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Functional Hemispherectomy in Adults: All We Have to Sphere Is Sphere Itself

Hemispherectomy in Adults and Adolescents: Seizure and Functional Outcomes in 47 Patients

McGovern RA, NV Moosa A, Jehi L, Busch R, Ferguson L, Gupta A, et al. *Epilepsia.* 2019;60(12):2416-2427. http://doi.org/10.1111/epi.16378.

Objective: To examine longitudinal seizure and functional outcomes after hemispherectomy in adults and adolescents. Methods: We reviewed 47 consecutive patients older than 16 years who underwent hemispherectomy between 1996 and 2016 at our center. Clinical, electroencephalographic (EEG), imaging, neuropsychological, surgical, and functional status data were analyzed. Results: Thirty-six patients were 18 years or older at surgery; 11 were aged between 16 and 18 years. Brain injury leading to hemispheric epilepsy occurred before 10 years of age in 41 (87%) patients. At a mean follow-up of 5.3 postoperative years (median = 2.9 years), 36 (77%) had Engel class I outcome. Longitudinal outcome analysis showed 84% seizure freedom (Engel IA) at 6 months, 76% at 2 years, and 76% at 5 years and beyond, with stable longitudinal outcomes up to 12 years from surgery. Multivariate analysis demonstrated that acute postoperative seizures and contralateral interictal spikes at 6-month follow-up EEG were associated with seizure recurrence. Patients who could walk unaided preoperatively and had no cerebral peduncle atrophy on brain magnetic resonance imaging were more likely to experience worsening of motor function postoperatively. Otherwise, postoperative ambulatory status and hand function were unchanged. Of the 19 patients who completed neuropsychological testing, 17 demonstrated stable or improved postoperative outcomes. Significance: Hemispherectomy in adults is a safe and effective procedure, with seizure freedom rates and functional outcome similar to those observed in children.

Commentary

"Hemispherectomy" (not otherwise specified, but will be soon) has been known for over half a century[1] to be one of the most effective epilepsy surgeries, and also gratifyingly safe, for appropriately selected candidates. However, it is most often performed in children with unilateral hemispheric onsets, in whom static neurological deficits are present and related to the affected hemisphere, or who are progressing. Epilepsies appropriate for hemispherectomy are classified into 3 groups: acquired (eg, perinatal infarction/infection, traumatic brain injury), developmental (eg, malformations of cortical development, including hemimegalencephaly), and progressive (eg, Sturge-Weber, Rasmussen's encephalitis). That most of these present in childhood accounts in part for the pediatric predominance of hemispherectomy. But another big reason is the belief that neural plasticity, ostensibly maximal before 5 years of age, allows the operation to be tolerated with regard to language and motor dysfunction, and the converse is one reason put forth for the relative rarity of this surgery in adolescents and adults.

Since there are many kids that graduate to adulthood without having this "radical" surgery, the lack of cases of adult hemispherectomy is likely due in large measure to misplaced fear of worsening of neural deficits. The paper by McGovern et al,[2] the largest series to date on hemispherectomy in the adolescent/adult population, goes a few steps toward alleviating that fear.

First, the specification on nomenclature. "-ectomy," from my Apple's dictionary, denotes "surgical removal of a specified part of the body, from the Greek ektomē 'excision'," whereas "-tomy" refers to cutting, from Greek -tomia 'cutting'." Thus, the original "anatomical hemispherectomy" involves removing the entire hemisphere.[1] Due to complications, this evolved to, first, "functional hemispherectomy" in which only the parietal and temporal lobes are removed (essentially leaving "bumpers"), but the white matter connections of the hemisphere are disconnected so, although likely still seizing, they can't spread to any remaining functional structures. The series of McGovern et al involves 37 functional hemispherectomies and 10 anatomical hemispherectomies (8 of which were performed for persistent seizures following a previous FH) in adolescents and adults, of whom 20 were 25 years

or older at the time of surgery.[2] The next evolution involved sparing of all or nearly all of the cortex using a variety of approaches (eg, trans- or perisylvian) to gain access for the disconnection, that is, "functional hemispherotomy", which is how many surgeons perform the surgery today. I will group functional hemispherectomy and functional hemispherotomy together as FH.

