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An updated assessment of morbidity and mortality following skull base surgical approaches

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ABSTRACT

Objectives: Updated multi-institutional database studies assessing perioperative risk factors on 30-day morbidity and mortality after skull base surgeries are limited. We aim to identify perioperative risk factors and report the incidence of 30-day morbidity and mortality in adult patients after skull base surgery.
Patients and Methods: We queried the 2007–2016 American College of Surgeons National Surgical Quality Improvement program database to identify patients who underwent anterior, middle, or posterior skull base surgery. We performed multivariable logistic regression to identify risk factors associated with 30-day morbidity and mortality. Postoperative events were compared between propensity score matched cohorts (no morbidity versus 30-day morbidity).
Results: The final analysis included 1028 adult (≥18 years old) patients. The incidence of 30-morbidity and mortality was 14.6% and 1.6%, respectively. Postoperative ventilator dependence (52.9%) followed by pneumonia (23.5%) and unplanned intubation (23.5%) had the highest prevalence among those with 30-day mortality. The adjusted odds of 30-day morbidity was significantly higher among patients with functional dependency, American Society of Anesthesiologists Physical Status ≥4, hyponatremia, and anemia ($p < 0.05$). The adjusted odds of 30-day mortality was significantly increased among patients with sepsis, bleeding disorder, disseminated cancer, and older age ($p < 0.05$).
Conclusion: Clinical perioperative factors are significantly associated with 30-day morbidity and mortality after skull base surgery. The reported rate of 30-day morbidity and mortality was similar to earlier studies and therefore highlights the need for continued quality improvement.

1. Introduction

The skull base encompasses the floor of the cranial cavity and includes the orbits, nasal sinuses, and bony regions to the cervical junction [1]; it is often divided anatomically into the anterior, middle, and posterior fossa. Advances in transcranial and endoscopic surgical techniques over the past several decades, with refinements in intraoperative neuronavigation and neuromonitoring and neuro-anesthesia, have broadened the safety and scope of skull base pathologies that can be surgically treated. While skull base surgeries are often performed with transcranial and craniofacial approaches, the demand for less invasive surgeries allowed for the integration and expansion of endoscopic approaches. Skull base surgery complications may lead to longer hospital stays, a potential proxy measure of both quality and efficiency of the healthcare system [2]. More recent literature has focused on small cohort, single institution studies and have shown that obesity and tumor location are associated with greater morbidity in skull base surgery [3,4].

While recent advances may have focused on the application of endoscopy, open approaches are still widely indicated for more complex pathologies, such as cancerous lesions with superior and lateral extension, and continue to represent the majority of skull base surgeries [5]. An updated assessment of morbidity and mortality utilizing a large national database is therefore necessary, as many studies in this area

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include a limited assessment of perioperative risk factors or evaluate small cohort single institutional data. We therefore aim to report the incidence of 30-day morbidity and mortality and identify perioperative risk factors associated with such outcomes in adult (≥18 years old) patients following skull base procedures. Understanding risk factors for complications is crucial for prevention, which may help to reduce medical expenditures and maximize healthcare efficiency.

2. Materials and methods

2.1. Data collection

We used the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) multi-center surgical outcome database for the years 2007–2016. NSQIP is de-identified and protects personal information and was therefore exempt from the consent requirement by the University of California, San Diego institutional review board. NSQIP contains demographic data (ex. race, ethnicity, sex, and age) perioperative risk factors (ex. functional status, diabetes mellitus, congestive heart failure, chronic obstructive pulmonary disease, disseminated cancer, and bleeding disorder), intraoperative variables (ex. operation time, anesthesia time, and work relative value units), and postsurgical outcomes (ex. pneumonia, emergent intubation, cardiac arrest, deep venous thrombosis, and surgical site infection) data from 183 participating hospitals in 2007 to over 600 hospitals in 2016 [6]. NSQIP undergoes a sampling process called the 8-day cycle to ensure cases are equally selected from each day of the week, thereby decreasing selection bias. Our study population consisted of all patients who underwent either an anterior, middle or posterior skull base surgical approach. NSQIP was queried and we extracted the American Medical Association defined current procedural terminology (CPT) codes for skull base surgical approaches: (1) anterior fossa: craniofacial approach (61580, 61581, 61582, 61583, 61584, 61,585), bicoronal/transzygomatic approach (61,586); (2) middle fossa: infratemporal pre-auricular approach (61,590), infratemporal post-auricular approach (61,591), middle orbitocranial zygomatic approach (61,592); (3) posterior fossa: transtemporal approach (61,595), transcochlear approach (61,596), transcondylar approach (61,597), and posterior transpetrosal approach (61,598).

