Neuroendoscopic Intervention in Posthemorrhagic Hydrocephalus : Feasibility and Outcomes

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Abstract

Backgroud:
To evaluate the feasibility of active neuroendoscopic lavage (NEL) for posthemorrhagic hydrocephalus (PHH) in preterm infants and to assess associated clinical outcomes.

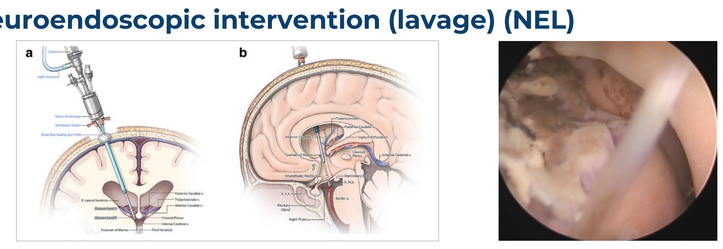
Methods:
Medical records of infants with PHH treated at Severance Children's Hospital between 1998 and 2023 were retrospectively reviewed. Patients were classified into two groups: active NEL (Group A) and conservative care (Group B). The presence of fibrinolysis therapy within Group A was also examined. Baseline demographics, surgical characteristics and shunt-related outcomes were compared.

Results:
Patients in Group A underwent VP-shunt placement at a later postnatal age and later postmenstrual age, compared to Group B. The duration of first EVD to VP-shunt was longer in group A than group B. In Group A, the fibrinolysis (+) subgroup underwent initial surgery earlier but received VP shunt placement at a comparable PMA to the non-fibrinolysis group. The VP-shunt-related complications were lower in group A than group B, while fibrinolysis therapy showed no significant difference.

Conclusion:
Active and early neuroendoscopic intervention improved PHH control and reduced infection rates, allowing delayed but safer shunt insertion with better growth. Larger, severity-matched cohorts and integrated brain MRI analysis are needed to further elucidate the long-term neurodevelopmental impact of early intervention.

Introduction

- Posthemorrhagic hydrocephalus (PHH) is a critical complication of high grade intraventricular hemorrhage (IVH) in preterm infants.
- Recently, the neuroendoscopic intervention (lavage) has been introduced as another promising treatment option.
- **Neuroendoscopic intervention (lavage) (NEL)**



- Minimal invasive surgery & direct removal of blood product in ventricle

  ➔ ↓ burden of inflammation, ↑ CSF circulation, ↓ needs for shunt revision
- lower mortality & infection rates compared to conventional surgical methods.
- We aimed to evaluate the feasibility of active neuroendoscopic intervention as part of the treatment strategy for PHH.

Methods

- Retrospecitve cohort study
- Study population
  - Preterm infants born in January 1998 – December 2023
  - Admitted in Severance Hospital NICU (Both Inborn & transferred patients)
  - Diagnosed with postnatal IVH with PHH
  - Underwent surgical intervention
- **Comparison between groups**:
  - Active neuroendoscopic intervention (Group A) and conservative care (Group B)
  - Presence of fibrinolysis therapy within Group A
  - Following variables were compared:
    - Gestational age, birth weight, sex
    - Postnatal days at diagnosis of IVH, first operation and VP shunt
    - PMA at VP shunt
    - Frequency of operation, interval between first operation and VP shunt
    - VP shunt rate
- **Active neuroendoscopic intervention (Group A)**
  - 2008 – 2023
  - Temporary treatment:
    - Bedside EVD insertion
    - Active neuroendoscopic lavage, 3-weeks interval
    - ± fibrinolytic therapy via EVD catheter (urokinase or tPA)
  - Permanent treatment: VP shunt
- **Conservative care (Group B)**
  - 1998 - early 2008
  - Temporary treatment : Ventricular tapping or EVD
  - Permanent treatment: V-P shunt
- **Primary outcome**: VP shunt- related complication rate
  - Shunt –related infection within 1 year
  - Shunt – revision within 1 year
- **Statistical analysis**
  - SPSS Statistics for Windows, version 23.0 (SPSS Inc., Chicago, IL., USA)
  - Continuous variables: Median and Interquartile range (IQR)
  - Analysis
    - Mann-Whitney U for continuous variables
    - Chi-square test or Fisher's exact test for categorical variables
  - Statistical significance: P < 0.05

