

EPILEPSY SURGEONS, RATHER THAN VASCULAR NEUROSURGEONS, SHOULD OPERATE ON CAVERNOUS MALFORMATIONS THAT CAUSE SEIZURES—A MODEST PROPOSAL

Electrocorticography-Guided Resection of Temporal Cavernoma: Is Electrocorticography Warranted and Does It Alter the Surgical Approach? Van Gompel JJ, Rubio J, Cascino GD, Worrell GA, Meyer FB. *J Neurosurg* 2009;110(6):1179–1185. **OBJECT:** Cavernous hemangiomas associated with epilepsy present an interesting surgical dilemma in terms of whether one should perform a pure lesionectomy or tailored resection, especially in the temporal lobe given the potential for cognitive damage. This decision is often guided by electrocorticography (ECoG), despite the lack of data regarding its value in cavernoma surgery. The purpose of the present study was several-fold: first, to determine the epilepsy outcome following resection of cavernomas in all brain regions; second, to evaluate the usefulness of ECoG in guiding surgical decision making; and third, to determine the optimum surgical approach for temporal lobe cavernomas. **METHODS:** The authors identified from their surgical database 173 patients who had undergone resection of cavernomas. One hundred two of these patients presented with epilepsy, and 61 harbored temporal lobe cavernomas. Preoperatively, all patients were initially evaluated by an epileptologist. The mean follow-up was 37 months. **RESULTS:** Regardless of the cavernoma location, surgery resulted in an excellent seizure control rate: Engel Class I outcome in 88% of patients at 2 years postoperatively. Of 61 patients with temporal lobe cavernomas, the mesial structures were involved in 35. Among the patients with temporal lobe cavernomas, those who underwent ECoG typically had a more extensive parenchymal resection rather than a lesionectomy ($p < 0.0001$). The use of ECoG in cases of temporal lobe cavernomas resulted in a superior seizure-free outcome: 79% (29 patients) versus 91% (23 patients) of patients at 6-month postresection, 77% (22 patients) versus 90% (20 patients) at 1 year, and 79% (14 patients) versus 83% (18 patients) at 2 years without ECoG versus with ECoG, respectively. **CONCLUSIONS:** The surgical removal of cavernomas most often leads to an excellent epilepsy outcome. In cases of temporal lobe cavernomas, the more extensive the ECoG-guided resection, the better the seizure outcome. In addition to upholding the concept of kindling, the data in this study support the use of ECoG in temporal lobe cavernoma surgery in patients presenting with epilepsy.

COMMENTARY

There is an ironic surgical adage that states: “all bleeding eventually stops.” The point is that when there is no longer any blood volume in the patient, there will also no longer be any more bleeding—a pyrrhic victory. A similar maxim can be applied to epilepsy surgery “If you remove enough brain, eventually the epilepsy will stop.” There is, indeed, an element of truth to both sayings; and, the single most common reason for failed epilepsy surgery, assuming appropriate patient selection, is inadequate resection of the epileptic focus.

Surgery for cavernous malformations has always elicited a turf battle within academic epilepsy centers. The vascular neurosurgeons, who control the management of aneurysms and arteriovenous malformations, feel similarly territorial about performing cavernous malformations surgical procedures, even though there is almost no active blood flow through a cavernous malformation (which is why they are angiographically occult). The problem arises when cavernous malformations present with seizures, which they do 40–70% of the time, or when the seizures become medically intractable, which they do 35–40% of the time (1–3). While a lesionectomy is an ade-

