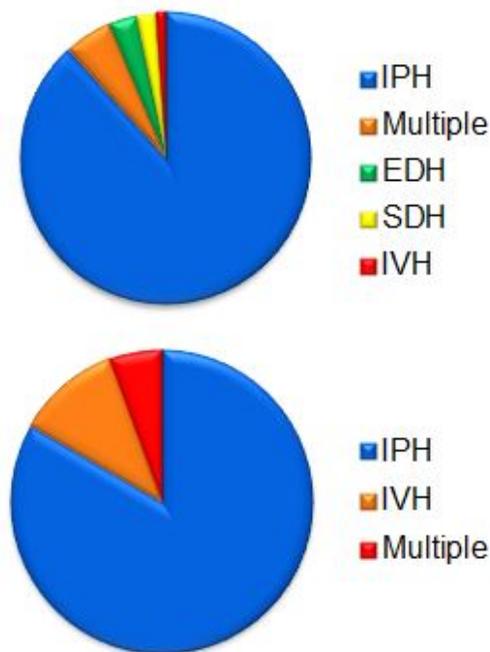
Reasons for EVD	#
Hemorrhage	
SAH	119
IPH/IVH/SDH	85
Cerebellar hemorrhage	9
Tumor	86
Shunt infection/malfunction	57
Hydrocephalus	48
Stroke/Edema	17
Trauma	8
Other	53

Results

482 EVDs were placed in 380 patients during the designated time period for hemorrhage (213), tumor (86), shunt infection or malfunction (57), hydrocephalus (48), cerebral edema (17), trauma (8), and other causes (53). Hemorrhage occurred in 94 patients (19.5%) on EVD placement. The hemorrhage volume ranged from 0.003cm³ to 45.9cm³ and the average was 1.96 ± 6.48cm³. Fifty-five EVDs (22.5%) were associated with a hemorrhage on EVD removal. The average volume was 8.25 ± 20.34cm³ and the hemorrhage volumes ranged from 0.012cm³ to 82.08cm³.

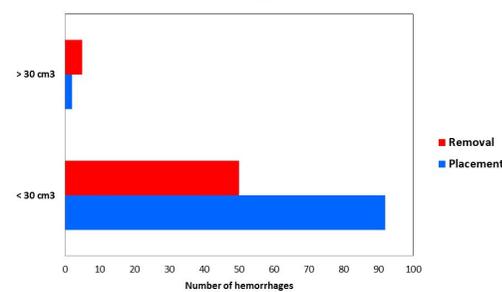
Demographics

Total EVDs	482 (380 patients)
Pediatric	73
Adult	409
Location	
Frontal	457
Occipital	14
Temporal	3
Parietal	8
Placement location	
Bedside	267
Intraop	215
Navigation	
Stealth	53 (1 bedside)
U/S	25
Endoscopic	13
None	390



Hemorrhage types with placement (top) and removal (bottom). IPH: intraparenchymal hemorrhage, EDH: epidural hematoma, SDH: subdural hematoma, IVH: intraventricular hemorrhage

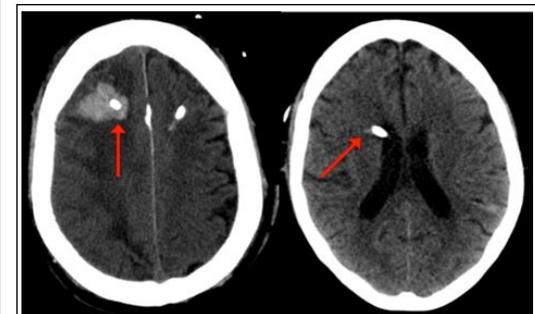
Hemorrhage Volume



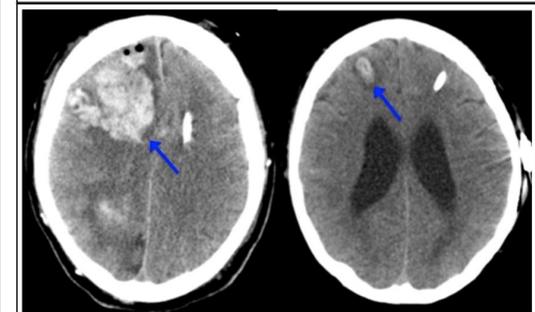
Identified hemorrhages divided into those less than 30cm³ and those larger than 30cm³.

Conclusions

Multiple studies have investigated hemorrhage related to EVD placement with rates varying from 0-42%, while very few studies have described hemorrhage secondary to EVD removal. This is the first reported analysis of risk factors associated with hemorrhage on EVD removal. In this series of patients, decreased platelet count on admission and an increasing number of attempts for placement correlated with an increased risk of hemorrhage on EVD placement. Only those with an EVD placed at bedside were more likely to have hemorrhage on EVD removal.



Variation in hemorrhage volume with EVD placement



Examples of hemorrhages with EVD removal