McGovern et al address the essential question: Is FH/AH safe and effective in adults? Since adults are big children, the answers should not be too surprising: yes and yes. Of 47 (77%), 36 were Engel 1 at a median of 2.9 years. This appeared to be stable out many years, with the Kaplan-Meier curve showing 76% seizure-free at 2 to 12 years, although it is not clear how many patients were lost to follow-up and thus potentially suffering recurrence. This accords well with the pediatric literature.[3] As to safety, patients who are candidates for surgery typically already have contralateral hemiparesis, with a "helper hand" (ie, good proximal tone from innervation from the ipsilateral motor cortex and poor distal fine finger movements due to denervation from the damaged contralateral cortex) and independent ambulation (distal motor group denervation does not affect gait), as well as some degree of hemianopsia. In this series, only 1 patient did not have hemiparesis prior to surgery. Thirty-seven (77%) had mild to moderate hemiparesis; fine finger movements were none or minimal in 40 (85%); and only 4 (9%) were nonambulatory. Language was normal in 24 (51%) or delayed in 18 (38%), and 10 (21%) had normal vision. Seventeen patients had left-sided surgery, of whom 10 had language lateralization tested (functional magnetic resonance imaging and/or Wada test), as well as 4 of 30 right-sided surgeries; contralateral language was seen in all but 1, who had bilateral language, and 1 Wada couldn't be completed. Postoperatively, hemiparesis was unchanged in 28 (60%) but was indeed worse in 16 (34%); fine finger movements were unchanged in 35 (75%) and worse in 11 (23%); ambulation was unchanged in 33 (70%) and required a new aid/orthosis in 13 (28%); and visual function was unchanged in 20 (43%), worse in 21 (45%), and unavailable in 6 (13%). Language was grossly unchanged in 46 (98%), but 1 previously reported patient who had confirmed right-sided language by Wada became permanently aphasic after left-sided AH.[4]

The authors examined predictors of outcome. With respect to seizure outcome, only presence of a vagus nerve stimulator (VNS) was a preoperative predictive of poorer outcome on Cox analysis, and the only pre- to postoperative factors of importance were presence of contralateral interictal spikes on EEG at 6 months and acute postoperative seizures. The patients with worsened hemiparesis typically had milder symptoms before surgery and more preserved cerebral peduncle volume which in recent years has been appreciated as a risk factor for worsening.[5] Since nearly all patients were ambulatory and had no worsening of language, there were no predictors of these. Similarly, 90% of the 19 patients tested with neurocognitive assessment pre- and postoperatively declined on none or only 1 measure.

Thus, as to effectiveness, FH/AH seems to be as effective in adolescents and adults as it is in kids, in whom a recent systematic review found that 73.4% of 1102 patients were seizure-free at last follow-up.[3] Notably, in that study there was no difference between types of FH/AH: a disconnection is a disconnection. But what about safety: perhaps the rate of motor function worsening is surprising? In another recent series of 6 adult patients that included a review of published series including 84 other adults who underwent FH/AH, Schusse et al.[6] found that 21% of patients had some worsening of hemiparesis, but with no patients losing ambulatory status or significant functional ability, slightly better on the former but no different on the latter compared to McGovern et al.[2] Other findings too were quite similar. Additionally, another recent report of 12 patients found that 7 had some deterioration of motor function and all had preserved language.[7] How does this compare to children? In their recent systematic review, Griessenauer et al[3] noted that "neurological deficits affecting motor and sensory function or visual fields are *expected* [italics added] following hemispherectomy and were not considered complications," so they were not tallied. This puts the above findings into the proper perspective.