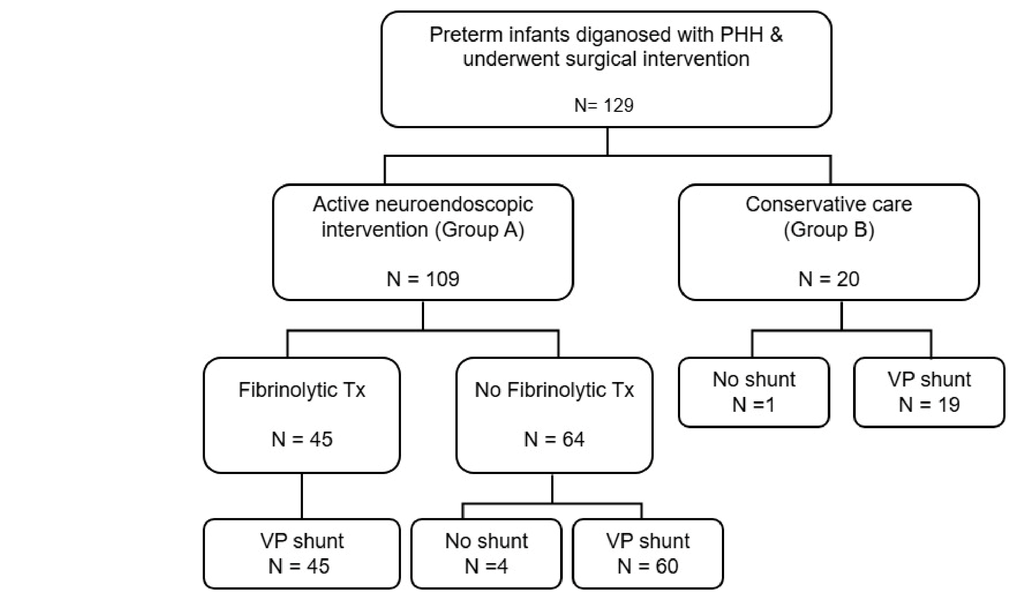
Results

Baseline and Surgical Characteristics Between Group A & B

Values	Group A (N=109)	Group B (N=20)	*P*
Gestational age, week	27.4 [26.3–29.3]	29.2 [27.1–31.5]	0.018
Weight at birth, g	1037 [820–1397]	1275 [1012–1700]	0.056
Male, n (%)	60 (55)	10 (50)	0.808
Inborn, n(%)	16 (14.7)	17 (85)	<0.001
Postnatal days at diagnosis of IVH≥ GIII	7 [2-14]	9.5 [6.3-17.8]	0.046
Postnatal days at first operation	60 [30–89]	63 [30–88]	0.431
Frequency of operation	4 [2–5]	2 [1–3]	<0.001
Postnatal days at VP shunt, days	141 [109–171]	93 [70–110]	0.001
PMA at VP shunt, weeks	44.7 [41.4–52.6]	35.5 [32.0–41.0]	0.002
Interval b/w first op and VP shunt, days	79 [40–111]	22 [10–34]	<0.001

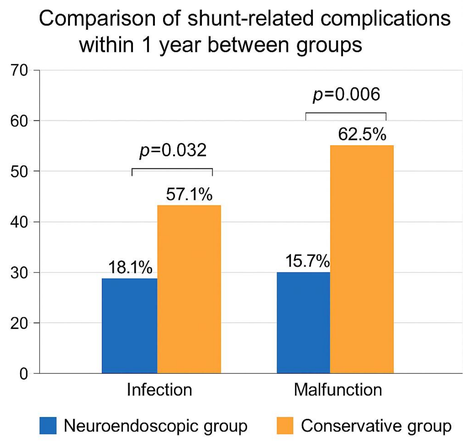
Baseline and Surgical Characteristics according to Fibrinolysis Tx

Values	Fibrinolysis (-) N=63	Fibrinolysis (+) N=45	P
Gestational age, week	27.6 [26.3-30.1]	27.7 [25.5-30.0]	0.995
Weight at birth, g	1040 [860-1520]	1060 [775-1430]	0.691
Male, n (%)	31 (49.2)	18 (40)	0.383
Inborn, n(%)	9 (14.2)	7 (15.6)	0.828
Postnatal days at diagnosis of IVH≥ GIII	6 [3-14]	7 [3-11]	0.900
Postnatal days at first operation	62 [39-99]	55 [20-80]	0.044
Frequency of operation	4 [3-6]	6 [4.5-7]	0.019
Postnatal days at VP shunt, days	143 [109-179]	148 [123-184]	0.280
PMA at VP shunt, weeks	47.6 [44.8-52.6]	50.3 [46.0-53.9]	0.078
Interval b/w first op and VP shunt, days	66 [43-96]	96 [69-130]	0.002



Prevalence of VP shunt-related complications within 1 year

All VP shunt-received patients



Complication type	Group A	Group B	p-value	OR (95% CI)
Shunt Infection	19/105 (18.1)	4/7 (57.1)	0.032	6.04 (1.25–29.22)
Shunt revision	16/102 (15.7)	5/8 (62.5)	0.006	8.96 (1.94–41.27)

Group A patients, fibrinolysis (+) vs. (-)

Complication type	Fibrinolysis (-)	Fibrinolysis (+)	p-value	OR (95% CI)
Shunt Infection	8/60 (13.3)	11/45 (24.4)	0.200	2.10 (0.77–5.76)
Shunt malfunction	12/57 (21.1)	4/45 (8.9)	0.108	0.37 (0.11–1.23)

Discussion

- Active and early neuroendoscopic intervention improved PHH control and reduced infection rates during the temporary management period, allowing delayed but safer shunt insertion with improved physical growth.
- By allowing shunt surgery after further maturation, this approach may help reduce shunt-related complications, leading to better overall outcomes.
- Further studies with larger, severity-matched cohorts and integrated brain MRI analysis are needed to better elucidate its long-term neurodevelopmental impact.

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