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Postoperative Complications and Readmission Rates Following Surgery for Cerebellopontine Angle Schwannomas

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Abstract

Objective—To investigate the 30-day postoperative complication, readmission, and reoperation rates following surgery for cerebellopontine angle (CPA) schwannomas.

Study Design—Cross-sectional analysis.

Setting—National surgical quality improvement program dataset (NSQIP) 2009 through 2013.

Patients—All surgical cases with an International Classification of Diseases, 9th edition, Clinical Modification (ICD-9-CM) diagnosis code of 225.1, benign neoplasms of cranial nerves, and one of the following current procedural terminology (CPT) codes, were included: 61616, 61526, 61530, and 61520.

Intervention(s)—Surgical resection as indicated by the CPT codes above.

Main Outcome Measure(s)—Demographics, comorbidities, 30-day postoperative complications, readmission rate, and reoperation rate.

Results—Overall, 404 cases were identified, of which 42.6% were men. The average age was 51 years. Comorbidities were present in 45.3%. NSQIP-tracked complications occurred in 9.7% of patients. Most common complications were wound infections including surgical-site infection and wound dehiscence (11 patients, 2.7%), sepsis (10 patients, 2.5%), blood loss (nine patients, 2.2%), and deep vein thrombosis (DVT; seven patients, 1.7%). Mortality occurred in four patients (1.0%). The complication rate was statistically higher in patients with comorbidities versus those without (10.2% versus 4.1%, $p = 0.04$). Patients with complications were more likely to undergo reoperation (2.5% with versus 4.1% without, $p = 0.001$). Unplanned readmissions occurred in 41 cases (10.1%) and reoperations occurred in 23 patients (5.7%).

Conclusions—Most common NSQIP-tracked complications in excision of CPA neoplasms are infections, sepsis, blood loss, and deep vein thrombosis (DVT). Further, investigation of patients

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with unplanned readmission and reoperation are warranted. Neurotologists need to take an active role in the data to be gathered in the NSQIP database as it relates to vestibular schwannomas.

Keywords

Acoustic neuroma; Cerebellopontine angle neoplasm; Complications; CPA tumors; NSQIP; Quality of care; Vestibular schwannoma

Cerebellopontine angle (CPA) neoplasms consist of a variety of tumors that comprise less than 10% of intracranial tumors. Approximately, 70 to 90% of these tumors are vestibular schwannomas (VS) (1). Other less common lesions include meningiomas, hemangiopericytomas, epidermoids, lipomas, paragangliomas, and arachnoid cysts (2). VSs are slow growing tumors of the eighth cranial nerve originating from the Schwann cells with an incidence rate of approximately 1 in 100,000 (3–5). While surgical resection, stereotactic radiosurgery, and observation are all viable treatment options for VSs, recent studies have demonstrated declining surgical volume, likely attributable to the increasing use of stereotactic radiosurgery and observation (5–7). Despite this trend, surgery continues to be the most commonly used treatment modality with approximately 50% of VSs treated with surgical excision (8). Postoperative complications depend on surgical approach, tumor size, and surgeon experience, and have been reported to occur in 28.2 to 45% of patients (9–11).

With the advent of quality metrics and pay for performance in medicine, particularly in surgical care, there has been an increased focus on quality improvement and its measurement methods. The Centers for Medicare and Medicaid Services have developed various performance initiatives aimed at rewarding hospitals and physicians for high quality of care (12). The National Surgical Quality Improvement Program (NSQIP) is a program designed and performed by the American College of Surgeons (ACS), which defines quality of care in surgery and is focused on 30-day postoperative complications, unplanned readmissions, and unplanned reoperations. Studies have shown benefits of enrollment in the NSQIP program to improve surgical morbidity and mortality (13). Despite the heightened awareness regarding quality metrics, there is little published in the field of neurotology. As the healthcare system experiences a gradual shift towards incentives for quality and performance, it is vital to investigate the quality metrics collected and evaluated by NSQIP and Centers for Medicare and Medicaid Services.

