Operative Outcomes Following Hemispherectomy versus Hemispherotomy for the Treatment of Hemimegalencephaly in Pediatric Patients: A Systematic Review

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Introduction

A rare congenital malformation, hemimegalencephaly (HME) is characterized by enlargement of all or most of 1 cerebral hemisphere due to issues with neuronal cell lineage, proliferation, maturation, and migration in a developing fetus.[1] Among 1000 children with epilepsy, the prevalence of HME is around 1 to 3 cases, presenting with the classic clinical hallmarks of epilepsy, contralateral motor deficits, and neurocognitive issues.[2,3] Generally, epilepsy is the first manifestation of HME with many patients progressing to drug-resistant seizures that are best treated by hemispherectomy or hemispherotomy.[4] The prognosis for HME patients tends to be variable due to the heterogeneity of their abnormal cortical development that results in a spectrum of disease severity.[5] Additionally, due to the infrequency of HME in the general population, there exists a paucity of literature on operative outcomes of the aforementioned surgeries with inconsistent conclusions.

Objectives

- Determine the efficacy of hemispherectomy vs. hemispherotomy in improving seizures.
- Evaluate relevant clinical outcomes of HME patients after surgical treatment over a long-term follow-up period.
- Correlate preoperative data with postoperative seizure status to assess the patient characteristics and other factors that allow for the most favorable patient state after surgical treatment.

Methods

A systematic review was conducted, starting with a comprehensive literature search (PubMed, Embase, and Scopus) with no restrictions in regard to language, date, or country of origin to identify articles that reported operative outcomes of pediatric HME patients undergoing hemispherectomy or hemispherotomy. Two independent reviewers then assessed the eligibility of studies based on inclusion and exclusion criteria. For each study, the authors recorded the rates of seizure freedom, improvement in motor deficits/neurocognitive issues, and preoperative factors that could affect seizure outcomes.

Results

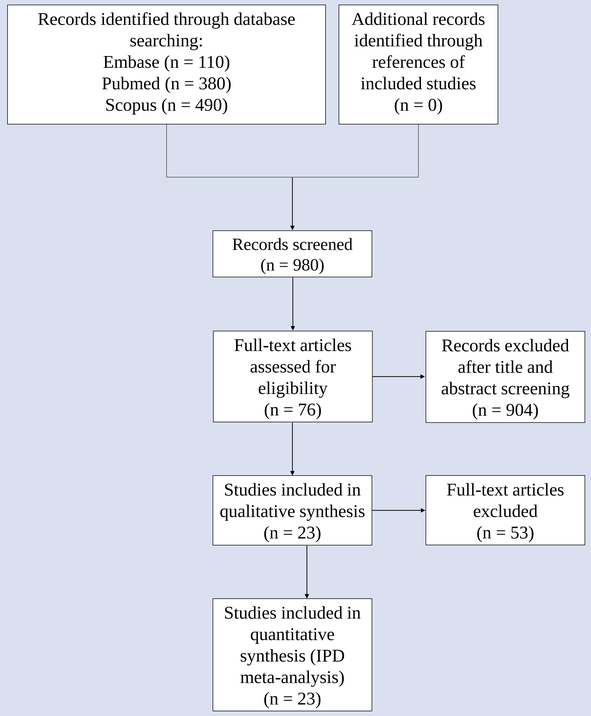

Figure 1. PRISMA flow diagram for search strategy and study selection.

Out of 980 articles, 23 were identified for inclusion with 132 patients considered eligible for this study. Based on the available data, 58.0% of patients were male. The mean age of seizure onset was 0.4 ± 1.2 years old, and the mean age at surgery was 1.6 ± 1.9 years old. 78 (59.1%) patients underwent hemispherotomy, while 54 (40.9%) patients underwent hemispherectomy. Over a mean follow-up period of 3.8 ± 4.5 years, seizure freedom, measured as Engel Class 1, was observed in 99 (75.0%) patients. Of those patients who experienced surgical complications, hydrocephalus (38%) and infection/fever (25%) were most prominent. 66% and 67% of patients reported neurocognitive and motor improvements, respectively.

The Kaplan-Meier plot (Figure 3) depicts greater seizure freedom with hemispherotomies initially, but after 5+ years of follow up, hemispherectomies showed more potential to sustain seizure freedom. On univariate analyses, older age at seizure onset (hazard ratio [HR] 1.209, p = 0.03) was the only significant predictor of improved seizure outcomes.

Patient Characteristics + Outcomes	
Gender (n = 86)	58% Male 42% Female
Affected hemisphere (n = 95)	60% Right 40% Left
Mean age at onset, yrs	0.4 ± 1.2
Mean age at surgery, yrs	1.6 ± 1.9
Surgery received	78 (59.1%) Hemispherotomy 54 (40.9%) Hemispherectomy
Mean follow-up, yrs	3.8 ± 4.5
Seizure outcomes, engel class	99 (75%) Engel Class I 7 (5.3%) Engel Class II 16 (12.1%) Engel Class III 10 (7.6%) Engel Class IV
Surgical complications (n = 40)	38% Hydrocephalus 25% Infection/Fever 10% Hemiparesis 10% Dysphagia 5% Incomplete Disconnection 3% Death 3% Strabismus 3% CN III Palsy 3% Subdural Hematoma
Neurocognitive outcome (n = 38)	66% Improved Neurocognitive Ability
Motor outcome (n = 39)	67% Improved Motor Ability

Figure 2. Chart of general patient characteristics for the study with postoperative outcomes.

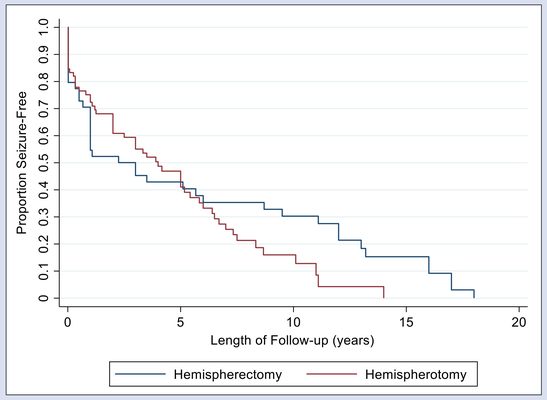

Figure 3. Kaplan-Meier plot of seizure freedom after hemispherectomy vs. hemispherotomy for HME patients.

Characteristic	HR	95% CI	p Value
Older age at seizure onset	1.209	1.018 - 1.434	0.03
Younger age at surgery	0.966	0.865 - 1.078	0.539
Female	1.177	0.710 - 1.951	0.529
Left hemisphere	1.428	0.889 - 2.296	0.141
Hemispherotomy	1.261	0.815 - 1.950	0.297

Figure 4. Univariate Cox regression analysis of predictive factors for favorable postoperative seizure outcomes in pediatric HME patients.

Conclusion

Although this project is still ongoing, the results of the Kaplan-Meier plot are novel amidst prior literature on HME. Additionally, this review based on individual participant data of the most appropriate evidence available suggests that older age at seizure onset is associated with seizure freedom with statistical significance. Thus, the findings of this study can better inform future clinical decision-making. Nevertheless, further investigations through large, long-term, multicenter studies are warranted to assess these results with greater validity.

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