Left thoracoscopic sympathectomy for cardiac denervation in patients with life-threatening ventricular arrhythmias

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Background: We reported the outcomes of a single-institution experience using video-assisted thoracoscopic left cardiac sympathetic denervation as an adjunctive therapeutic technique in pediatric and young adult patients with life-threatening ventricular arrhythmias.

Methods: We conducted a retrospective clinical review of all patients who underwent left cardiac sympathetic denervation by means of video-assisted thoracoscopic surgery at our institution. From August 2000 to December 2011, 24 patients (13 with long QT syndrome, 9 with catecholaminergic polymorphic ventricular tachycardia, and 2 with idiopathic ventricular tachycardia) were identified from the cardiology database and surgical records.

Results: There were no intraoperative complications. The median postoperative length of stay was 2 days (range, 1-32 days). There were no major perioperative complications. Longer-term follow-up was available in 22 of 24 patients at a median follow-up of 28 months (range, 4-131 months). Sixteen (73%) of the 22 patients experienced a marked reduction in their arrhythmia burden, with 12 (55%) becoming completely arrhythmia free after sympathectomy. Six (27%) of the patients were nonresponsive to treatment; each had persistent symptoms at follow-up.

Conclusions: Video-assisted thoracoscopic left cardiac sympathetic denervation can be safely and effectively performed in most patients with life-threatening ventricular arrhythmias. This minimally invasive procedure is a promising adjunctive therapeutic option that achieves a beneficial response in most symptomatic patients. These results support the inclusion of thoracoscopic cardiac sympathetic denervation among the treatment armamentarium in all patients with ventricular arrhythmias refractive to conventional medical therapy. (J Thorac Cardiovasc Surg 2014;147:404-11)

CHD

The sympathetic nervous system plays a prominent role in the genesis of many life-threatening ventricular arrhythmias. β-Blockade is the mainstay of therapy; however, despite reducing arrhythmia frequency, many patients experience persistent cardiac events and remain at risk of sudden death.[1,2] Intolerance to antiarrhythmic agents is also a common problem.[1] In some patients, a more aggressive strategy to prevent sudden cardiac death is required. Implantable cardioverter-defibrillator (ICD) implantation has frequently been used in these cases. Although ICDs effectively protect against lethal arrhythmias, associated morbidities are prominent and include procedural risks, device malfunction, inappropriate shocks, and psychological distress, particularly among adolescents.[3] Left cardiac sympathetic denervation (LCSD), first described in 1971,[4] has been a safe and effective procedure to reduce fatal arrhythmias and prevent cardiac death. The surgical technique has undergone several modifications,[5] with variations in strategy among different centers.

Video-assisted thoracoscopic (VATS) LCSD was first reported by Reardon and colleagues[6] in 2000, with Li and colleagues[7] reporting the first small series in patients with LQTS in 2003. Several groups have demonstrated positive intermediate outcomes using adjunctive thoracoscopic LCSD to treat intractable ventricular arrhythmias in pediatric patients,[8-11] with the largest experience in children with refractory LQTS (long QT syndrome).[8-10,12] The indications for performing VATS-LCSD continue to evolve, with recent reports demonstrating its utility in children with non-LQTS arrhythmias.[2,8,12] Herein, we report our single-center experience performing adjunctive VATS-LCSD in 24 pediatric and young adult patients with life-threatening ventricular arrhythmias.

PATIENTS AND METHODS

This retrospective study was performed after approval from the Institutional Review Board. Patients were identified using the cardiology database and surgical notes. Medical records were reviewed for baseline

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Abbreviations and Acronyms

CPVT = catecholaminergic polymorphic ventricular tachycardia
ICD = implantable cardioverter-defibrillator
IVT = idiopathic ventricular tachycardia
JLNS = Jervell and Lange-Nielsen syndrome
LCSD = left cardiac sympathetic denervation
LQTS = long QT syndrome
VATS = video-assisted thoracoscopic
VF = ventricular fibrillation
VT = ventricular tachycardia

characteristics, treatment indications, details of operative strategy, intraoperative events, and postoperative course. Between August 2000 and December 2011, VATS-LCSD was performed in a total of 24 patients (11 males; median age, 13 years; range, 5 weeks to 27 years) at Boston Children's Hospital (Boston, Mass). The cohort includes the 9 patients in our initial study from 2008 reporting the VATS-LCSD technique.[8] Thirteen were diagnosed with congenital LQTS (2 had *Jervell and Lange-Nielsen syndrome*, defined as severe QT prolongation and congenital hearing loss), 9 with catecholaminergic polymorphic ventricular tachycardia (CPVT), and 2 with idiopathic recalcitrant ventricular tachycardia (VT).

