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Rate and complications of adult epilepsy surgery in North America: Analysis of multiple databases

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ABSTRACT

Epilepsy surgery is under-utilized, but recent studies reach conflicting conclusions regarding whether epilepsy surgery rates are currently declining, increasing, or remaining steady. However, data in these prior studies are biased toward high-volume epilepsy centers, or originate from sources that do not disaggregate various procedure types.

All major epilepsy surgery procedures were extracted from the Centers for Medicare and Medicaid Services Part B National Summary Data File and the American College of Surgeons National Surgical Quality Improvement Program. Procedure rates, trends, and complications were analyzed, and patient-level predictors of postoperative adverse events were identified.

Between 2000–2013, 6200 cases of epilepsy surgery were identified. Temporal lobectomy was the most common procedure (59% of cases), and most did not utilize electrocorticography (63–64%). Neither temporal nor extratemporal lobe epilepsy surgery rates changed significantly during the study period, suggesting no change in utilization. Adverse events, including major and minor complications, occurred in 15.3% of temporal lobectomies and 55.6% of hemispherectomies.

Our findings suggest stagnant rates of both temporal and extratemporal lobe epilepsy surgery across U.S. surgical centers over the past decade. This finding contrasts with prior reports suggesting a recent dramatic decline in temporal lobectomy rates at high-volume epilepsy centers. We also observed higher rates of adverse events when both low- and high-volume centers were examined together, as compared to reports from high-volume centers alone. This is consistent with the presence of a volume-outcome relationship in epilepsy surgery.

1. Introduction

Recent studies suggest that epilepsy surgery is underutilized and declining in frequency, particularly anterior temporal lobectomies (ATL) (Englot et al., 2012, 2013; Jehi et al., 2015; Kaiboriboon et al., 2015). This is despite randomized controlled trials documenting the superiority of ATL compared to continued medical therapy for refractory epilepsy (Engel et al., 2012; West et al., 2015; Wiebe et al., 2001). One potential confound of these studies showing declining rates of surgery is that they are drawn from study populations at historically high-volume epilepsy centers (Englot et al., 2013; Jehi et al., 2015; Kaiboriboon et al., 2015), rather than the smaller community hospitals that now also offer epilepsy surgery. This high-volume bias also holds for complication rates, which tend to be lower in high-volume academic centers (Englot et al., 2013; Rolston et al., 2015). The actual complication rates experienced by patients in the community might be significantly higher (Englot et al., 2013; Rolston et al., 2015). How these trends are manifested outside high-volume centers is unknown.

Patient registries and databases offer one method of answering these questions, but only so far as the limitations are acknowledged. For example, the Nationwide Inpatient Sample (NIS), the source of several studies on epilepsy surgery trends (Englot et al., 2013, 2012), indexes procedures based on International Classification of Diseases (ICD-9) codes. This coding obscures important differences between temporal and extratemporal surgeries, however, since it does not clearly define anatomical locations of procedures, or their indication (e.g., the ICD-9 code for selective amygdalohippocampectomy, 01.39, is the same code for evacuation of cerebral hematoma).

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Table 1
CPT codes for epilepsy surgery.

CPT Code	Description
61534	Craniotomy with elevation of bone flap; for excision of epileptogenic focus without ECoG during surgery
61536	Craniotomy with elevation of bone flap; for excision of epileptic focus, with ECoG during surgery
61537[a]	Craniotomy with elevation of bone flap; for lobectomy, temporal lobe, without ECoG during surgery
61538	Craniotomy with elevation of bone flap; for lobectomy with ECoG during surgery, temporal lobe
61539	Craniotomy with elevation of bone flap; for lobectomy other than temporal lobe, with ECoG during surgery
61540[a]	Craniotomy with elevation of bone flap; for lobectomy other than temporal lobe, without ECoG during surgery
61541	Craniotomy with elevation of bone flap; for transection of corpus callosum
61543	Craniotomy with elevation of bone flap; for partial or subtotal hemispherectomy
61566[a]	Craniotomy with elevation of bone flap; for selective amygdalohippocampectomy
61567[a]	Craniotomy with elevation of bone flap; for multiple subpial transections, with electrocorticography during surgery

[a] Introduced in 2004.

This ambiguity with ICD-9 procedure codes is one reason the more specific Current Procedural Terminology (CPT) codes, which are maintained by the American Medical Association (AMA), are preferred by insurers and newer databases. For instance, there are two CPT codes for ATL alone – 61537 for ATL without electrocorticography (ECoG) and 61538 for ATL with ECoG – whereas ICD-9 has no code specific to anterior temporal lobectomy, only lobectomy in general (01.53). Two databases utilizing CPT codes are of particular interest when examining epilepsy surgery.

