The Efficacy of Shunting vs. Endoscopic Third Ventriculostomy as First-line Treatments for Posthemorrhagic Hydrocephalus in Infants

Ayathi Gogineni

Medical Science Internship Program

Virginia Commonwealth University School of Medicine

Background

Intraventricular Hemorrhage (IVH) is one of the most commonly detected brain lesions on ultrasound in premature infants. The classic pathogenesis of IVH is the rupturing of the intrinsically fragile germinal matrix vasculature and the fluctuation in cerebral blood flow. Two prominent prophylaxes of IVH include: prenatal glucocorticoids and postnatal indomethacin. If IVH is not successfully prevented, the risk of posthemorrhagic ventricular dilation or posthemorrhagic hydrocephalus significantly increases. As hydrocephalus is associated with an increased risk of mortality and physical and cognitive deficits, it is important to determine the efficacy of the permanent, first-line treatments: endoscopic third ventriculostomy (ETV) and shunting. In ETV, the third ventricle floor is perforated to create a connection between the ventricles and cisterns in the subarachnoid space to reduce intracranial pressure; in shunting, a perforation is created in the brain with a catheter placed in one of the lateral ventricles to drain extra cerebrospinal fluid (CSF) to other parts of the body, including the pleural cavity or the right atrium..

Methods/Materials

- A literature search was conducted using PubMed and UpToDate to find experimental studies investigating the efficacy of ETV and shunting.
- Luther et al. 2019 Study: A retrospective analysis of the Nationwide Inpatient Sample (NIS) yielded 11,017 infant discharges with posthemorrhagic hydrocephalus of prematurity (PHHP) between 1998- 2014
- Jernigan et al. 2014 Study: A retrospective analysis of the Pediatric Health Information Systems database yielded 5416 infants with congenital or acquired hydrocephalus; out of which 1205 infants had a history of IVH; between 2004-2009
- Both studies looked at the differences in mortality rates, operative failure rates, and long- and short-term consequences using statistics from infant (< 1 year old) pools of different ages and weights with specific ICD-9-CM codes.
- Both studies had more patients receive the shunting treatment than ETV.

References

1. Luther, Evan & McCarthy, David & Sedighim, Shaina & Niazi, Toba. (2020). Endoscopic third ventriculostomy inpatient failure rates compared with shunting in post-hemorrhagic hydrocephalus of prematurity. Child's Nervous System. 36. 10.1007/s00381-019-04465-w. :
2. Jernigan, S. C., Berry, J. G., Graham, D. A., & Goumnerova, L. (2014). The comparative effectiveness of ventricular shunt placement versus endoscopic third ventriculostomy for initial treatment of hydrocephalus in infants, *Journal of Neurosurgery: Pediatrics PED*, *13*(3), 295-300. Retrieved Jul 21, 2021, from https://thejns.org/pediatrics/view/journals/j-neurosurg-pediatr/13/3/article-p295.xml
3. de Vries LS., Leijser, LM. (2021). Germinal matrix hemorrhage and intraventricular hemorrhage (GMH-IVH) in the newborn: Prevention, management, and complications. In: UpToDate, Post TW (Ed), UpToDate, Waltham, MA.

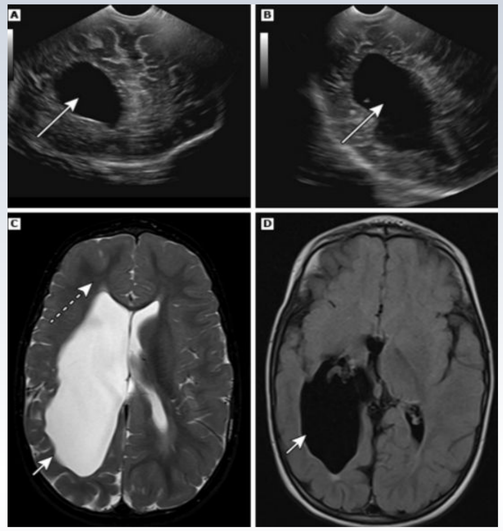

Figure 1

Follow-up ultrasound (Coronal: A; Sagittal: B) and MRI (T2-weighted: C; FLAIR: D) that demonstrate periventricular hemorrhagic infarction (grade IV IVH: worst level of IVH). On images A and B, the white arrows mark resulting hydrocephalus. Figure adapted from De Vries and Leijser, 2021.