In this study, we aimed to investigate the 30-day postoperative complications, readmissions, and reoperation rates following surgery for CPA schwannomas, and by investigating the NSQIP data from 2009 to 2013.

MATERIALS AND METHODS

Data Source

The NSQIP collects data on the outcomes of surgical interventions across the United States. The data collected by this program is accessible through annual datasets released by the ACS and used to monitor quality of surgical care and complications within and between hospitals. The ACS NSQIP collects data on over 300 variables, including preoperative risk factors, intraoperative variables, and 30-day postoperative mortality and morbidity outcomes

for patients undergoing major surgical procedures in both the inpatient and outpatient setting. Patient diagnosis is captured through the International Classification of Diseases, 9th edition, Clinical Modification (ICD-9-CM) diagnosis codes and procedures performed are captured through current procedural terminology (CPT) codes. Furthermore, information regarding data collection instruments, variable definitions, and quality control is available elsewhere (14). The datasets did not contain identifiable patient information and are available by request and considered exempt by our institutional review board. Data use agreement was signed before obtaining the data.

Variables and Definitions

The NSQIP datasets of 2009 through 2013 were obtained and merged. All surgical cases with an ICD-9-CM diagnosis code of 225.1, benign neoplasms of cranial nerves, which listed one of the following CPT codes as their principal procedure code, were included: 61616, 61526, 61530, and 61520 (Table 1). For each record, age, sex, associated comorbidities, American Society of Anesthesiologists (ASA) classification, total operation time, length of stay, complications, readmission, and reoperation were analyzed. Age and sex information were captured. Comorbidities related to the same system were regrouped as one. These included pulmonary conditions, including chronic obstructive pulmonary disease, dyspnea, and ventilator dependence, and cardiovascular conditions including hypertension and congestive heart failure. Total operation time was reported in minutes and total length of stay reported in days.

Reoperation was defined as an unplanned return to the operating room for a surgical procedure related to the principal procedure performed. This return must have been within the 30-day postoperative period and could have occurred at any hospital or surgical facility. By definition, follow up procedures based on the pathology results were excluded such as return for re-excisions or insertion of port-a-caths for chemotherapy for other types of tumors. Readmission was defined as unplanned readmission (to the same or another hospital) for a postoperative occurrence likely related to the principal surgical procedure within 30 days of the procedure. The last 2 years analyzed, 2012 and 2013, collected associated CPT codes and ICD-9-CM codes with each reoperation. The previous years (2009–2011) only reported whether reoperation occurred but did not specify what type of surgery was performed.

Statistical Analyses

Data distribution of continuous variables was examined for normality. Mean \pm standard deviation (SD) was calculated for normal distributions and median for skewed distributions. Frequency and percentages were reported for binary or categorical variables. Chi-square test was used to evaluate associated factors with complications and reoperations. The PASW Statistics 18.0 (SPSS, Inc., Chicago, IL) was used for all data analyses. A *p* value of less than 0.05 was considered significant.

RESULTS

The 2009 through 2013 datasets combined contained 2,337,145 cases collected from 237 hospitals in 2009, 258 hospitals in 2010, 315 hospitals in 2011, 374 hospitals in 2012, and 435 hospitals in 2013. Of these, 404 cases (0.02%) met our inclusion and exclusion criteria and had undergone a craniotomy for a cerebellopontine angle schwannoma. The mean age was 51 ± 14 years and 42.6% (172 cases) were men. The frequency of principal CPT codes is presented in Table 2. Comorbidities existed in 183 cases (45.3%) including cardiovascular conditions in 132 (32.7%), current smoking in 38 (9.4%), diabetes mellitus in 17 (6.4%), chronic steroid use in 21 (5.2%), pulmonary conditions in 12 (3.0%), and bleeding disorders in 2 (0.5%). ASA classification was described as class I in 17 cases (4.2%), class II in 214 (53.0%), class III in 165 cases (40.8%), and class IV in 8 cases (2.0%). Mean total operation time was 406 ± 172 minutes. Median length of stay was 4 days (range, 2–25 days).

