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Neurosurgical Training

Complications of epilepsy surgery in the first 8 years after neurosurgical training

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Abstract

Background: Surgery is the most effective means of eliminating or reducing seizures in cases of medically refractory epilepsy. As elective surgery, however, there is little tolerance for complications. We have reviewed the early operative experience of a single epilepsy surgeon to identify the presence or absence of a surgical learning curve.

Methods: All phase II (diagnostic) and phase III (therapeutic) procedures for epilepsy surgery during the surgeon's first 8 years of practice were retrospectively reviewed. Complications were analyzed and subdivided into major or minor. Trends in complication rates were evaluated.

Results: During the first 8 years, there were 96 phase II and 94 phase III cases. Complications occurred in 26 (14%) of 190 cases, including 16 major (8%) and 10 minor (5%) complications. There was a decline in both the number and severity of complications associated with temporal lobectomy over time. Complications involving subdural grids shifted, over time, from those attributed to surgical technique or experience to those felt to be unavoidable risks of the procedure itself. Over time there was a decline in the proportion of major vs minor complications, but the overall complication rate remained stable.

Conclusions: There appears to be a surgical learning curve for epilepsy surgery involving complications associated with removal of medial temporal lobe structures, which lessen as the surgeon's experience increases.

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Keywords: Epilepsy surgery; Complications; Learning curve

1. Introduction

Surgery is the most effective means to eliminate or markedly reduce seizures for patients with medically refractory epilepsy. Eliminating or significantly reducing the number and/or intensity of seizures has major physical, mental, and socioeconomic benefits [1,13,16,18]. However, major complications of epilepsy surgery are well recognized and include cerebral infarction, hematoma formation, mass effect due to cerebral edema, infection, and even death [2,5,6,7,8,17,19,20].

Complications of epilepsy surgery have been presented in several large series, as well as in many case reports [9,10,11,19]. These reports typically originate from well-established centers with senior level neurosurgeons or from multiple centers using varying methods of patient selection and a variety of primary surgeons. Unfortunately, there is a natural tendency for less experienced surgeons to underreport their complications, lest it be viewed as a negative reflection of their surgical prowess in an early stage of their career. Yet, a "learning curve" is likely inherent and inevitable to any surgeon's experience. We reviewed all of

Abbreviations: AED, antiepileptic drug; CSF, cerebrospinal fluid; CVA, cerebral vascular accident; ICU, intensive care unit; MRI, magnetic resonance imaging; VEEG, video electroencephalography; VNS, vagus nerve stimulator.

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the operations performed for the diagnosis and treatment of epilepsy by a single epilepsy surgeon (ANM) during the first 8 years after completion of residency training to better understand the learning curve in this type of practice.

2. Patients and methods

2.1. Patient selection

Patient data were extracted from a comprehensive database of all epilepsy-related surgical procedures performed by the primary surgeon (ANM) from April 1998 to December 2005. Before surgery, every patient underwent extensive presurgical evaluation for medically refractory epilepsy and was referred specifically for the surgical treatment of their epilepsy rather than other disease processes. Patients with seizures attributable to tumors, vascular malformations, or other lesions who were not medically refractory were excluded from this analysis. Patients were considered medically refractory if seizures remained uncontrolled after a trial of at least 2 AEDs at therapeutic levels and/or rational polytherapy. Most patients had been treated with 3 to 7 AEDs.

Before surgery, the cases of all patients were discussed at a multidisciplinary surgical planning conference that included neurologists, neurosurgeons, a neuropyschologist, and technicians. Case review included evaluation of the patient history, physical findings, seizure semiology, medication history, scalp VEEG, and imaging data.

The senior neurologist in this practice had extensive (>20 years) experience in the selection of patients for epilepsy surgery. The surgical data were collected by the epilepsy program in a prospective fashion with no preconceived intention to perform the analysis presented here.

A variety of procedures were performed over the 8-year period. For analysis the operations were divided into 3 categories: (1) "phase II" diagnostic procedures, (2) "phase III" therapeutic procedures, or (3) VNS insertion. Phase II procedures consisted primarily of stereotactic depth electrode placement, craniotomy for placement of a subdural grid electrode array, and burr hole placement of subdural strip electrode arrays. Each of these procedures was then followed by inpatient video-EEG telemetry to characterize and localize a seizure focus and for cortical mapping (subdural grids only).

Phase III procedures included anterior temporal lobectomy, neocortical resection, multilobar resection, selective amygdalohippocampectomy, lesionectomy, corpus callosotomy, and hemispherectomy. Removal of intracranial electrodes (ie, subdural grid) was performed at the same time as resection was considered a phase III procedure.

The number and types of procedures performed and the associated complications per patient were tabulated. Because many patients had more than one procedure, and several had 3 or more procedures (eg, phase II depth followed by phase II grid and then phase III resection), complications were classified per case rather than per patient to give a more accurate determination of the surgical risk per procedure, which is the salient measurement of a surgical learning curve. We defined a complication as an unanticipated or unwanted sign, symptom, or condition that developed within 30 days of a diagnostic or therapeutic procedure. Exclusions to this were contralateral superior quadrantanopsia after anterior temporal lobectomy or selective amygdalohippocampectomy, drug reactions, and complications related to the seizures themselves (eg, aspiration pneumonia after a seizure). Similarly, CSF leaks from electrode exit sites were not considered complications unless a subsequent infection developed or the leak persisted after electrode removal.

The severity of the complication was further categorized as major or minor based on previous criteria [18]. A neurologic deficit was considered a minor complication if it was transient or resolved within 3 months of surgery. A major neurologic complication was one that lasted longer than 3 months and/or affected the patient's activities of daily living. All infections requiring longer than 2 weeks of intravenous antibiotics were considered major complications. Any hematoma, deep venous thrombosis, cardiopulmonary event, an event requiring an unexpected return to surgery, or death was considered a major complication.

2.2. Surgical methods

Several standardized techniques were used throughout the series. All subdural grids and strips were placed using an image-guided surgical navigation system (OTS, Radionics Inc, Burlington, Mass). Digital photographs of the cortical surface before and after grid placement were used to detect migration of the grid at the time of removal and ensure accurate determination of electrode sites.

All depth electrodes were inserted using a fixed, arc-based stereotactic frame (CRW, Radionics, Inc), using orthogonal trajectories, skull fixated anchor bolts, and a depth electrode insertion guide (Cosgrove Depth Electrode Kit, Radionics, Inc). For depth electrode placement, all targeting was performed using the surgical navigation system with superimposition of MRI and stereotactic angiographic data to avoid surface vasculature. Electrode tips were typically placed at 5 standardized targets bilaterally: amygdala, hippocampus, orbitofrontal cortex, anterior cingulum, and supplementary motor area. Targets were modified to accommodate other areas of interest.

All temporal lobectomies were performed without image guidance unless there was an underlying tumor. The standard lobectomy was tailored to intraoperative language mapping for dominant hemisphere resections and was generally restricted to the anterior 3.5 cm of the superior temporal gyrus angling posteriorly to include 5 cm of the inferior temporal gyrus. The lateral temporal cortex and fusiform gyrus were removed via subpial aspiration. The temporal horn of the lateral ventricle was then opened from the uncal notch to the choroidal point. The hippocampus would then be amputated approximately 2.5 to 3 cm from its anterior

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