Epilepsy Surgery for Hemimegalencephaly: ***The UCLA Experience***

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Background

Clinical: Hemimegalencephaly (HME) is a congenital malformation of the brain due to hypertrophy of a hemisphere, resulting in drug resistant epilepsy, cognitive impairment, hydrocephalus and hemiparesis[1,2]. HME is quite rare, with a prevalence of only 1-3 cases per 1000 epileptic children[1], and thus our knowledge on treatment and outcomes is quite limited.

Objective: Currently, the standard of care is hemispheric resection and disconnection, either anatomically, or more commonly, functionally. However, complication rate is quite high[2] and outcomes knowledge is limited to case reports in the literature. Here, we present an outcomes and predictors analysis of the largest HME patient series from UCLA Mattel Children's Hospital.

Methods

Overview: This observational study is a retrospective chart review of pediatric patients who were diagnosed with HME and received resective surgery, either functional or anatomic hemispherectomies at UCLA. This included 53 patients from 1990-2021, of which 50 had records available for analysis.

Inclusion Criteria: Patients were included for analysis if they had a diagnosis of HME, followed by drug-resistant epilepsy and resective surgery. All patients had at least one epilepsy surgery at UCLA. Patients with revision histories and/or VP shunts were also included.

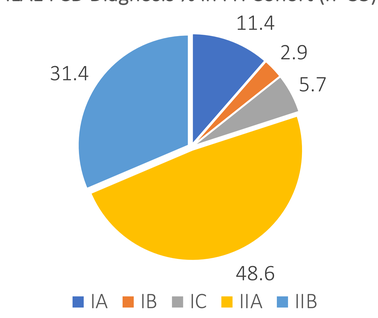
Analysis: Demographic information, seizure outcomes, complications and predictors of seizure outcomes were analyzed using R Studio.

Patient Demographics

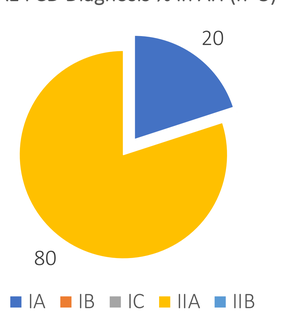
Independent Variable	Full Cohort (n=50)	FH Cohort (n=40)	AH Cohort (n=5)
Age at Seizure Onset (mo.)	4.2 ± 11.9	4.0 ± 12.5	6.8 ± 9.9
Age at Surgery (mo.)	26.3 ± 37.4	22.8 ± 34.4	56.2 ± 64.3
% Male	62.0	62.5	40
History of EPC	7 (14.0%)	6 (15.0%)	0 (0.0%)
Infantile Spasms	25 (54.3%)	22 (56.4%)	2 (40.0%)
Follow-Up Duration (mo.)†	48.5 [0, 227]	52.0 [0, 227]	40.0 [13, 156]

Abbreviations: AH=Anatomical Hemispherectomy; EPC=Epilepsia Partialis Continua; FH=Functional Hemispherectomy. Values expressed as mean ± standard deviation, median [range] or number of patients (%). *Three cases did not specify the type of resection, †Data were missing from some of the patient histories.

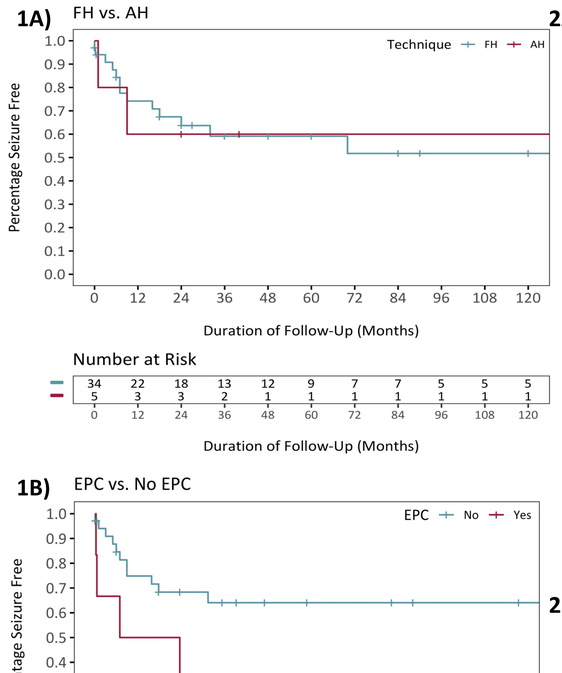
ILAE FCD Diagnosis % in FH Cohort (n=35)



