Journal of Clinical Anesthesia (2016) **34**, 15–20

ELSEVIER

Journal of Clinical Anesthesia

Original contribution

Acute stroke after total joint arthroplasty: a population-based trend analysis☆

Mohammad R. Rasouli MD, Reza Mostafavi Tabatabaee MD, Mitchell G. Maltenfort PhD, Antonia F. Chen MD, MBA*

Investigation performed at the Rothman Institute of Orthopaedics, Thomas Jefferson University, Philadelphia, PA, USA

Received 7 November 2014; revised 10 March 2016; accepted 10 March 2016

Keywords:
Total joint arthroplasty;
Stroke;
Nationwide Inpatient Sample

Abstract

Study objectives: This study aims to determine trends and predictors of acute stroke among total joint arthroplasty (TJA) patients using nationally representative data.

Design: Retrospective database review.

Setting: Nationwide Inpatient Sample database.

Patients: A total of 1,762,496 TJAs from 2002 to 2011.

Interventions: Patients underwent primary or revision total hip or total knee arthroplasty.

Measurements: Development of perioperative acute stroke.

Main Results: Among 1,762,496 TJAs, 2414 patients (0.14%) developed stroke; 1918 (79.45%) cases were ischemic and the remaining 496 (20.55%) cases were hemorrhagic stroke. The incidence of stroke decreased steadily from 0.17% in 2002 to 0.14% in 2011, which was statistically significant ($P < .0001$). The in-hospital mortality rate was much higher after stroke at 9% vs 0.15% for general TJA patients. Logistic regression analysis showed that stroke is a strong predictor of in-hospital mortality (odds ratio [OR], 27.73; 95% confidence interval [CI], 23.06-33.05; $P < .001$). Independent predictors of stroke were presence of pulmonary circulation disorders (including pulmonary embolism; OR, 2.23; 95% CI, 1.73-2.87), advanced diabetes mellitus (OR, 2.10; 95% CI, 1.61-2.73), cardiac arrhythmia (OR, 2.05; 95% CI, 1.83-2.29), peripheral vascular disease (OR, 1.74; 95% CI, 1.42-2.12), valvular heart disease (OR, 1.67; 95% CI, 1.43-1.95), renal disease (OR, 1.66; 95% CI, 1.38-1.99), and revision hip (OR, 1.39; 95% CI, 1.18-1.65). History of stroke or ischemic heart disease was not an independent predictor of stroke.

Conclusions: Despite a decline in the rate of stroke and stroke-related mortality after TJA, stroke still seems to be a major cause of in-hospital mortality. The present study outlines some risk factors for stroke after TJA. Recognition of these factors and identification of the at-risk patients may allow for appropriate allocation of resources and ability to minimize this complication after TJA.

1. Introduction

Stroke after total joint arthroplasty (TJA) is a rare but catastrophic complication that is associated with substantial morbidity and mortality. Perioperative acute stroke is a well-recognized complication of cardiac and certain vascular

☆ The authors declare that they did not receive any grants, sponsors, and funding sources that provided direct financial support to the research work reported in the manuscript.

* Corresponding author at: The Rothman Institute at Thomas Jefferson University, The Sheridan Building, 125 S. 9th St, Suite 1000, Philadelphia, PA 19107, USA. Tel.: +1 267 339 3617; fax: +1 215 503 5651.
E-mail address: antonia.chen@rothmaninstitute.com (A.F. Chen).

http://dx.doi.org/10.1016/j.jclinane.2016.03.034
0952-8180/

procedures because the risks of stroke directly correlate with the use of cardiopulmonary pumps and direct manipulation of the heart and major vessels [1]. Other types of surgery, including TJA, may not directly cause strokes but may lead to perioperative acute stroke due to perioperative risk factors including postoperative arrhythmia, hypotension, hypercoagulability, and perioperative myocardial infarction [1–4].

Relatively few data exist regarding the incidence, risk factors, and outcome of perioperative acute stroke after TJA. In 2009, Bateman et al [5] performed a study to determine the epidemiology of perioperative acute stroke using the Nationwide Inpatient Sample (NIS) database for 3 common noncardiac surgeries, including primary total hip arthroplasty (THA). The study concluded that 0.2% of 201,235 primary THA patients developed perioperative acute stroke, with a slightly higher risk (0.3%) for patients older than 65 years. The authors also found that renal disease, atrial fibrillation, history of stroke, and cardiac valvular disease were the most significant risk factors for developing perioperative acute ischemic stroke [5]. However, patients undergoing total knee arthroplasty (TKA) and revision arthroplasty of the hip or the knee were not included in the latter analysis. The current study was designed to examine the incidence of and the risk factors leading to acute stroke after all types of TJA using nationally representative data.

