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Is stellate ganglion resection really necessary for cardiac sympathetic denervation?

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ABSTRACT

Introduction: An electrical storm (ES) is characterized by electrical instability and the recurrence of clustered ventricular arrhythmias (VAs). The current definition according to the latest European Society of Cardiology (ESC) guidelines is the occurrence of sustained VAs three or more times within 24 h requiring intervention, with each event separated by at least 5 min management often requires an implantable cardioverter-defibrillator (ICD), pharmacologic therapy, catheter ablation, and modulations of the autonomic nervous system. Permanent cardiac sympathetic denervation (CSD) can be considered a valid option when resolving cannot be achieved in persistent cases.

Materials and Methods: This study comprises a retrospective series of 7 patients experiencing ES who underwent CSD at our medical facility, spanning from December 2019 to May 2023. Patients' age, sex, left ventricular ejection fraction (%), New York Heart Association class, operation side, number of ports, operation time, and length of hospital stay were recorded.

Results: The mean age of the patients was 52±18 years, with male patients being the majority (71.4%). All patients were followed up for a mean of 473±455 days. There was no mortality associated with the surgical procedure, and our morbidity was a prolonged air leak lasting 10 days in one patient. We observed only one case of ES related to an ICD shock occurring once at 6 months postoperatively.

Conclusion: Considering the possible serious complications, our modification may be perceived as an easy-to-use technique for treating VAs. Large, multicenter studies are needed for validation.

Keywords: Arrhythmia, Video-assisted thoracoscopic surgery, sympathetic denervation

Introduction

An electrical storm (ES) is characterized by electrical instability and the recurrence of clustered ventricular arrhythmias (VAs). The current definition according to the latest European Society of Cardiology (ESC) guidelines is the occurrence of sustained VAs three or more times within 24 h requiring intervention, with each event separated by at least 5 min.[1]

This syndrome typically occurs in patients with underlying structural heart disease (ischemic or non-ischemic cardiomyopathy) or inherited channelopathies. The management of ES requires a multidisciplinary approach. Acute management aims at stopping ES and suppressing arrhythmogenic stimuli. More definitive management targets the underlying VA substrate to terminate it and prevent recurrence.[2]

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Management often requires an implantable cardioverter-defibrirallator (ICD), pharmacologic therapy, catheter ablation, and modulations of the autonomic nervous system.[3]

Permanent cardiac sympathetic denervation (CSD) can be considered a valid option when resolving cannot be achieved in persistent cases. The literature is generally limited to case reports and/or series. In addition, this procedure is not harmless. Potential complications include Harlequin syndrome, dyshidrosis, and regional temperature changes, particulary Horner syndrome, which is associated with partial resection of the stellate ganglion.[4,5]

Standard CSD is performed by video-assisted thoracoscopy (VATS), resecting the lower 1/3 to 1/2 of the stellate and T2 to T4 thoracic ganglions and transecting the Kuntz nerve, if present.[6,7] However, Hofferberth et al.,[8] performed this procedure using a different technique, which involved cauterizing and removing the sympathetic chain from the lower part of the stellate ganglion down to the T4 ganglion. One-third or half of the stellate ganglion remains untouched. In this way, they argued that complications could be avoided. We also employed a similar approach with the same concerns. This study aimed to present our experiences with this technique.

Materials and Methods

Study Design and Parameters

This study comprises a retrospective series of 7 patients experiencing ES who underwent CSD at our medical facility, spanning from December 2019 to May 2023. A written informed consent form was obtained from all patients.

Patients' age, sex, left ventricular ejection fraction (LVEF%), New York Heart Association class, operation side, number of ports, operation time, and length of hospital stay were recorded. Irrespective of its etiology, all patients with ventricular tachycardia (VT) were included in the study.

Measurement of Arrhythmia Burden

The VT storm was characterized by the occurrence of three or more sustained VT episodes within a 24 h timeframe, each necessitating intervention for termination. Refractory VT was identified as recurrent ICD shocks unresponsive to antiarrhythmic, medical, or radiofrequency catheter ablation treatments.

