

Risk Factors and Consequences of Intraoperative Seizures Associated with Direct Cortical Stimulation

During Awake Craniotomy

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Introduction

- Intraoperative stimulation is a crucial adjunct in neurosurgical oncology, aiding maximal tumor resection with the preservation of sensorimotor and language function.

- Afterdischarges (ADs) should be monitored as they represent precursors to intraoperative seizures.

- There is currently limited data on intraoperative seizure and after discharge frequency in patients undergoing neurosurgical procedures and their effects on outcomes.

- The objective of this study was to better understand the frequency of intraoperative seizures and afterdischarges in patients who underwent awake craniotomy with direct cortical stimulation and to better understand their effect on patient outcomes.

Methods

- A retrospective chart review was conducted comprised of adult patients undergoing awake craniotomy with direct cortical stimulation from 2013 – 2017.

- Using BrainLab (Chicago, IL) iPlan software, tumor and edema volumes as well as mass effect assessed by midline shift were obtained.

- Intraoperative seizures and afterdischarges were documented based on findings from the intraoperative neurological monitoring report.

- Univariate analysis was performed to assess significance of various risk factors.

Results

Table 1a - AD information			
	Intraoperative AD	No Interoperative AD	P Value
Age	50.75 ± 3.713, n=39	48.46 ± 1.076, n=189	0.5562
Current Amplitude (mA)	2.313 ± 0.1149, n=40	2.097 ± 0.06234, n=175	0.1044
Length of Surgery (min)	236.9 ± 6.07, n=40	229.3 ± 5.019, n=187	0.3392
Estimated Blood Loss (cc)	285.6 ± 26.08, n=40	317.2 ± 25.72, n=181	0.3909
Length of Stay (days)*	5.125 ± 0.4101, n=40	6.17 ± 0.2716, n=182	0.0368
FLAIR Tumor Volume (first time resection)	127.7 ± 31.93, n=16	65.36 ± 7.314, n=60	0.0743
T1+C Tumor Volume (first time resection)	26.5 ± 4.332, n=17	29.56 ± 4.261, n=63	0.6165

Table 1b - AD Information					
	Intraoperative AD	No Interoperative AD	Odds Ratio	Range	P Value
Male	23	102	1.154	0.5903 to 2.237	0.6836
Female	17	87	0.8666	0.447 to 1.694	0.6836
Prior Resection	8	72			
Repeat Awake	1	13	0.3471	0.03178 to 1.968	0.2937
History of Seizure	21	116	0.6956	0.3522 to 1.4	0.2982
Tumor Location					
Right	9	67	0.52	0.2279 to 1.155	0.105
Left	31	120	1.923	0.8655 to 4.387	0.105
Frontal	28	104	1.907	0.9348 to 3.921	0.0817
Parietal	12	69	0.7453	0.3599 to 1.533	0.4342
Temporal	10	45	1.067	0.5 to 2.378	0.8728
Occipital	1	14			
Insular	1	7			
Other	1	6			
Tumor Histology					
Grade 1	1	10			
Grade 2	7	25			
Grade 3	13	40	1.575	0.7565 to 3.416	0.2358
Grade 4	18	91	0.7064	0.3593 to 1.429	0.3291
MGMT Methylation	18	73	0.9863	0.459 to 2.089	0.9718
IDH1 Mutation	18	65	1.26	0.6387 to 2.626	0.5241
IDH2 Mutation	0	4	0	0 to 2.649	0.2013
Post Operative Deficits	14	59	1.059	0.4983 to 2.152	0.8769
Complications	3	10	1.338	0.3791 to 4.979	0.669

Table 2a. Intraoperative Seizure Information			
	Intraoperative Seizures	No Interoperative Seizures	P Value
Age	50.18 ± 2.146, n=36	48.6 ± 1.234, n=192	0.5263
Current Amplitude (mA)	2.136 ± 0.1425, n=35	2.138 ± 0.06008, n=180	0.9908
Length of Surgery (min)	236 ± 9.688, n=34	229.7 ± 4.73, n=193	0.4091
Estimated Blood Loss (cc)	329.4 ± 52.23, n=34	308.2 ± 23.72, n=187	0.713
Length of Stay (days)	5.29 ± 0.4688, n=31	6.084 ± 0.2629, n=191	0.146
FLAIR Tumor Volume (first time resection)	99.85 ± 48.87, n=10	75.25 ± 7.829, n=66	0.6306
T1+C Tumor Volume (first time resection)	22.13 ± 6.795, n=10	29.88 ± 3.847, n=70	0.3362