2. Methods

The NIS database from 2002 to 2011 was used for this study. The database was developed by the Agency for Healthcare Research and Quality as a part of the Healthcare Cost and Utilization Project. The NIS database is the largest all-payer hospital database in the United States and represents approximately 20% of all hospital inpatient stays. Because the NIS data are sufficiently de-identified, this study was exempt from institutional board review [6].

Using the *Ninth Revision of the International Classification of Diseases, Clinical Modification* (*ICD-9-CM*) diagnostic and procedure codes, we identified patients who underwent primary THA (*ICD-9-CM* code of 81.51), revision THA (*ICD-9-CM* codes of 81.53 and 00.70-00.73), primary TKA (*ICD-9-CM* code of 81.54), or revision TKA (*ICD-9-CM* codes of 81.55 and 00.80-00.84) between 2002 and 2011. Patients who had perioperative stroke or intracranial hemorrhage were identified using the following *ICD-9-CM* diagnostic codes: 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, and 436 for acute ischemic stroke and 430-432 for acute intracranial hemorrhage. Patients who were coded for iatrogenic stroke (*ICD-9-CM* code of 997.02) were also included in this study.

Demographics, hospital characteristics, and comorbidities were also obtained for this study population. Comorbidities that were considered potential risk factors for perioperative acute stroke are listed in the appendix with corresponding *ICD-9-CM* codes. Data on length of hospital stay and hospital charges were also extracted for study patients.

2.1. Statistical analysis

To determine predictors of stroke, we ran a multivariate analysis to control for confounders including year of surgery, type of TJA (hip vs knee and primary vs revision), sex, age, race, type of insurance, type and size of hospital, and certain patient comorbidities.

Total hospital charges in various years were adjusted to 2011 US dollars. Because neither total hospital charges nor length of hospital stay follows normal (Gaussian) distributions, bivariate comparisons between perioperative acute stroke and nonperioperative acute stroke cases were analyzed using nonparametric Wilcoxon tests. We used R 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria) for all analyses, and a P value less than .05 was considered to be statistically significant in all analyses.

3. Results

A total of 1,762,496 TJAs were evaluated; within this cohort, 2414 cases (0.14%) developed perioperative acute stroke, including 1918 (79.45%) ischemic and 496 (20.55%) hemorrhagic stroke. The incidence of stroke decreased steadily from 0.17% in 2002 to 0.14% in 2011; this was statistically significant in multivariate analysis ($P < .001$; Fig. 1). The incidence of perioperative acute stroke in revision TJA patients was higher than that of primary cases (odds ratio [OR], 1.39; 95% confidence interval [CI], 1.18-1.65; $P < .001$; Fig. 2).

Multivariate analysis identified the following as significant risk factors for stroke after TJA: presence of pulmonary circulation disorders, including pulmonary embolism (OR, 2.23; 95% CI, 1.73-2.87, $P < .001$); diabetes mellitus with complications (OR, 2.10; 95% CI, 1.61-2.73; $P < .001$), arrhythmia (OR, 2.05; 95% CI, 1.83-2.29; $P < .001$), peripheral vascular disease (OR, 1.74; 95% CI, 1.42-2.12; $P < .001$), valvular heart disease (OR, 1.67; 95% CI, 1.43-1.95; $P < .001$), renal disease (OR, 1.66; 95% CI, 1.38-1.99; $P < .001$), congestive heart failure (OR, 1.46; 95% CI, 1.24-1.72; $P < .001$), and revision TJA (OR, 1.39; 95% CI, 1.18-1.65; $P < .001$). History of stroke ($P = .73$) or ischemic heart disease ($P = .07$) were not predictive for perioperative acute stroke in TJA patients.

The in-hospital mortality rate was much higher in TJA patients who sustained a stroke (9%) compared with TJA patients without stroke (0.15%, $P < .001$). When controlling for demographics and comorbidities, stroke was confirmed to be an independent predictor of in-hospital mortality (OR, 27.73; 95% CI, 23.06-33.35; $P < .001$). However, a history of stroke was not associated with an increased risk of mortality ($P = .12$). Table 1 demonstrates the predictors of in-hospital mortality in patients who developed perioperative acute stroke after TJA. There was a significant decrease in mortality due to