quate treatment for a hemorrhagic cavernous malformation as a prevention of further hemorrhage, the goal of surgery on a cavernous malformation associated with seizures, first and foremost, is to stop the seizures. Although vascular neurosurgeons may argue that they are trying to prevent a potential future hemorrhage, in reality, the risk of hemorrhage in a superficial cerebral cavernous malformation that has never bled is approximately 0.00–0.6% per patient years (1,2). By training and experience, the neurosurgeons most capable of stopping seizures are epilepsy surgeons. However, the crux of the debate lies in the question of whether a tailored epilepsy surgery (i.e., with ECoG, functional mapping, and maybe even a WADA test or an implant) is really needed versus an anatomic resection (i.e., either a lesionectomy alone or a lesionectomy with the removal of the surrounding ring of hemosiderin-stained tissue). If the latter operations were sufficient, then the approach of a vascular neurosurgeon would be adequate. In fact, a tumor surgeon might be even more preferable than a vascular neurosurgeon in this setting. Hence, it is in the best interest of patients and their seizure outcome for epilepsy surgeons to determine for which patients an anatomic resection is not adequate, since such a surgery would not offer them the best possible outcome.

For this reason, multiple articles published over the years have tried to identify predictors of poor postoperative seizure control following anatomic resection. Predictors have included longer duration and higher frequency of seizures, temporal

location, presence of secondary generalized tonic-clonic seizures, larger lesion size, younger age at surgery, and multifocal seizures (3–7). In addition, surgical variables—such as complete removal of the lesion, complete removal of the hemosiderin-stained surrounding tissue, and, as described in the paper by Van Gompel et al., the use of ECoG and the removal of areas of interictal and ictal activity—are prognostic of better postoperative seizure control.

Engel I outcome after lesionectomy is reported to be 70% after 1 year and falls to 65% after 3 years (7). If hemosiderin-stained tissue is also removed, Engel I reaches 77% compared with 65% for lesionectomy alone (4). In another recent series of patients, in which a subset with truly medically intractable epilepsy was identified, Engel I was achieved in 81% with lesionectomy, 77% with lesionectomy plus removal of surrounding hemosiderin, and 86% when resection was also guided by ECoG, which was only used in cases with the most severely intractable epilepsy (3). In the Van Gompel et al. paper, the addition of ECoG, for temporal lobe epilepsy cases, led to Engel I outcome in 91% at 1 year and 83% at 2 years compared with 79% with lesionectomy plus the removal of surrounding hemosiderin in temporal lobe cavernomas resected without ECoG.

Although only trending toward statistical significance, these results are actually quite startling. Overall, the subtext of these papers is clear. While seizure-free outcome is reasonable with lesionectomy and slightly better with lesionectomy plus resection of additional hemosiderin, it is even better if guided by ECoG and cortical mapping performed by an epilepsy surgeon. Should patients settle for a good outcome when a better outcome is possible? The answer is “no.” Given these data, perhaps it is time for a paradigm shift in the management of cavernous malformations: these lesions ought to be considered primarily epileptogenic lesions, rather than hemorrhagic vascular lesions, and managed accordingly to optimize postoperative seizure control. The exception to this strategy would be patients that present with either a hemorrhage or a posterior fossa/brainstem lesion location and whose treatment would benefit from alternative surgical strategies because of a higher risk of bleeding and difficult surgical access.

The same argument could be made for patients with low-grade neoplasms, such as gangliogliomas and dysembryoplastic neuroepithelial tumors, who are generally treated with a lesionectomy by a tumor surgeon. While seizure-free rates in this situation may be good, a higher postoperative seizure control rate can be achieved with an epilepsy operation as compared to an oncologic lesionectomy surgery (8–10). The counter argument is that a more extensive resection carries a higher risk of neurologic injury, which is why epilepsy surgeons routinely perform functional mapping studies (e.g., WADA and neuropsychological testing), functional MRI, and stimulation mapping.

An example of the benefit of using an epilepsy strategy would be for a lesion in or near the hippocampus, where lesionectomy alone may fail to control seizures. In this situation, a complete amygdalohippocampectomy is often required, the safety and necessity of which may require chronic seizure monitoring with implanted electrodes, WADA and neuropsychological testing, and awake language mapping (9).

There is another old adage that states: “the enemy of the good is the better,” but when it comes to seizure outcome after surgery, this phrase does not apply. Why settle for less?

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