# Anesthetic Considerations for Thoracoscopic Sympathetic Ganglionectomy to Treat Ventricular Tachycardia Storm: A Single-Center Experience

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***Objective:*** **The aim of this study was to determine the pertinent anesthetic considerations for patients undergoing surgical sympathectomy for electrical storm (incessant ventricular tachycardia (VT) refractory to traditional therapies).**

***Design:*** **This is a retrospective review of a prospective database.**

***Setting:*** **This single-center study took place in a university hospital setting.**

***Participants:*** **Twenty-six patients were enrolled.**

***Interventions:*** **Fifteen patients underwent left-sided sympathectomy, whereas 11 patients underwent bilateral sympathectomy.**

***Measurements and Main Results:*** **Anesthetic management of these patients was quite complex, requiring invasive monitoring, transesophageal echocardiography, one-lung ventilation, programming of cardiac rhythm management devices, and titration of vasoactive medications. Paired *t* test of hemodynamic data before, during, and after surgery showed no significant difference between preoperative and postoperative blood pressure values, regardless of whether the patient underwent unilateral or bilateral sympathectomy. Eight patients remained free of VT, three patients responded well to titration of oral medications, and one patient required 2 radiofrequency ablations after sympathectomy to control his VT. Three patients continued to have VT episodes, although reduced in frequency compared with before the procedure. Four patients were lost to followup. Overall, five patients within the cohort died within 30 days of the procedure. No patients developed any anesthetic complications or Horner's syndrome. The overall perioperative mortality (within the first 7 days of the procedure) was 2 of 26, or 7.7%.**

***Conclusions:*** **The anesthetic management of patients undergoing surgical sympathectomy for electrical storm can be quite complex, because these patients often present in a moribund and emergent state and cannot be optimized using current ACC/AHA guidelines. Expertise in invasive monitoring, transesophageal echocardiography, one-lung ventilation, cardiac rhythm device management, and pressor management is crucial for optimal anesthetic care.**



***KEY WORDS: sympathectomy, stellate ganglionectomy, ventricular tachycardia, electrical storm***

DESPITE MULTIPLE RECENT advances in treatment, ventricular arrhythmias leading to sudden cardiac death remains the leading cause of death in the United States, even eclipsing the overall mortality of all cancers combined.[1,2] "Electrical storm" refers to ventricular arrhythmias refractory to medical treatment, for which the need for electrical therapy may range from twice in a 24-hour period to nearly continuous shocks.[3] Such arrhythmias classically are treated with a combination of antiarrhythmic drugs, defibrillation, and/or rapid pacing. However, class I antiarrhythmics often fail, and amiodarone may take days to achieve sufficient rhythm control[4]—a luxury of time not afforded in the case of electrical storm. Although the implantable cardioverter/defibrillator (ICD) remains the standard in treatment for recurrent ventricular tachycardia (VT), it is not curative therapy, and the risk of recurrent arrhythmia remains unaffected. Furthermore, the occurrence of frequent ICD shocks has been tied to increased mortality and decreased quality of life.[5] Recently, electrical storm refractory to medical and electrical therapies has been treated successfully via catheter ablation,[4,6,7] although the failure rate of this approach remains high, thus necessitating alternative treatment. Stellate ganglionectomy has been introduced as a definitive surgical approach to ameliorate sympathetically mediated VT in patients refractory to conventional therapies, and its use is gaining momentum.

Although most patients in electrical storm have a low immediate mortality,[8] patients who are candidates for this approach (having typically failed pharmacologic catheter-based interventions with persistent life-threatening arrhythmias) universally present on both an emergent basis and often moribund cardiac state. Therefore, perioperative optimization of these patients cannot be undertaken using the American College of Cardiology/American Heart Association (ACC/AHA) guidelines and, thus, pose a unique challenge to the perioperative care team.

In this single-center study, the authors retrospectively reviewed a prospectively collected database to determine anesthetic considerations in managing patients undergoing sympathetic ganglionectomy via video-assisted thoracic surgery (VATS) for treatment of electrical storm. The challenges in perioperative care and surgical, electrophysiologic, and anesthetic management for these complex patients are described, and clinical outcome measures are reviewed to determine if these patients could be ushered safely through the perioperative period despite the significant challenges posed by patient comorbidities and surgical and anesthetic complexity.

## OPERATIVE CASE CONSIDERATIONS

Twenty-six consecutive patients undergoing bilateral or unilateral sympathetic ganglionectomy via the VATS approach were recruited for this study. Arterial access was obtained in

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all patients before induction of anesthesia. Induction of general anesthesia was achieved using titrated doses of lidocaine (1-1.5 mg/kg), fentanyl (1-3 ug/kg), and etomidate (0.1-0.2 mg/kg) and/or propofol (1-2 mg/kg). In general, fentanyl and etomidate were preferred for patients with significantly depressed ejection fraction (EF); otherwise, fentanyl and propofol were preferred. Neuromuscular blockade was maintained by administration of a nondepolarizing agent (rocuronium, vecuronium, or cisatracurium). All patients were intubated via direct laryngoscopy and placement of a left-sided double-lumen tube for single-lung ventilation. Patients without pre-existing central venous access received a 9-French Cordis introducer in anticipation of either possible initiation of inotropic/vasopressor support and/or pulmonary artery catheterization.