Thirty-day postoperative complications occurred in 39 patients (9.7%). These complications as well as the postoperative day in which they occurred are listed in Table 3. Once grouped into broader categories, most common complications were surgical site infection and wound dehiscence (11 patients, 2.7%), sepsis (10 patients, 2.5%), blood loss (9 patients, 2.2%), deep vein thrombosis (DVT; 7 patients, 1.7%). Mortality occurred in four patients (1.0%), all of which had 61520 listed as their principal procedure code (Table 4). There was no association between complications and sex (9.9% in women versus 9.3% in men, $p = 0.8$), ASA class (0% in class I, 7.0% in class II, 13.9% in class III, and 12.5% in class IV, $p = 0.06$), or principal CPT code (12.3% in 61520, 10.3% in 61526, 2.2% in 61530, and 4.9% in 61616, $p = 0.1$). The complication rate was statistically higher in patients with comorbidities versus those without (10.2% versus 4.1%, $p = 0.04$). The mean age was also higher in complicated cases (57 ± 14 versus 51 ± 13 , $p = 0.01$).

Unplanned readmissions occurred in 41 cases (10.1%). Two patients had a second readmission related to the principal procedure. Twenty-three patients (5.7%) had an unplanned reoperation, of which 15 (3.7%) occurred in years 2012 to 2013. The years 2012 to 2013 reported associated CPT codes and ICD-9-CM codes with the reoperations, which are presented in Table 5. Reoperations were not associated with sex (4.7% in women versus 7.0% in men, $p = 0.3$), ASA class (0% in class I, 6.5% in class II, 5.5% in class III, and 0% in class IV, $p = 0.6$), comorbidities (6.8% with versus 4.8% without, $p = 0.04$), or principal CPT codes (5.2% in 61520, 8.0% in 61526, 0% in 61530, and 8.2% in 61616, $p = 0.1$). Patients with complications were more likely to undergo a reoperation (2.5% with versus 4.1% without, $p = 0.001$).

DISCUSSION

The NSQIP is being increasingly implemented by authorities to monitor quality of surgical care and by investigators in otolaryngology–head and neck surgery to investigate postoperative outcomes and complication predictors (12,15–17). This study used this dataset to evaluate the 30-day postoperative complications, readmission, and reoperation rates after surgery for VS excision. Complications after VS excision occur frequently and can be broadly categorized to specific and systemic complications. Specific complications are

usually correlated with the unique nature of VSs and their anatomic location, size, and surgical approach. These include facial nerve paralysis, hydrocephalus, cerebrospinal fluid leak, seizure, meningitis, and other cranial nerve palsies. Systemic complications generally include common complications after any surgery including infection, DVT, pneumonia, and pulmonary embolism among others.

In a previous study on the California Hospital Inpatient Discharge Datasets, specific and systemic complications occurred in 28.2 and 5.1% of the cases, respectively (9). When comparing the two studies, the complication rates closely match with a few exceptions. Examples of similar complication rates include blood transfusion in 2.2% of cases in the current study versus 2.1% in the California study, ventilator dependence in 1.7% versus 1.3%, pneumonia in 1.2% versus 0.9%, myocardial infarction in 0.2% versus 0.2%, and pulmonary embolism in 0.5% versus 0.2%. In contrast, the overall complication rate in this study was 9.7%, which is higher than the 5.1% systemic complication rate in the California study. Other complication rates that were different include overall wound infection/dehiscence in 2.7% versus 0.3% in the California study and DVT in 1.7% versus 0.3%. These differences can be explained by the nature of the NSQIP datasets, which capture complications up to 30 days after the main operation and not only those during the initial hospitalization in the California study.

One of the most important factors related to specific complications is the size of the tumor or Koos grade (18,19), which is not captured by the NSQIP datasets. The Koos grading system is used to classify the tumor grade based on its extension (G1: intrameatal tumors; G2: tumors extending to the cerebellopontine angle; G3: tumors filling the cerebellopontine angle; G4: tumors compressing the brainstem and cerebellum) (20). Another important factor directly influencing the types of complications is the surgical approach, which is captured by the NSQIP datasets and is recorded as CPT codes. Surgical volume of the surgeons performing VS excision is also known to affect the complication rates; however, this metric is not measured by the NSQIP (5,21). It is also unclear whether the surgeries were performed by a single surgeon or as a team approach.