Surgical Technique

Before the operation, the ICDs were deactivated. An external defibrillator was provided on the surgical table to promptly manage VAs and fibrillation. All patients underwent general anesthesia and were ventilated using a double-lumen endotracheal tube for single-lung ventilation. A single-shot second-generation CFS was administered just before intubation. To enable performing bilateral procedures within the same session without changing the patient's position, a 45° semi-sitting position was employed. In one patient with extensive adhesions due to prior cardiac surgery, a unilateral procedure was performed, while bilateral sympathectomy procedures were applied to other patients. During the procedure, dual ports were used in one case due to cardiomegaly, while single ports were used in others. For the case with dual ports, a 10 mm camera port was placed along the midclavicular line at the 3rd intercostal space, and a second 10 mm working port was inserted along the mid-axillary line at the 3rd intercostal space. A 30° camera was preferred. In cases with single ports, a 2.5 cm incision was made along the mid-axillary line at the 3rd intercostal space, and a 10 mm camera and L-hook cautery were used for dissection. A 30° camera was preferred. The surgical procedure was initiated by exploring the left hemithorax via a videothoracoscopic approach. Adhesions were managed using energy devices and blunt dissection. Both sides of the sympathetic chain were surgically opened using a L-hook cautery on the parietal pleura over the T1-T4 ganglion, and the sympathetic chain was exposed. Subsequently, the sympathetic nerve was cut and resected using cautery from beneath the T1 ganglion to beneath the T4 ganglion, and it was removed using an endo grasper. The Kuntz nerves were cauterized 2 cm laterally in parallel to the sympathetic chain line, based on their possible course. Following hemostasis, air within the left thorax was evacuated with a nasotracheal tube through a trocar incision while inflating the lung. Subsequently, subcutaneous and skin closures were performed to conclude the procedure. Similar steps were applied to the right sympathetic chain. An 8-F chest tube was placed on the right hemithorax, connected to a closed underwater drainage system, and the procedure was completed. Patients were extubated in the operating room and monitored in the cardiology intensive care unit. The patients' ICDs were reactivated in the early postoperative period. Routine postoperative analgesia included administering 1 g of paracetamol in-

travenously 3 times daily. With the exception of one patient who had prolonged air leakage, all others had their chest tubes removed on the first postoperative day.

Morbidity and Mortality

Surgical morbidity and mortality were assessed within the first 30 days postoperatively. In only one case, the drain was removed on the 10th day due to prolonged air leakage. The same patient was discharged from the hospital on the 13th day. No procedure-related mortality was observed in any of our patients postoperatively.

Follow-up

All patients were followed longitudinally by a multidisciplinary team through regular ICD controls in the outpatient department, telephone calls, and/or external hospital records when available. All patients were transferred to the general ward after their cardiology intensive care unit monitoring. Except for one patient who experienced aspiration pneumonia and passed away on the 14th postoperative day, the others were able to be discharged from the hospital. Only one patient experienced an ES once in the 6th postoperative month during the 31-month follow-up period. The minimum follow-up duration was 3 months in the most recent case, and no issues were observed. The longest-followed case died due to cardiac causes at the 36th month. The follow-up data for all patients are presented in Table 1.

Statistical Analysis

The statistical product and service solutions (SPSS) software version 22 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analyses of the study. The normality of the distribution of the data were checked out using the Shapiro-Wilk test. Qualitative data were presented as frequency and percentage. Quantitative data were given as Mean±SD if the data were normally distributed and median ınterquartile range (IQR) if not normally distributed.

Results

The mean age of the patients was 52±18 years, with male patients being the majority (71.4%). The preoperative median (IQR) LVEF value was 55% (20–65). Unilateral procedures were performed on only 1 patient (14.7%). In addition, 85.7% of the patients underwent procedures using single-port access. The surgeries were conducted within a mean operation time of 44±18 min. The median length of hospital stay was 2 days (2–13). All patients were followed up for a mean of 473±455 days. There was no mortality associated with the surgical procedure, and our morbidity was a prolonged air leak lasting 10 days in one patient. All patients experienced dryness of the hands. However, none of the patients developed compensatory hyperhidrosis. During the follow-up period, we observed only one case of ES related to an ICD shock occurring once at 6 months postoperatively, while we did not encounter any mortality related to the surgical procedure (Table 1).

