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Original Article

General Anesthesia for Transcatheter Aortic Valve Replacement: Total Intravenous Anesthesia is Associated with Less Delirium as Compared to Volatile Agent Technique

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Objective: Investigate the effect of volatile anesthesia versus total intravenous anesthesia on the incidence of postoperative delirium and length of stay in patients undergoing transcatheter aortic valve replacement under general anesthesia.
Design: Retrospective study.
Setting: Single institution, academic medical center.
Participants: Adult patients who underwent transcatheter aortic valve replacement under general anesthesia between November 2014 and February 2017.
Interventions: This study was not an interventional study.
Measurements and Main Results: Electronic medical records were reviewed for intraoperative maintenance anesthetic technique, hospital and intensive care unit length of stay, 30-day mortality, and documentation of delirium. Delirium was defined as either 1) positive Confusion Assessment Method for the Intensive Care Unit score or 2) documentation of delirium or confusion by the care team within 2 days of surgery. Overall, 116 patients were included and 84 (72%) received a total intravenous anesthesia technique. Twenty-three patients (20%) had postoperative delirium. The odds of delirium were lower in patients undergoing transcatheter aortic valve replacement with total intravenous anesthesia, compared with volatile anesthesia, even after adjusting for procedure approach (odds ratio 0.22, 95% confidence interval 0.06, 0.79, $p = 0.02$). No significant difference in hospital or intensive care unit length of stay was seen after adjusting for procedural characteristics.
Conclusions: While postoperative delirium is a complex and multifactorial problem, the type of general anesthetic maintenance may contribute to the incidence of postoperative delirium in patients undergoing transcatheter aortic valve replacement, and total intravenous anesthesia may be an attractive alternative to volatile-based general anesthesia maintenance.

Key Words: aortic stenosis; transcatheter aortic valve replacement; postoperative delirium; total intravenous anesthesia

POSTOPERATIVE DELIRIUM is a well described—yet poorly understood—complication of cardiac surgical procedures. Although transient, delirium has clinical implications that extend beyond the period of the delirium itself. Namely,

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delirium negatively impacts patient recovery and is associated with increased total hospital length of stay (LOS) and total healthcare costs.[1–3] Postoperative delirium has been associated with prolonged mechanical ventilation following surgery, higher rates of aspiration pneumonia and sepsis, decreased functionality following surgery, and overall increased perioperative morbidity and mortality.[1–5] Furthermore, patients who experience postoperative delirium are at higher risk for long-term cognitive impairment and need for nursing home placement.[5–7]

Transcatheter aortic valve replacement (TAVR) patients are at risk for postoperative delirium given their advanced age, comorbidities, frailty, sensory impairment, and low baseline functional status. In a retrospective study of 427 patients undergoing TAVR or surgical aortic valve replacement, 32% of patients experienced postoperative delirium, and this was associated with a three-fold increase in mortality during the first year following the procedure.[3] In other published studies, the incidence of delirium in TAVR, whether performed with general anesthesia or conscious sedation, has ranged from 12% to over 40%.[2,8,9]

As TAVR delivery systems and procedural experience have improved, increased emphasis is placed upon identifying how the type of anesthesia impacts postoperative outcomes. For patients undergoing TAVR under general anesthesia, the impact of anesthesia maintenance technique on postoperative outcomes, including delirium, LOS, and mortality, has not been described. Total intravenous anesthesia (TIVA) maintenance technique for general anesthesia, when compared with volatile anesthesia (VA) technique, has been suggested to be advantageous in noncardiac surgery with regard to reduced recovery time, reduced risk of behavioral disturbances following surgery, and faster return of cognitive function.[10,11] The objective of this study was to describe the effect of anesthetic maintenance technique (VA versus TIVA) on the incidence of postoperative delirium among TAVR patients.

Materials and Methods

After approval from the Institutional Review Board, (IRB #16-2956), a retrospective review was performed of 116 consecutive patients undergoing TAVR at an academic medical center between November 2014 and February 2017, under general anesthesia with either TIVA or VA. Medications used for induction of anesthesia were left to the discretion of the anesthesia care team. Following induction and endotracheal intubation, anesthesia was maintained with the use of either continuous propofol and remifentanil infusions in the TIVA cases, or with inhalation of desflurane or isoflurane and remifentanil infusion in the VA cases. Valves used in this study include the Edwards SAPIEN XT and SAPIEN 3 (Irvine, CA,) and Medtronic CoreValve and Evolut R (Minneapolis, MN). Both transfemoral and nontransfemoral cases were included in this study.

Electronic medical records from the last preoperative clinic visit prior to TAVR and the inpatient hospitalization for TAVR were reviewed to capture patient demographics, comorbidities, preoperative laboratory values, surgical characteristics, postoperative delirium, LOS after surgery, intensive care unit (ICU) LOS after surgery, and inpatient mortality. Variables of interest included: preoperative albumin, history of cerebrovascular accident (CVA) or transient ischemic attack (TIA), history of cognitive impairment, New York Heart Association (NYHA) Heart Failure Class, left ventricular ejection fraction (LVEF), mean aortic valve (AV) gradient, gait speed (determined by the 5-meter walk test), Katz Index of Independence in Activities of Daily Living (ADL) score, Lawton-Brody Instrumental Activities of Daily Living (IADL) scale, TAVR approach, valve type, type of maintenance anesthesia, anesthesia time, procedure time, and total intravenous fluids used during the procedure. Delirium was defined as 1) a positive confusion assessment method intensive care unit (CAM-ICU) score or 2) documentation of delirium or confusion by the care team (physician or nurse) within the first 2 days following surgery (postoperative days [POD] 0, 1, and 2). ICU LOS was defined as the total number of days the patient was at ICU status after the procedure, until level of care was downgraded to step-down or floor status.

Statistical Analyses

Patient demographics, preoperative and perioperative characteristics, stratified across anesthesia type, were compared using Fisher's exact and Student's t-tests, where appropriate. Median (and interquartile range [IQR]) morphine equivalents and extubation time were reported and compared using Wilcoxon-Mann-Whitney tests because the distribution of both variables in the authors' patient population was highly skewed. A p value < 0.05 was considered significant for all tests. The incidence of delirium, 30-day mortality, and both the average LOS after surgery and average ICU LOS after surgery also were compared across anesthesia type using Fisher's exact and Student's t-tests. Multivariable logistic and linear regression was used to estimate the effect of TIVA compared with VA on delirium and LOS, respectively, after adjusting for TAVR approach (cutdown versus percutaneous) and access site (femoral versus apical versus aortic, etc). Unadjusted logistic and linear regression was used to identify potential risk factors for delirium and changes in the LOS after surgery. Patient age, albumin, aortic valve (AV) gradient, 5-meter walk, total intravenous fluids, ADL score, IADL score, valve size, and anesthesia time were all modeled as linear variables.

All analyses were performed using SAS 9.4 (SAS Institute Inc, Cary, NC).

Results

Overall, 116 TAVR patients were included in the analyses, and 84 (72.4%) patients received a TIVA maintenance technique. Patients receiving TIVA were significantly more likely to have a higher albumin (average 3.8 g/dL *v* 3.6 g/dL, $p = 0.005$), history of cognitive impairment (30.1% *v* 6.3%, $p = 0.007$), have their transfemoral TAVR procedure performed via percutaneous access (90.1% *v* 23.3%,

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