CrossMark

Identification of Preoperative and Intraoperative Risk Factors for Complications in the Elderly Undergoing Elective Craniotomy

Stephen J. Johans[1], Jonathan R. Garst[2], Daniel J. Burkett[2], Kurt Grahnke[1], Brendan Martin[3], Tarik F. Ibrahim[1], Douglas E. Anderson[1], Vikram C. Prabhu[1]

■ BACKGROUND: **Neurosurgical patients are aging as the general population is becoming older.**

■ METHODS: **A retrospective review of patients ≥65 years of age who underwent an elective craniotomy from 2007 to 2015 to identify risk factors for 30-day morbidity/mortality was conducted. Key preoperative variables included age, comorbidities, and functional status based on the Karnofsky Performance Status score and modified Rankin Scale score. Outcome variables included long-term care (LTC) complications, neurologic complications, systemic/infectious complications, length of stay, functional outcomes, and mortality.**

■ RESULTS: **A total of 286 patients ≥65 years underwent elective craniotomy at Loyola University Medical Center over 8 years. Seventy-two patients had a preoperative neurologic deficit and 95 had a systemic morbidity before surgery. Postoperative neurologic and systemic morbidity was 14% and 23%, respectively. 7% of patients experienced a LTC complication and 5 patients (1.7%) died. Worse preoperative scores on both the Karnofsky Performance Status and modified Rankin Scale predicted increased length of stay and mortality ($P < 0.05$). Univariable and multivariable analyses showed that patients with preoperative motor deficit, altered mental status, congestive heart failure, smoking history, and chronic steroid use were all more likely to have an LTC complication, and increased anesthesia time and estimated blood loss increased risk for LTC, neurologic, and systemic/infectious complications.**

■ CONCLUSIONS: **This study identifies factors that predict perioperative complications for elderly patients undergoing elective craniotomies, particularly congestive heart failure, smoking history, chronic steroid use, anesthesia time, and estimated blood loss. Age alone should not preclude elective craniotomy.**

INTRODUCTION

The world's older population continues to grow at an unprecedented rate. Of people worldwide (617 million) 8.5% are aged 65 years and older. According to a report, *An Aging World: 2015*,[1] this percentage is projected to increase to nearly 17% of the world's population by 2050 (1.6 billion). By 2050, global life expectancy at birth is projected to increase by almost 8 years, increasing from 68.6 years in 2015 to 76.2 years in 2050. The population of the United States is also becoming older. The elderly are projected to comprise 20.6% of the U.S. population by 2030, compared with 14.5% in 2014.[2] Neurosurgeons report an increase in patient age among their patients,[3] and it is likely that this trend will continue. Paradoxically, some studies also suggest that elderly patients receive less neurosurgical care than do younger patients.[4,5] Neurosurgeons may be averse to accepting the perceived higher operative risk given a patient's age or comorbidities; the effect of age as a significant perioperative risk

Key words
- Aging population
- Elective craniotomy
- Outcomes

Abbreviations and Acronyms
ASA: American Society of Anesthesiologists
CI: Confidence interval
EBL: Estimated blood loss
IQR: interquartile range
KPS: Karnofsky Performance Status
LOS: Length of stay
LTC: Long-term care
mRS: Modified Rankin Scale
OR: Odds ratio
pRBC: Packed red blood cells

From the [1]Department of Neurological Surgery, Loyola University Medical Center, Maywood, Illinois; [2]Loyola University Chicago Stritch School of Medicine, Maywood, Illinois; and [3]Clinical Research Office, Health Sciences Division, Loyola University Chicago, Maywood, Illinois, USA

To whom correspondence should be addressed: Vikram C. Prabhu, M.D.
[E-mail: vprabhu@lumc.edu]

Citation: World Neurosurg. (2017) 107:216-225.
http://dx.doi.org/10.1016/j.wneu.2017.07.177

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

factor is debated.[6-17] Comorbidities that preclude surgery have been analyzed in cerebrovascular[11,18-20] and neurosurgical oncology.[7,12,17,21-27] Composite classification scores such as the American Society of Anesthesiologists (ASA) Physical Classification Scale,[17,21,24,25] Karnofsky Performance Status (KPS),[7,12,17,21-27] and modified Rankin Scale (mRS)[11,18-21,28] have been studied as risk predictors. Our surgical group has a varied practice including all aspects of cranial neurosurgery; the goal of this study was to identify preoperative and intraoperative risk factors that could predict short-term surgical complications and eventual functional status in patients ≥65 years of age undergoing elective craniotomy.