Anesthesia was maintained using potent inhaled anesthetic agents (0.7-1.3 minimum alveolar concentration) in 100% oxygen. Hemodynamic monitoring consisted of standard monitors as described by the American Society of Anesthesiologists with the addition of invasive arterial monitoring. Because most patients had implanted devices and were, thus, at risk of electromagnetic interference due to electrocautery, device interrogation and reprogramming were performed after the patients were anesthetized. Reprogramming consisted of disabling electronic antitachycardia therapies after placement of cutaneous defibrillator pads, disabling rate responsiveness, if present, and adjusting electronic bradycardia therapies on a patient-specific basis. Adhesive defibrillator pads were placed in the anterior-posterior orientation, so as not to interfere with the surgical field and to minimize the risk of damage to the patients' electronic pacing systems. Transesophageal echocardiography (TEE) was performed in all patients to assess cardiac function and guide intraoperative hemodynamic management.

Patients then were placed in the lateral decubitus position with the operative side up. For patients undergoing concurrent, bilateral procedures, the left was performed first. Upon completion of the left-sided VATS, patients then were repositioned toward the opposite side for performance of the contralateral VATS.

At the end of the surgical procedure, patients who were not intubated before surgery were assessed for standard extubation criteria. Once criteria were met, these patients were extubated. Patients then were transferred to the postanesthesia care unit (PACU) or intensive care unit (ICU), depending on level of acuity.

## METHODS

After institutional review board (IRB) approval, volunteers within the Department of Anesthesiology collected a prospective database of consecutive patients meeting inclusion criteria of undergoing unilateral or bilateral sympathetic ganglionectomy via VATS for treatment of electrical storm due to any cause. Given the observational nature of the study, there were no exclusion criteria. The authors then retrospectively reviewed the data collected from this cohort including all pertinent preoperative , intraoperative, and postoperative data.

A total of 26 patients undergoing thoracoscopic sympathectomy for ventricular tachycardia storm from April 2009 through December 2011 were enrolled. Data were collected pertaining to patient age, gender, ASA physical status, preoperative left ventricular EF, cause and prior treatment of arrhythmia, and presence of an implanted cardioverter/defibrillator.

Data were collected pertaining to type of procedure (unilateral versus bilateral sympathectomy), surgical time, anesthesia time, estimated blood loss (EBL), intravenous fluid administration, transfusion, and inotropic and vasopressor support. Any intraoperative occurrence of significant arrhythmia or hypoxemia also was noted, along with measures used to maintain hemodynamic stability. Performance of intraoperative TEE was deemed significant, and any abnormalities were recorded in the database. Finally, data were collected regarding successful extubation at the end of surgery versus requirement of prolonged ventilatory support.

Postoperative disposition was noted, as was length of ICU stay. Data were collected pertaining to residual arrhythmia and subsequent treatment, as well as mortality.

Hemodynamic data were gathered for each patient, including lowest blood pressures (1) in the final 24 hours before surgery, (2) intraoperatively before sympathectomy, (3) intraoperatively after sympathectomy, and (4) in the first 24 hours after surgery, to assess hemodynamic effects of sympathectomy.

Significant complications requiring further intervention (such as chest tube placement or dialysis) were recorded. Change in EF after sympathectomy was noted, as were any signs or symptoms of development of Horner's syndrome.

Numeric values in the database were analyzed for proportions and expressed as percentage, median, and range. Paired *t* test was used to determine significant changes between preoperative and postoperative values.

## RESULTS

A total of 26 patients underwent thoracoscopic sympathectomy. Table 1 shows patient demographic data. Mean age was 58 ± 11 years. Twenty-four patients (92%) were male, and all patients were deemed ASA class 4E. Mean preoperative EF was 31% ± 14%, with a median of 25% and a range of 15% to 59%. The primary cause of VT was predominantly ischemic cardiomyopathy (23%) or nonischemic dilated cardiomyopathy (54%). Most patients (92%) had an ICD. In all patients, the indication for thoracoscopic sympathectomy was recurrent VT requiring multiple ICD shocks despite maximal medical management and failed catheter ablation.

Table 2 shows relevant intraoperative clinical information. Eleven of 26 patients underwent bilateral sympathectomy (42%). Median surgical time for the procedure was 164 minutes, with a range of 91 to 296 minutes, and median anesthesia time was 229 minutes with a range of 132 to 358 minutes. Median estimated blood loss (EBL) was 50 mL with a range of 0 to 400 mL, and median IV fluid (IVF) administered was 1,100 mL with a range of 150 to 2,500 mL. No patients required blood transfusion. In this patient population, 4 patients (15%) required inotropic support before surgery, consisting primarily of norepinephrine, epinephrine, milrinone, dopamine, or vasopressin. During the procedure, however, 50% of patients required inotropic or vasopressor support, consisting of epinephrine, vasopressin, norepinephrine, and/or dopamine. Seven patients (27%) required postoperative inotropic support (within the first 24 hours of surgery), consisting of vasopressin, dopamine, epinephrine, phenylephrine, norepinephrine, and milrinone. One patient required extracorporeal membrane oxygenation 5 days before sympathectomy because of severe hemodynamic instability after attempted catheter-based radiofrequency ablation for VT. Three patients required intraaortic balloon pump support for severe hemodynamic decompensation