Predictors of Outcome in Cerebral Aqueductoplasty: An Individual Participant Data Meta-Analysis

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No conflicts of interest
Illustrative Case

- 2 year old female with a history of post-Germinal Matrix Hemorrhage leading to hydrocephalus
- s/p VP shunt following failed ETV/CPC
- Subacute presentation of progressive clumsiness, falls and right sixth nerve palsy
Objectives

**Primary:** To perform an individual participant data meta-analysis to determine the efficacy and safety of Cerebral Aqueductoplasty.

**Secondary:** To determine the effect of patient’s age, etiology, surgical approach and use of stent on success.
Main inclusion/exclusion criteria for articles

Inclusion criteria
[1] Case cohort methodology
[2] Consecutive participants (minimum of 2)
[3] Participants that have undergone CA
[4] Outcome reported for individual participants

Exclusion criteria
[1] Single case reports
[2] Reviews
[3] Participants reported due to anomalous features
[4] Participants that had undergone simultaneous ETV or CSF shunt insertion/revision at the time of CA
Methodology

- Electronic databases (MEDLINE, EMBASE, and CINAHL) were searched with no language or date restrictions.
- Data extraction: By one author and verified by a second author.
- Outcome: Time elapsed from the index operation until a second procedure for CSF diversion.
- Statistical Analysis: Time-to-event. Univariate and Multivariate Cox Regression models to test our hypothesis.
Results

- 14 articles included: 137 participants
- Median age at surgery: 4.0 (IQR=1.0-16.5) years
- 103 (75%) of participants did not require a second CSF diversion procedure
  - 25 (19.3%) participants with congenital etiology (primary aqueductal stenosis)
  - 104 (80.6%) with acquired etiology:
    - 44 post-hemorrhagic
    - 24 post-infectious
    - 10 IFV
    - 9 post-tumor resection
    - 2 myelomeningocele related
    - 10 other
    - Rest – no etiology reported
Efficacy of Cerebral Aqueductoplasty

Mean duration till repeat CSF diversion procedure was 121.6 (95% CI = 102.2-141.0) months
## Multivariate Regression

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Hazard Ratio</th>
<th>Confidence Interval (95%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log_{10}(Age at Surgery)</td>
<td>0.430</td>
<td>0.211-0.877</td>
<td>0.020*</td>
</tr>
<tr>
<td>Congenital Etiology</td>
<td>0.184</td>
<td>0.040-0.846</td>
<td>0.030*</td>
</tr>
<tr>
<td>Infratentorial approach</td>
<td>0.469</td>
<td>0.157-1.400</td>
<td>0.175</td>
</tr>
<tr>
<td>Stent placed</td>
<td>0.297</td>
<td>0.125-0.703</td>
<td>0.006*</td>
</tr>
</tbody>
</table>

* Statistically significant independent predictors of outcome in CA
Complications

Tracked in 58 (42%) participants

- Mortality 0
- Morbidity 13 (22%) of participants
  - New ophthalmoparesis 7 (12%) – 1 was permanent
  - Hemorrhage (Subdural hematoma, Venous hemorrhage) – 3 (5%)
  - Catheter related complications 2 (3%)
  - Procedure abandoned 1 (2%)
Effect of Etiology (Congenital vs. Acquired)

Congenital etiology (HR=0.18, 95%CI=0.04-0.85, p=0.030)
Effect of Approach (Supra- vs. Infra-tentorial)

Infratentorial approach (HR=0.47, 95%CI=0.18-1.40, p=0.175)
Effect of Stent (Stent vs. No stent)

Use of stent (HR=0.30, 95%CI=0.13-0.70, p=0.006)
Strengths

1) We performed a comprehensive search
2) We did not exclude studies based on language of publication or date of publication
3) We obtained IPD to perform our meta-analysis.
Limitations

1) Non-standardized reporting affects the validity of data abstraction and assessment of risk of bias

2) Self-reported surgical series may be biased. Lack of appropriate tools to evaluate risk of bias in observational prognostic studies

3) Neuropsychological and quality of life outcomes following CA which are patient-important outcome measures were not evaluated
Conclusions

• Small retrospective cohort studies are inherently prone to bias, some are overcome using IPD.

• The best available evidence suggests that CA is an effective procedure with a moderate morbidity profile.

• Older age at surgery, congenital etiology and use of stent predicts a longer durability of treatment.
Thank you

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