The study population was defined as patients ≥ 18 years of age. Patients were selected for review if they underwent skull base surgery in the 2007–2016 study period. Clinical factors were chosen based on their clinical significance and literature evidence suggesting an association with outcomes in skull base surgery. Here, we identified 23 potential preoperative risk factors which included: body mass index (BMI) expressed in units of kg/m^2, age (years), gender, functional status in which patients were functionally independent (does not require assistance for activities daily living), partially dependent (requires some assistance for activities of daily living), or totally dependent (requires total assistance for activities of daily living), American Society of Anesthesiologists (ASA) Physical Status (PS) ≥ 4, diabetes mellitus, cigarette smoking in the year prior to admission for surgery, history of chronic obstructive pulmonary disease, disseminated cancer in which the primary malignancy has spread to at least one distant site, 30-day steroid use, bleeding disorder defined as a deficiency in blood clotting elements, dyspnea, history of congestive heart failure, blood transfusion, renal dialysis, ventilator dependence (required ventilator – assisted respiration 48 h preoperatively), hypertension, sepsis, wound infection, hyponatremia (serum sodium < 135 meq/L), anemia (hematocrit < 36%), blood urea nitrogen (mg/dL), and creatinine (mg/dL). Clinical significance guided our choice of intraoperative factors. We identified four potential intraoperative risk factors which included: operation time (hours), emergency surgery (versus urgent and semi-elective surgery), work relative value units, and surgical approach (anterior, middle, and posterior). We also identified the etiology of the postoperative diagnosis as a potential contributor of postoperative morbidity and mortality. The postoperative diagnosis for each patient was categorized into one of the following six categories: other (ex. neoplasms of uncertain behavior, bell's palsy, unspecific brain conditions, cholesteatoma, Meniere's disease, skull fracture, and unspecific nervous system conditions), infection (ex. mycoses, intracranial abscess, meningitis, orbital cellulitis, sinusitis, and mastoiditis) vascular (ex. hemangioma, intracranial hypertension, subarachnoid and intracerebral hemorrhage, stenosis of carotid artery, and cerebral aneurysm), malignant neoplasm of all sites (ex. sinuses, orbit, brain and ventricles, cranial nerves, head and neck, neuroendocrine, meninges, and secondary neoplasms), benign neoplasm of all sites (ex. head and neck, brain, cranial nerves, meninges, parathyroid gland), and unknown. NSQIP Participant Use Data File provides definitions of all clinical factors [7].

Briefly, the following postoperative events defined 30-day morbidity: superficial incisional surgical site infection, wound infection, internal organ infection, urinary tract infection, sepsis, shock, pneumonia, unplanned intubation, pulmonary embolism, ventilator dependence, cerebrovascular accident, deep venous thrombosis, wound dehiscence, renal insufficiency, acute renal failure, myocardial infarction, and cardiac arrest. We defined 30-day mortality as death from any cause within 30 days of surgery. Hospital length of stay was defined as the number of days from hospital admission to discharge. Here, we defined prolonged hospital length of stay at length of stay ≥ 75th quartile (≥ 8 days) for the cohort. NSQIP Participant Use Data File provides definitions of all postoperative factors [7]. Complete cases analysis was performed and 23% of missing data were excluded from the analysis. Fig. 1 outlines the inclusion and exclusion criteria.

2.2. Statistical analysis

R, a software environment for statistical computing (R version 3.3.2), was used to perform all statistical analysis. Bivariate analysis of postoperative 30-day morbidity cohorts was derived from the Pearson chi-square and Wilcoxon rank sum tests for categorical (with continuity correction) and nonparametric continuous variables, respectively. We assessed multicollinearity with variance inflation factor. Model discrimination was evaluated with area under the receiver operating characteristics curve (AUC) and with DeLong statistic for the 95% confidence interval. Hosmer – Lemeshow (HL) test goodness-of-fit test evaluated model calibration. The odds ratio (OR) of 30-day morbidity, mortality, and prolonged hospital length of stay for preoperative risk factors was assessed with unadjusted and adjusted logistic regression

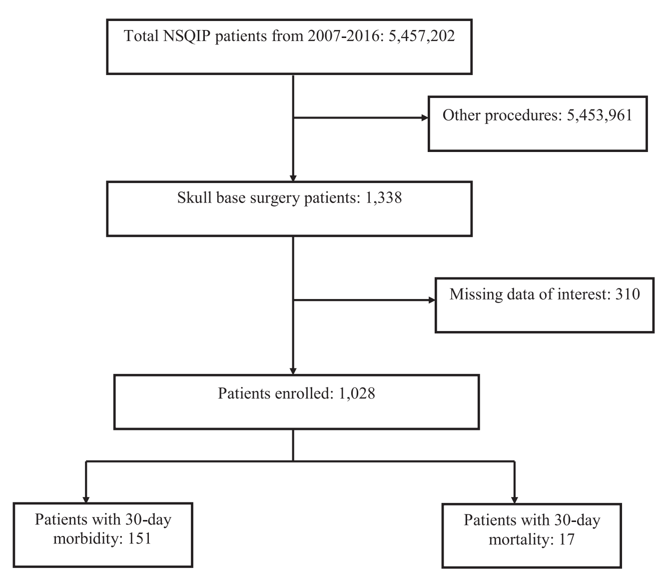

Fig. 1. Flowchart defining inclusion and exclusion of sample population.