Surgical Technique

In all patients, LCSD was performed via a left-sided VATS approach under general anesthesia. The operative technique is largely unchanged from that described previously,[8] with the following exceptions: dissection is performed using a harmonic scalpel in place of electrocautery, and chest tube placement in the left pleural cavity is no longer undertaken. The stellate ganglion was intentionally spared in 23 of the 24 patients.

Patient Descriptions

Long QT syndrome. Thirteen patients were identified with LQTS (Table 1). The median age at LCSD was 8 years (range, 2-22 years). Six (patients 1, 2, 4, 5, 6, and 8; Table 1) of the 13 had undergone previous ICD implantation. Indications for LCSD included delivery of recurrent appropriate ICD shocks despite optimal antiarrhythmic therapy in 4 (patients 4, 5, 6, and 8), ongoing arrhythmic events despite optimal antiarrhythmic therapy in 4 (patients 9, 11, 12, and 13), failed medical therapy (unable to tolerate β-blocker dose increase) in 3 (patients 1, 2, and 3), with 2 (patients 7 and 10) high-risk patients treated prophylactically. Of the 13 patients, 9 had available genotypic information: 7 were LQTS-1 and 2 were LQTS-2 genotype.

Catecholaminergic Polymorphic VT. Nine patients were identified with CPVT (Table 1). The median age at LCSD was 17 years (range, 8-27 years). Seven had prior ICD implantation, with 1 (patient 19) also receiving a dual-chamber pacemaker. Delivery of recurrent ICD shocks despite optimal medical therapy was the indication for LCSD in 6 of these 7 patients. Patient 17 had recurrent ICD shocks associated with failure to tolerate medical therapy. The remaining 2 (patients 14 and 21) were symptomatic despite optimal medical therapy.

Intractable VT. Two patients (patients 23 and 24) had intractable VT. Both had persistent symptoms despite optimized medical therapy. Patient 23 had recurrent VT despite maximal antiarrhythmic therapy and multiple electrophysiology studies for ablation of a left-sided accessory pathway and 3 distinct VT foci. Follow-up was limited to the time of discharge, and he had ongoing runs of VT during a prolonged postoperative hospital stay. Patient 24 was treated at 5 weeks of age in the setting of recalcitrant ventricular arrhythmias requiring repeated defibrillation.

RESULTS

Left Cardiac Sympathetic Denervation and Video-Assisted Thoracoscopic Surgery

Video-assisted thoracoscopic LCSD was performed in 24 patients. Eight patients received concomitant ICD implantation; 1 received a dual-chamber pacemaker. There were no intraoperative complications, and blood loss was minimal. Continuous cardiac rhythm monitoring (telemetry) was used in all patients postoperatively, with a pediatric electrophysiologist reviewing the telemetry twice daily. Two (9%) of the patients experienced arrhythmias before discharge. Patient 2 developed VT necessitating cardioversion and began taking esmolol and magnesium infusion. No further arrhythmic episodes occurred. Patient 17 experienced recurrent runs of VT, which led to a prolonged hospital stay of 32 days.

There were no major postoperative complications. Minor postoperative complications occurred in 3 (13%) of the patients. Patient 16 developed a small apical pneumothorax, necessitating chest tube suction. She was discharged 1 day later. Patient 18 developed a small left apical pneumothorax and was successfully treated with 24 hours of oxygen therapy. Her length of stay was 2 days. Patient 8 developed prominent harlequin facial flushing, but not Horner syndrome, and this had resolved at follow-up. She is the only patient to have had the left stellate ganglion included in the LCSD. No patients developed Horner syndrome. Eleven patients were initially managed in the postoperative intensive care unit (ICU). The median length of postoperative hospital stay was 2 days (range, 1-32 days).

Follow-up Outcomes

Long QT syndrome. Of the 13 patients with LQTS, 4 were treated with LCSD for recurrent appropriate ICD shocks despite optimal medical therapy. Of the 4 patients, 2 were symptom free post-LCSD. Patient 4 was event free at 33 months, whereas patient 8 had complete resolution of her frequent VT episodes at 131 months post-LCSD treatment (Table 2). One patient (patient 5) demonstrated some reduction in arrhythmia burden. She experienced multiple ICD discharges in the months before LCSD, and at latest follow-up, she had experienced 2 further ICD firings and required 4 antiarrhythmic medications. The fourth patient treated for recurrent ICD discharges (patient 6) did not respond to LCSD, experiencing ongoing recurrent ICD shocks at 23 months. In the 4 patients who were symptomatic despite optimal medical therapy, patients 11 and 12 were both asymptomatic and required no antiarrhythmic therapy at 31- and 29-month follow-up, respectively. Patient 13 experienced 2 ICD shocks during 13 months of follow-up, although this occurred in the setting of poor medication