Some complications were more likely to occur in the immediate postoperative setting such as blood transfusion and reintubation while others such as wound infection, DVT, and pulmonary embolism occurred at any time during the 30-day period (Table 3). This signifies the importance of continued care for surgical patients and proper follow up to detect and treat these complications. Analysis of the most recent datasets of 2012 and 2013, which collected data on associated diagnosis and procedure codes with reoperations, reveals that unplanned reoperations in the 30-day postoperative period are generally related to facial paralysis such as lagophthalmus as well as cerebrospinal fluid leak, hydrocephalus, and wound infections. This underscores the importance of specific complications, and perhaps, the need to include recording of additional variables related to surgical volume, hospital setting, and tumor size which can directly influence the complication types and rates and as a result, quality of surgical care. Although complication, readmission, and reoperation rates did not statistically correlate with the principal CPT code, the surgical approach is a known correlating factor. This observed lack of association in this study might be related to the

sample size and the fact that several VS excision specific complications are not captured by the NSQIP dataset.

A number of limitations must be considered while interpreting the findings of this study. First, the data are only collected from hospitals and sites participating in the NSQIP program and the complication, readmission, and reoperation rates in non-participating sites and as a result, nationally, may vary. Second, the complications or mortality as a direct result of the principal surgery beyond the 30-day postoperative period is not captured by these datasets. Third, as with many other large datasets, the data are subject to collection bias and omission. The diagnoses and procedures are reported as ICD-9-CM and CPT codes, which inherently fail to capture details of the complications. Information on the type of the institution (academic versus non-academic) and surgical load were not available (10,11). In addition, it is unclear whether the patients had surgery for sporadic or neurofibromatosis type 2 (NF2) as complications in the NF2 group is higher (22).

Nonetheless, the study of NSQIP dataset provides valuable insight into the postoperative complications associated with excision of VS and the variables being collected and quality measures being investigated by healthcare organizations and agencies. In many institutions, otolaryngologists and neurotologists have taken important administrative roles and can certainly contribute in shaping the variables that are gathered.

CONCLUSIONS

NSQIP-tracked complications occurred in 9.7% of patients. Most common complications were wound infections including surgical site infection and wound dehiscence, sepsis, blood loss, and DVT. Unplanned readmissions occurred in 41 cases (10.1%) and reoperations occurred in 23 patients (5.7%). Treating complications related to facial nerve paralysis, cerebrospinal fluid leak, hydrocephalus, and wound infections are among the reasons for reoperation within the 30-day postoperative period. The complication rate was statistically higher in older patients and those with comorbidities. Patients with complications were more likely to undergo a reoperation.

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TABLE 1

List of CPT codes related to excision of cerebellopontine angle tumors

CPT Code	Description
61520	Craniectomy for excision of brain tumor, infratentorial or posterior fossa; cerebellopontine angle tumor
61526	Craniectomy, bone flap craniotomy, transtemporal (mastoid) for excision of cerebellopontine angle tumor
61616	Resection or excision of neoplastic, vascular or infectious lesion of base of posterior cranial fossa, jugular foramen, foramen magnum, or C1–C3 vertebral bodies; intradural, including dural repair, with or without graft
61530	Craniectomy, bone flap craniotomy, transtemporal (mastoid) for excision of cerebellopontine angle tumor; combined with middle/posterior fossa craniotomy/craniectomy

CPT indicates current procedural terminology.

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TABLE 2

Frequency of principal CPT codes

CPT Code	Frequency (%)
61520	211 (52.2%)
61526	87 (21.5%)
61616	61 (15.1%)
61530	45 (11.1%)

CPT indicates current procedural terminology.