The American College of Surgeons (ACS) started the National Surgical Quality Improvement Program (NSQIP) in 2005 as a way to reliably track adverse events in North American hospitals, including centers in Canada and Mexico. It is continually growing and currently documents nearly 3 million procedures sampled randomly from over 600 hospitals (Ingraham et al., 2010; Khuri, 2005; Rowell et al., 2007). The mix of hospitals is heterogeneous, and includes both low- and high-volume centers. Critically, it uses highly trained and frequently audited personnel to enter procedural data and follow patients for complications. Procedures and concurrent procedures are all documented with up to 21 CPT codes per case. Postoperative complications have strictly defined criteria, and are not solely based upon billing data like other nationwide databases. For example, to register in NSQIP as a deep venous thrombosis (DVT), the patient must have a confirmed diagnosis of DVT via duplex venogram, computed tomography (CT) scan, or another definitive imaging modality (including autopsy). Then the patient must be treated with anticoagulation therapy, an inferior vena cava filter, or be documented as refusing these recommended therapies. Asymptomatic events are excluded, as are events that only raise clinical suspicion but lack imaging confirmation. This makes NSQIP a remarkably reliable means of documenting complications, demographics, and procedures.

Though NSQIP contains nearly 3 million surgical procedures, the majority are not for epilepsy surgery. A useful complement, to expand the sample size, is the Centers for Medicare and Medicaid Services (CMS) Part B National Summary Data File. This dataset documents the number of allowed services for each CPT code in the United States (US) by year. These data are limited to beneficiaries of these programs (a large percentage of patients with medically intractable epilepsy do qualify and are enrolled in these programs), but they only describe the frequency of such procedures rather than patient-level characteristics. However, the size and application to such a large segment of the US population makes these data a useful means for documenting trends in surgical procedures.

Using data from multiple independent databases allows us to identify the frequency of epilepsy surgery procedures with greater confidence than one database alone, and the NSQIP dataset in particular allows us to accurately estimate the frequency of surgical complications along with their patient-level predictors. Understanding these statistics, particularly any areas of high variance, will allow us to better identify procedures and modifications requiring further study, so that better surgical guidance can be provided.

2. Materials and methods

All cases of epilepsy surgery were extracted by CPT code (Table 1) from the CMS Part B data file for the years 2000–2013 and the NSQIP database for 2005–2013. The identified CPT code could be either the primary code or any of the supplementary codes listed for the procedure (of which there are 20 in NSQIP).

Starting in 2009, the CMS data file censored procedures when fewer than 11 cases were documented in a single year, for privacy purposes. When relative frequencies were calculated, only the years for which all data were available were used.

Vagus nerve stimulation procedures were not indexed, since the same CPT code is used for all indications, including depression. Pulse generator placement codes also overlap with those used for deep brain stimulation, and again are not differentiated by indication (movement disorder vs. epilepsy).

Demographic data and 30-day complication data were extracted for all cases from the NSQIP database. NSQIP tracks many complications, but some might reflect preexisting conditions. For instance, one tracked complication is postoperative ventilator dependence for longer than 48 h. However, if a patient was ventilator dependent preoperatively, this postoperative event is more a reflection of a preexisting condition, rather than a new complication. We therefore excluded complications when associated preexisting conditions were present, but only when the postoperative complication was present within the first 48 h after the operation. If it took 48 h for the condition to develop, it was unlikely present at the time of surgery, and therefore included. Note that this restriction was only for possible preexisting complications—all complications without evidence of preexisting conditions were included, regardless of timing (0–30 days postoperatively). This correction for possible preexisting conditions was done for the following complications: superficial surgical site infection (SSI), deep incisional SSI, organ space SSI, pneumonia, ventilator-dependence >48 h postoperatively, progressive renal insufficiency, acute renal failure, coma lasting >24 h, sepsis, and septic shock.

Statistical analysis was performed with version 23 of SPSS (IBM; Armonk, NY, USA). Averages were presented with standard deviation (SD) unless otherwise specified. Multivariate regression was done using the backward Wald method, an exclusion cut-off of 0.1, and a maximum of 200 iterations.

3. Results

From 2000–2013, 6200 cases of epilepsy surgery were identified from the CMS Part B National Summary Data File (5725 cases) and the ACS NSQIP database (475 cases; Table 2). The relative frequency of each procedure was very similar across the two independent datasets, with temporal lobectomy the most frequently performed of all epilepsy surgeries at 58.6–59.2%.