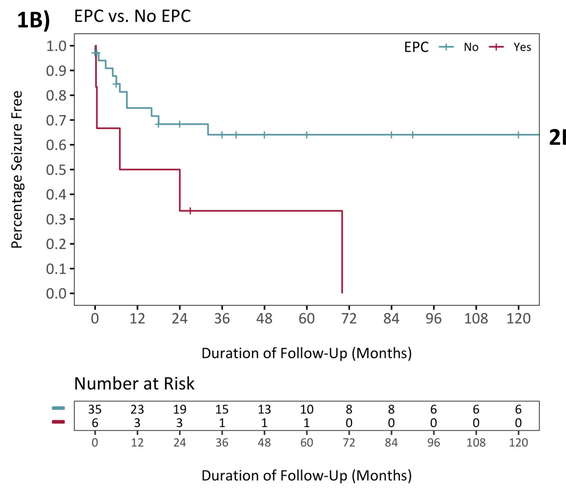
ILAE FCD Diagnosis % in AH (n=5)



1A) FH vs. AH



1B) EPC vs. No EPC



1C) ILAE FCD Diagnosis

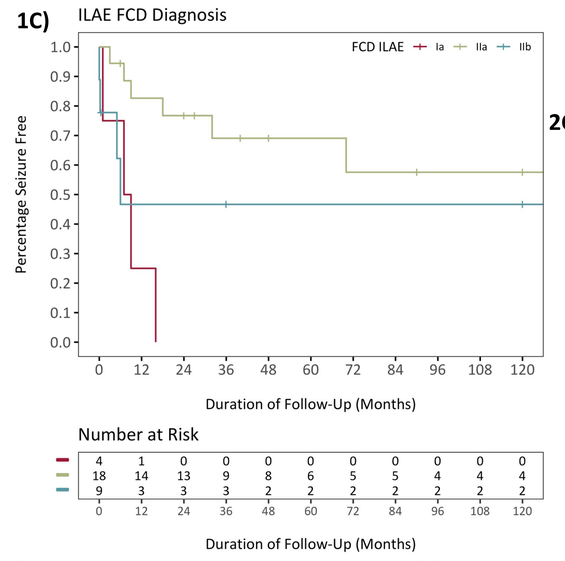


Figure 1. Kaplan-Meier curve of seizure freedom function for HME patients undergoing resective surgery. 1A) stratified by hemispheric surgery technique. 1B) stratified by history of EPC. 1C) stratified by ILAE FCD diagnosis. Abbreviations: EPC=Epilepsia Partialis Continua

2A)

Seizure Outcomes	FH Cohort (n=40)	AH Cohort (n=5)
Follow-Up Duration (months)†	52.0 [0, 227]	40.0 [13, 156]
Postoperative Seizure Recurrence†	17 (45.9%)	2 (40.0%)
Time to Postoperative Seizure Recurrence (months)†	8.0 [0, 142]	5.0 [1, 9]
Engel Classification†		
I	19 (52.8%)	3 (60.0%)
II	3 (8.3%)	0
III	12 (33.3%)	2 (40.0%)
IV	2 (5.6%)	0
Shunt Placement Required†	12 (34.3%)	1 (20.0%)
Time to Shunt Placement (months)	2.3 [0.3, 45]	1.3 [1.3, 1.3]

2B)