Table 2b. Intraoperative Seizure Information					
	Intraoperative Seizures	No Interoperative Seizures	Odds Ratio	Range	P Value
Male	20	105	1.048	0.5033 to 2.119	0.8986
Female	16	88	0.9545	0.472 to 1.987	0.8986
Prior Resection	16	64	1.6	0.7807 to 3.377	0.1999
Repeat Awake	3	11	1.504	0.4291 to 5.377	0.5448
History of Seizure	21	116	0.9293	0.4455 to 1.932	0.8423
Tumor Location					
Right	12	64	0.9922	0.4663 to 2.134	0.9838
Left	24	127	1.008	0.4685 to 2.145	0.9838
Frontal	18	114	0.693	0.3523 to 1.368	0.3121
Parietal*	18	63	2.063	1.036 to 4.101	0.0455
Temporal	9	46	1.065	0.4485 to 2.345	0.8805
Occipital	2	13			
Insular	1	7			
Other	2	5			
Tumor Histology					
Grade 1	1	10			
Grade 2	4	28			
Grade 3	11	42	1.833	0.8461 to 4.234	0.1432
Grade 4	14	95	0.7368	0.3519 to 1.638	0.4397
MGMT Methylation*	19	72	3.035	1.167 to 7.817	0.0209
IDH1 Mutation	11	72	0.7894	0.3657 to 1.799	0.5669
IDH2 Mutation*	3	1	18.23	2.434 to 238.4	0.0014
Post Operative Deficits	8	65	0.5011	0.2292 to 1.118	0.1033
Complications	3	10	1.536	0.4335 to 5.779	0.5281

Table 3a. Post-Operative Seizure Information			
	Post Operative Seizures	No Post Operative Seizures	P Value
Age	51.12 ± 2.785, n=38	48.15 ± 1.207, n=191	0.332
Current Amplitude (mA)	2.096 ± 0.1408, n=34	2.145 ± 0.06022, n=181	0.7483
Length of Surgery (min)	245.4 ± 10.91, n=38	227.7 ± 4.619, n=189	0.1425
Estimated Blood Loss (cc)	364.5 ± 50.02, n=38	300.4 ± 23.88, n=183	0.253
Length of Stay (days)**	9.459 ± 0.8087, n=37	5.286 ± 0.1969, n=185	<0.0001
FLAIR Tumor Volume (first time resection)	82.75 ± 18.73, n=14	77.53 ± 10.53, n=62	0.8103
T1+C Tumor Volume (first time resection)	22.08 ± 6.116, n=15	30.48 ± 4.027, n=65	0.2612

Table 3b. Post-Operative Seizure Information					
	Post Operative Seizures	No Post Operative Seizures	Odds Ratio	Range	P Value
Male	16	109	0.5471	0.2752 to 1.103	0.0907
Female	22	82	1.828	0.9067 to 3.633	0.0907
Prior Resection	7	73			
Repeat Awake	0	14	0	0 to 1.34	0.085
History of Seizure	24	113	1.183	0.5816 to 2.5	0.6464
Tumor Location					
Right	10	66	0.6656	0.3169 to 1.457	0.3051
Left	28	123	1.502	0.6863 to 3.156	0.3051
Frontal	24	108	1.317	0.6488 to 2.778	0.4512
Parietal	13	68	0.9406	0.4697 to 1.944	0.1639
Temporal	7	48	0.6727	0.2606 to 1.579	0.3766
Occipital	3	12			
Insular	2	6			
Other	1	6			
Tumor Histology					
Grade 1	2	9			
Grade 2	1	31			
Grade 3*	14	39	2.672	1.25 to 5.934	0.0118
Grade 4	15	94	0.7416	0.3383 to 1.576	0.4372
MGMT Methylation	14	77	1.058	0.4471 to 2.4	0.8976
IDH1 Mutation	8	75	0.4571	0.2011 to 1.1	0.0729
IDH2 Mutation	0	4	0	0 to 6.465	0.3986
Intraoperative Sz	8	28	1.543	0.6672 to 3.737	0.3297
Intraoperative AD	4	36	0.5065	0.1836 to 1.445	0.2172
Post Operative Deficits	15	58	1.338	0.6419 to 2.767	0.4284
Complications*	6	7	4.554	1.365 to 13.29	0.0055

Conclusions

-MGMT, IDH2 mutation and parietal tumor location appear to be risk factors for intraoperative seizures

-Grade III tumor histology increases the risk of post-operative seizures

-Intraoperative seizures or afterdischarges do not predict an increased length of stay, new or worsening post-operative deficits, or post-operative seizures

-Post-operative seizures are associated with both post-operative complications (post-operative hemorrhage, mass effect, or infection requiring further intervention) and post-operative length of stay

-These findings suggest that intraoperative seizures or afterdischarges as a byproduct of functional mapping are likely not harmful to the patient