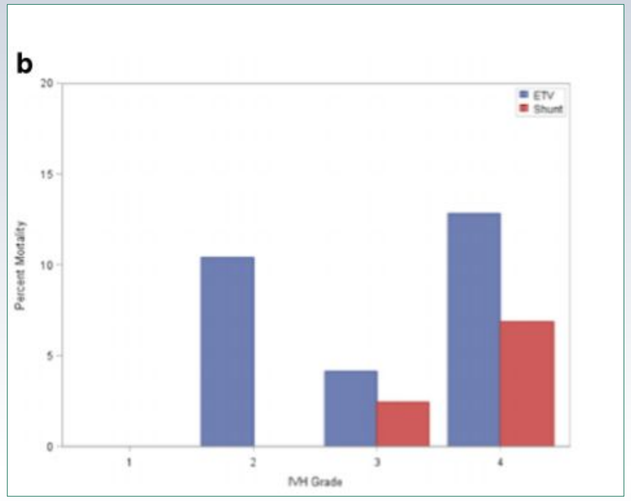

Figure 2

PHHP trend of patient mortality percentages stratified by treatment modality and IVH grade of severity. infants initially shunted had higher proportions of grade I-III IVH; however, ETV has higher mortality rates for those grades. Figure adapted from Luther et al. 2019.

Factor	Risk of Surgical Failure			
	Unadjusted OR (95% CI)	p Value	Adjusted OR (95% CI)	p Value
all patients: ETV vs VPS	2.9 (2.3–3.5)	<0.001	2.6 (2.1–3.2)	<0.001
0–90 vs 91–365 days	1.9 (1.7–2.1)	<0.001	1.6 (1.4–1.8)	<0.001
prematurity	1.8 (1.6–2.1)	<0.001	1.3 (1.2–1.5)	<0.001
IVH	2.1 (1.8–2.4)	<0.001	1.4 (1.2–1.7)	<0.001
MMC	1.0 (0.9–1.2)	0.75	1.1 (1.0–1.4)	0.15

Figure 3

Multivariate analysis of factors contributing to risk of surgical failure within one year. VPS: ventriculoperitoneal shunting; MMC: myelomeningocele. Figure adapted from Jernigan et al. 2014.

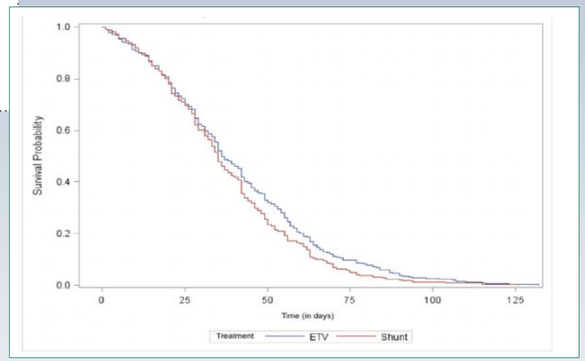

Figure 4

Kaplan-Meier curve analyzing time to inpatient treatment failure for ETV and shunt. Figure adapted from Luther et al. 2019.

Results/Conclusions

- ETV patients had higher overall and per IVH grade mortality rates and treatment failure rates.
- ETV had a higher inpatient failure crossover rate (79.5%) than shunting (54.3%).
- However, ETV patients had an increased number of comorbidities and were usually delivered at < 29 weeks and had a low birth weight (<1 kg), which may contribute to the greater mortality rates.
- ETV failed later during hospitalization than shunt patients specifically for this etiology of hydrocephalus.
- IVH-mediated hydrocephalus had the highest shunt failure rate and a 2.1 times greater risk of surgical failure than other etiologies/factors of hydrocephalus.

Future Directions

- Further studies must be conducted specifically accounting for the environment in which these procedures are administered, considering factors such as geographic region, hospital funding, and stress factors.
- It is also recommended to conduct a study with larger and more similar sample sizes between ETV and shunting groups of infants. This can be conducted using a power analysis and case-controlling.