So, ambulation, language, and cognition remain essentially unchanged in adolescent and adult patients selected to undergo FH/hemispherectomy. The question is: Are the worsened hand function or hemiparesis (in patients with preoperatively milder deficits and more preserved cerebral peduncles—likely containing preserved motor and sensory fibers from the affected hemisphere), and in some patients worsened visual function, worth the benefits? First, it must be remembered that these patients are having many very disabling seizures: In McGovern et al, 21 of 47 patients were having generalized seizures. And 25 of 47 were having daily seizures, and 18 of 47 weekly seizures. Second, the real question relates to postoperative quality of life for these patients. That question was not addressed in the present report, nor in the recent paper of Schusse et al.[6] Only 2 studies have included measures of quality of life on small numbers of patients: in the first, only 1 of 20 reported deterioration after functional hemispherectomy,[8] and in the study by Schmeiser et al, 2 of 10 patients with data reported poor quality of life, and both of them had persistent seizures.[7] Thus, with the limited data, it is hard to conclude whether—for patients with more intact motor function and cerebral peduncle prior to surgery—the tradeoff is worth it. But it should be also noted that the patients in the study by McGovern et al with prior VNS, which predicted a worse seizure outcome, also had worse preoperative hemiparesis; by imputation, more intact motor function actually was associated with a better seizure outcome—perhaps not statistically significant, but it might be important.

Thus, all told, I suspect that the tradeoff was well worth the seizure benefit. And adult patients, who graduate from childhood without being offered or accepting such a radical procedure as a hemispherotomy or who acquire hemispheric injury on the nondominant side, needn't fear that the treatment is worse than the disease: they stand an outstanding chance of

becoming seizure-free, with very little chance of experiencing new or significantly worsened neurological deficits and further loss of functional status. That is why, were it not for Covid-19, I would literally right this moment be doing an FH on a 22-year old "graduated kid." When he was 13 he had an fMRI that showed bilateral language. He could not tolerate a Wada test to clear him so, despite my reassurances to the contrary, his mother would not consent to a right FH because she feared he would lose language. It took 9 years to finally get the Wada test to clear his right hemisphere. At long last, this young adult can get the definitive operation he needs, with the McGovern et al. supported expectation that it will not hurt him, but rather will eliminate his seizures - likely for the rest of his life.

By Robert E. Gross

References

1. Krynauw RW. Infantile hemiplegia treated by removal of one cerebral hemisphere. *S Afr Med J*. 1950;24(27):539-546.
2. McGovern RA, Moosa NV, Jehi A, et al. Hemispherectomy in adults and adolescents: seizure and functional outcomes in 47 patients. *Epilepsia*. 2019;60(12):2416-2427. http://doi.org/10.1111/epi.16378.
3. Griessenauer CJ, Salam S, Hendrix P, et al. Hemispherectomy for treatment of refractory epilepsy in the pediatric age group: a systematic review. *J Neurosurg Pediatr*. 2015;15(1):34-44.
4. Loddenkemper T, Dinner DS, Kubu C, et al. Aphasia after hemispherectomy in an adult with early onset epilepsy and hemiplegia. *J Neurol Neurosurg Psych*. 2004;75(1):149-151.
5. Mullin JP, Soni P, Lee S, et al. Volumetric analysis of cerebral peduncles and cerebellar hemispheres for predicting hemiparesis after hemispherectomy. *Neurosurgery*. 2016;79(3):499-507.
6. Schusse CM, Smith K, Drees C. Outcomes after hemispherectomy in adult patients with intractable epilepsy: institutional experience and systematic review of the literature. *J Neurosurg*. 2018;128(3):853-861.
7. Schmeiser B, Zentner J, Steinhoff BJ, et al. Functional hemispherectomy is safe and effective in adult patients with epilepsy. *Epilepsy Behav*. 2017;77(1):19-25.
8. Schramm J, Delev D, Wagner J, Elger CE, Von Lehe M. Seizure outcome, functional outcome, and quality of life after hemispherectomy in adults. *Acta Neurochir (Wien)*. 2012;154(9):1603-1612.