METHODS

An institutional review board–approved retrospective review of a prospectively maintained database of all patients ≥65 years of age who underwent an elective craniotomy at a single academic medical center from January 2007 to December 2015 under the care of 2 neurosurgeons (D.E.A. and V.C.P.) was performed. Data were collected from the respective electronic medical records. Preoperative factors recorded included age, sex, preoperative mRS score,[29,30] preoperative KPS score, ASA physical status classification score,[31] and body mass index. Preoperative comorbidities were recorded in a binary manner (either present or absent) and included a history of cerebrovascular disease, dementia or altered mental status (defined as acute/subacute confusion secondary to pathology), type 2 diabetes mellitus, coronary artery disease, cardiac arrhythmia, congestive heart failure, peripheral vascular disease, bleeding diathesis, hypertension, hyperlipidemia, chronic kidney disease, end-stage renal disease on dialysis, active infection, chronic obstructive pulmonary disease, or autoimmune disease. A history of tobacco use, alcohol consumption, and steroid use for greater than 2 weeks before surgery was also noted. Intraoperative factors recorded included total operative time, anesthesia time, units of packed red blood cells (pRBC) transfused in the operating room, estimated blood loss (EBL), laterality of procedure (right, left, midline), surgical approach, and location of procedure relative to the tentorium (infratentorial, supratentorial) and surgical approach (frontal, parietal, temporal, occipital, pterional, suboccipital, retrosigmoid, translabyrinthine, or middle fossa).

Seven postoperative outcomes were defined, all occurring within 30 days of the original operation: length of hospital stay (LOS), postoperative mRS score, postoperative KPS score, long-term care (LTC) complications, neurologic complications, systemic/infectious complications, and mortality. LTC complications included tracheostomy, or gastrostomy tube placement, and new living dependence requirement (e.g., a patient living independently preoperatively but requiring postoperative subacute nursing facility placement). Neurologic complications included stroke, new neurologic deficit (motor, sensory, or cranial nerve), decline in mental status compared with baseline, and seizure. Systemic complications included myocardial infarction, deep venous thrombosis/pulmonary embolism, acute kidney injury, wound infection, wound hematoma, cerebrospinal fluid leak, meningitis, abscess, urinary tract infection, pneumonia, *Clostridium difficile* colitis, any other infections, new arrhythmia, reintubation, and cardiac arrest.

Statistical Analysis

Descriptive statistics included an analysis by patient gender, age, preoperative and intraoperative comorbidities, and select postoperative outcomes. Continuous variables were expressed as means and standard deviations or medians and interquartile ranges, based on their underlying distributions. Categorical results included the number and percentage of patients within each level. Binary logistic regression models were used to estimate the odds of experiencing LTC, neurologic, and surgical site infection complications as a function of univariable and multivariable demographics, comorbidities, and preoperative mRS and KPS ordinal scores. A binomial distribution was specified for each response variable, and logit links were used to estimate the odds ratio (OR) for each explanatory variable against a referent. Risk factors for 30-day inpatient mortality were also identified using a binary logistic regression model, but only univariable results were reported because of the limited number of patient deaths ($n = 5$). Similarly, postoperative mRS and KPS scores were analyzed on a binary scale, with mRS score ≥3 and KPS score <80 deemed to be clinically relevant. This approach accounted for low patient counts along the full ordinal scale and appropriately adjusted for baseline mRS and KPS scores, respectively. For all analyses, certain variables were not available for modeling because of low variability detected among the observed cell counts, a problem commonly referred to as quasicomplete separation. The LOS variable was highly skewed and, thus, nonnormally distributed with most patients' inpatient stay lasting fewer than 10 days. As a result, a Wilcoxon rank sum test was used to compare LOS for those patients who presented with certain preoperative comorbidities and those who did not. A Kruskal-Wallis test was used to compare LOS for those patients who had certain intraoperative risk factors with more than 2 levels. Adjustments to account for possible type 1 error were made when assessing all pairwise comparisons for select intraoperative risk factors.

RESULTS

Two-hundred and eighty-six patients older than 65 years underwent an elective cranial procedure by 1 of the 2 senior authors at our institution over a span of 9 years. The mean age of the patents was 71.8 ± 5.9 years (range, 65–92 years), and 160 (56%) were female (Table 1). A total of 223 patients (78%) had a craniotomy for tumor resection, and 63 of the craniotomies (22%) were for nononcologic indications, including microvascular decompression for trigeminal neuralgia ($n = 40$), subdural hematoma ($n = 8$), aneurysm ($n = 4$), and 11 other miscellaneous nontumor cases.

Overall, 91 patients (32%) experienced at least 1 complication (systemic or neurologic), whereas 195 people (68%) did not experience any complications. Forty-one patients (14%) experienced a total of 52 neurologic complications. Overall, there were no meaningful associations between any preoperative comorbidities and patients' neurologic complications. By contrast, patients with increased operative time (OR, 1.11; 95% confidence interval [CI], 1.02–1.20; $P = 0.01$), anesthesia time (OR, 1.13; 95% CI, 1.05–1.22; $P = 0.001$), and EBL (OR, 1.10; 95% CI, 1.01–1.21; $P = 0.04$) were more likely to have a neurologic complication (Table 2). Only anesthesia time (adjusted OR, 1.12; 95% CI,