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TABLE 3

Thirty-day complication rates and number of days from operation to occurrence

Complication Type	Frequency (%)	Days from Operation
Sepsis	10 (2.5%)	2, 6, 8, 8, 13, 17, 17, 25, 26
Blood transfusion	9 (2.2%)	0, 0, 0, 0, 0, 0, 0, 1, 2
Ventilator dependence >48 hours	7 (1.7%)	0, 2, 2, 2, 2 [*] , 4, 4, 5 [*]
Deep vein thrombosis	7 (1.7%)	4, 7, 10, 12, 18, 23, 26
Pneumonia	5 (1.2%)	1, 2, 3, 4 [*] , 18
Cerebrovascular accident	4 (1.0%)	0, 1 [*] , 3 [*] , 7
Urinary tract infection	4 (1.0%)	8, 15, 17, 18
Deep incisional infection	3 (0.7%)	17, 22, 28
Organ/Space infection	3 (0.7%)	7, 18, 25
Wound dehiscence	3 (0.7%)	4, 12, 30
Superficial incisional infection	2 (0.5%)	18, 20
Reintubation	2 (0.5%)	2, 3 [*]
Pulmonary embolism	2 (0.5%)	9, 23
Cardiac arrest	1 (0.2%)	8 [*]
Myocardial infarction	1 (0.2%)	1

(mortality cases indicated with asterisk)

TABLE 4

Characteristics of surgical cases with mortality

ID	Year of Operation	Gender/ Age	Comorbidities	ASA Class	Length of Stay (Days)	Complications	Reoperation
1	2009	F//72	Dyspnea	III	7	Cerebrovascular accident	No
2	2011	F/67	COPD, hypertension	III	6	Reintubation, ventilator dependence, cerebrovascular accident	No
3	2011	F/81	None	II	7	Pneumonia, ventilator dependence	Yes
4	2013	M/68	Chronic steroid use, hypertension	III	3	Cardiac arrest	No

ASA indicates American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease.

TABLE 5

CPT codes associated with reoperations. Percentages are based on total number of cases in years 2012 to 2013 (265 cases)

Reoperation CPT Codes	Reoperation ICD-9-CM Codes	Principal CPT Code	Frequency (%)
67912 correction of lagophthalmos, with implantation of upper eyelid lid load	374.21 paralytic lagophthalmos; 781.94 facial weakness; 951.4 injury to facial nerve	61520, 61520, 61526	3 (1.1%)
62100 craniotomy for repair of dural/cerebrospinal fluid leak, including surgery for rhinorrhea/otorrhea	349.81 cerebrospinal fluid rhinorrhea; 997.09 other nervous system complications	61526, 61526	2 (0.8%)
69631 tympanoplasty without mastoidectomy (including canalplasty, atticotomy, and/or middle ear surgery), initial or revision; without ossicular chain reconstruction	E878.8 other specified surgical operations and procedures	61616	1 (0.4%)
69511 mastoidectomy; radical	388.61 cerebrospinal fluid otorrhea	61520	1 (0.4%)
69140 excision exostosis (es), external auditory canal	349.81 cerebrospinal fluid rhinorrhea	61616	1 (0.4%)
67999 unlisted procedure, eyelids	374.20 lagophthalmos, unspecified	61520	1 (0.4%)
62160 neuroendoscopy, intracranial, for placement or replacement of ventricular catheter and attachment to shunt system or external drainage	331.4 obstructive hydrocephalus	61520	1 (0.4%)
41000 intraoral incision and drainage of abscess, cyst, or hematoma of tongue or floor of mouth; lingual	728.86 necrotizing fasciitis	61520	1 (0.4%)
13160 secondary closure of surgical wound or dehiscence, extensive or complicated	998.59 other postoperative infection	61616	1 (0.4%)
11043 debridement, muscle and/or fascia (includes epidermis, dermis, and subcutaneous tissue, if performed); first 20 cm ² or less	998.59 other postoperative infection	61520	1 (0.4%)
10180 incision and drainage, complex, postoperative wound infection	998.59 other postoperative infection	61520	1 (0.4%)
69799 unlisted procedure middle ear	388.61 cerebrospinal fluid otorrhea	61526	1 (0.4%)

CPT indicates current procedural terminology; ICD-9-CM, International Classification of Diseases, 9th edition, Clinical Modification.