Table 1. Characteristics of the all patients

Patients	Age	Sex	LVEF (%)	NYHA class	Operation side	Ports	Operation time/min	LOH stay/days	Follow-up
Patient 1	60	M	20	III	Bilateral	Two	80	3	Death at 36th month due to cardiac reasons
Patient 2	43	F	65	I	Bilateral	Single	45	2	Alive at 31st month
Patient 3	64	M	20	II	Bilateral	Single	40	14	Death at 14th day due to aspiration pneumonia
Patient 4	25	M	65	I	Unilateral	Single	20	2	Alive at 28th month
Patient 5	68	M	55	III	Bilateral	Single	50	13	Death at 6th month due to respiratory failure
Patient 6	32	F	65	I	Bilateral	Single	35	2	Alive at 6th month
Patient 7	69	M	45	II	Bilateral	Single	40	2	Alive at 3rd month

LVEF: Left ventricular ejection fraction; NYHA: New York Heart Association; LOH: Length of hospital.

Discussion

ICD shocks have been demonstrated to increase morbidity and mortality while decreasing quality of life.[6] In cases of refractory ES, CSD has demonstrated a 90% reduction in the occurrence of ICD shocks for 90% of patients.[4] Considering the limited treatment options, significant risks of morbidity, and minimal available data for this patient group, CSD stands as a useful option of ultima ratio for selected patients.[4,9]

Cardiac sympathectomy is a minimally invasive procedure performed using VATS with one to three ports. The procedure is typically recommended bilaterally. In cases where there is concern about the patient's tolerance for right-sided cardiac sympathectomy, initiating with left-sided cardiac sympathectomy is preferred.[6,10,11] Some studies suggest that unilateral left-sided cardiac sympathectomy alone may be sufficient.[12] In our series, Patient 4 underwent a unilateral procedure due to significant adhesions resulting from a prior cardiac intervention.

Among the complications of surgical cardiac sympathectomy, Horner's syndrome is reported at a rate of 4.3%.[13] This complication may occur from the use of electrocautery during the dissection of the lower half of the stellate ganglion.[7] In Bourke et al.'s study,[12] temporary Horner's syndrome developed in one patient among nine patients, while Coleman et al.[14] reported three patients with transient Horner's syndrome in 27 patients. In the study by Vaseghi et al.,[6] Horner's syndrome was observed in 5 patients among 121 patients, with one case being persistent. On the other hand, Cauti et al.[5] have published a case series comprising five patients in which they reported successful outcomes through a modified sympathectomy procedure that preserves the stellate ganglion. Hofferberth et al.[8] conducted a study involving 24 cases in which 23 patients retained the stellate ganglion. The last two authors state that none of the patients developed Horner's syndrome. In our study, we also protected the stellate ganglion and were not confronted with Horner's syndrome.

Another essential problem in the postoperative period is VT shock. Assis et al.[10] and Yalin et al.[11] reported only one patient experiencing VT storm after CSD. Also, in our series, only patient 2 suffered an ES associated with an ICD shock once 6 months after the operation.

This study has some limitations. First, it is a retrospective study with a small sample size. Furthermore, tough we believe that the stellate ganglion is protected, we cannot express this definitively. Perhaps the distal segment of the stellion ganglion may have a thermal impact due to electrocautery. It is, therefore, not clear whether the possible mechanisms of effect and damage are limited to the stellate ganglion. Certainly, we need more studies to verify the effectiveness of this technique.

Conclusion

Considering the possible serious complications, our modification may be perceived as an easy-to-use technique for treating VAs. Large, multicenter studies are needed for validation.

Disclosures

Ethichs Committee Approval: Patient records were evaluated retrospectively after the approval of the local Ethics Committee (Decision number: 2023/15/728).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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