Revision Surgery Outcome	FH Cohort	AH Cohort
Number of Patients After to Revision Surgery	38	9
Revision Surgery Required†	10 (25.0%)	1 (20.0%)
Time to Revision Surgery (months)	17.0 [0.3, 115]	1.0 [1, 1]
Revision Surgery Type		
AH	3 (10.5%)	0
Revision of Residual Connections	7 (18.4%)	1 (20.0%)
Engel Classification After Revision Surgery		
I	24 (72.7%)	3 (33.3%)
II	5 (15.2%)	1 (11.1%)
III	4 (9.1%)	5 (55.6%)
IV	1 (3.0%)	0

2C)

Univariate Analysis Variable (Cox Regression)	HR	95% CI	p-value
Surgery Type (Relative to FH)			
Frontal Lobectomy	18.36	1.65-203.87	0.018*
AH	0.88	0.20-3.90	0.869
History of EPC (Yes)	3.35	1.16-9.69	0.026*
Multivariate Analysis (Logistic Regression)	**OR**	**95% CI**	**p-value**
Age at Surgery (> 6 months)	7.91	1.37-44.60	0.021*
History of EPC (Yes)	14.86	1.06-208.41	0.045*

Figure 2. Tables for outcomes analysis in FH and AH cohorts. 2A) Engel Classification, Time to Post-Operative Seizure Recurrence and Shunt Requirements following initial operation (FH or AH). 2B) Seizure outcomes following revision surgery in FH and AH cohorts. 2C) Variables of Significance following Univariate Cox Regression and Multivariate Analysis with Stepwise Variable Selection (Logistical Regression). Abbreviations: AH=Anatomical Hemispherectomy; FH=Functional Hemispherectomy. Values expressed as mean ± standard deviation, median [range] or number of patients (%). †Data were missing from some of the patient histories. ‡HR > 1 indicates a faster time to seizure recurrence. ‡OR > 1 indicates greater odds of seizure recurrence at last follow-up (Engel II, III, IV). *p < 0.05.

Outcome	FH with AH Revision (n=3)	FH with Residual Connection Revision (n=7)	p-value
Engel Classification After Revision Surgery			0.125
I	0	5 (71.4%)	
II	1 (33.3%)	1 (14.3%)	
III	2 (67.7%)	1 (14.3%)	
IV	0	0	

Table 3. Seizure outcomes between functional hemispherectomy patients who had AH revision surgery and patients who had revision of residual disconnection surgery

Discussion

This study helps improve current knowledge on the treatment of HME. Due to a significantly faster time to seizure recurrence with less than hemispheric resections (HR 18.36; p=0.018), patients diagnosed with HME should be treated with either FH or AH, however, there does not seem to be a significance in time to seizure recurrence between the two (p=0.869). Both techniques did not show an advantage in complication rate as well. If a patient fails after a FH, they can have either an AH or residual connection revision operation as neither shows statistical significance (p=0.125), but there is a trend favoring better seizure freedom with residual connection revision surgeries. Significant predictors for a shorter time to seizure recurrence include a positive EPC status (HR 3.35; p=0.026) and > 6 months of age at time of first surgery (OR 7.91; p=0.021). ILAE FCD diagnosis of Type IIa showed favored better outcomes with respect to time to seizure recurrence (HR 0.12; p=0.040). For long term outcomes, in the full cohort (n=35), 37.1% were non-ambulatory and 71.4% had some level of communicative ability decline. In the FH and AH cohorts, 10 (30.3%) and 2 (50%) patients were non-ambulatory, while 21 (77.8%) and 2 (40%) patients had some level of communicative ability decline, respectively.

Conclusions

This study demonstrates the importance of performing hemispheric resections over less than hemispheric resections for HME, and the subtle advantage in seizure freedom when performing residual connection revision surgeries for failed functional hemispherectomies. This work also determines EPC status, > 6 months of age at time of surgery and ILAE FCD Type IIa diagnosis as predictors of seizure outcomes. Overall this study provides surgeons, clinicians and patients with valuable information on the outcomes of various surgical techniques for HME in one of the largest HME datasets.

References

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