Open surgical ablation of ventricular tachycardia: utility and feasibility of contemporary mapping and ablation tools

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Introduction

- Percutaneous catheter ablation is effective in managing refractory ventricular tachycardia(VT)[1-3]. Depending on the origin of the VT, epicardial access and ablation may be required.
- However, success of epicardial catheter ablation may be limited when transcutaneous access is contraindicated, such as in cases of dense adhesions from prior cardiac surgery, myocarditis, or prior epicardial ablation[4-8].
- Open surgical ablation is an option, but guidance for ablation is limited without simultaneous electrophysiologic data. Open surgical ablation is an alternative when epicardial access is needed or other surgical procedure is needed in addition to arrhythmia treatment.[4-8]
- Contemporary intra-operative electrophysiology (EP) mapping (involving voltage, pace-mapping, activation mapping) is feasible[6] and may help improve efficacy of ablation and long-term outcomes of patients. We aim to describe our novel approach with this technique and outcomes of this procedure.

Methods

- In this case series, 8 patients with recurrent VT despite medications and prior ablations and in need of epicardial access with ablation were included and underwent open surgical ablation.
- These patients had at least 1 of the following characteristics warranting open surgical ablation: 1) prior cardiac surgery, 2) failed attempt at percutaneous epicardial access or mapping due to adhesions, 3) planned, concurrent LVAD implantation
- Procedures were performed with a multi-disciplinary team of cardiothoracic (CT) surgery, cardiac electrophysiology, cardiac anesthesia, and perfusion. General anesthesia was used in all cases, CT surgeons provided access and implanted LVAD in select patients, and cardiac electrophysiologists used intra-operative electroanatomic (EAM) and EP mapping techniques to guide ablation for each case.
- Regions with late potentials, abnormal ventricular activity, and pace-maps for induced VTs, early activation, and entrainment features were targeted for ablation with a cryoprobe.
- Patients were hospitalized on the CT surgical service and consulted by EP until time of discharge, then followed in outpatient visits at 4-6 weeks post-discharge followed by outpatient visits every 3 months afterward.
- Patients were followed for average of 599 days for outcomes of VT recurrence, amount of VT burden, amount and type of antiarrhythmic drugs (AADs), orthotopic heart transplant (OHT), and death. COMIRB approved data collection and analysis for this project.

Results

Table 1: Baseline Characteristics

Patient	Sex	Age (yrs)	LVEF (%)	Prior AADs	Amiodarone Treatment	Cardiomyopathy	Prior Catheter Ablation Endo/Epi	Reason for Surgical Ablation	Incessant VT	VT Storm
1	M	65	57	4	Yes	None known	Yes/Yes	H/o Surgical Ablation	No	Yes
2	M	66	40	4	Yes	Nonischemic	Yes/Yes	H/o Hemopericardium	Yes	Yes
3	M	54	19	5	Yes	Nonischemic	Yes/No	LVAD Planned	Yes	Yes
4	M	62	40	2	Yes	Mixed	Yes/Yes	H/o Hemopericardium	No	Yes
5	M	69	40	3	Yes	Ischemic	Yes/Yes	H/o Extensive Epi Ablation	No	Yes
6	M	62	36	2	Yes	Ischemic	Yes/Yes	H/o Extensive Epi Ablation	Yes	Yes
7	M	69	30	2	Yes	Nonischemic	Yes/No	LVAD Planned	No	Yes
8	M	60	50	1	Yes	Nonischemic	Yes/Yes	Extensive Adhesions in Prior Epi Attempt	No	Yes

AAD=Anti-Arrhythmic Drug; Endo=Endocardial; Epi=Epicardial; H/o=History Of; LVAD=Left Ventricular Assist Device; LVEF=Left Ventricular Ejection Fraction; M=male; VT=Ventricular Tachycardia

Table 2: Procedural Characteristics

Patient	Surgical Approach	Substrate Location	No. VTs Targeted	Mapping Time (min)	Radiofrequency Ablation Time (min)	Cryoablation Time (min)	Cryoprobe Temperature	Procedural Time (min)†	Acute Endpoint(s) Achieved
1	Lateral Thoracotomy	Inferolateral LV	1	20	0	30	-80ºC	240	Any VT Non-Inducible + Exit Block
2	Lateral Thoracotomy	Inferior, Inferolateral LV	1	30	0	80	-80ºC	340	Exit Block
3	Median Sternotomy	Inferolateral LV	1	15	0	16	-80ºC	354	Any VT Non-Inducible + Exit Block
4	Lateral Thoracotomy	Inferior, Inferolateral LV	2	32	5	20	-80ºC	436	Any VT Non-Inducible + Exit Block
5	Lateral Thoracotomy	Inferolateral LV	1	12	0	20	-80 to -150ºC	284	Any VT Non-Inducible + Exit Block
6	Lateral Thoracotomy	LV Summit	1	10	2	15	-150ºC	313	Clinical VT Non-Inducible
7	Median Sternotomy	LV Summit	1	12	0	12	-140ºC	353	Any VT Non-Inducible + Exit Block
8	Lateral Thoracotomy	Inferolateral LV	2	10	0	44	-140ºC	215	Any VT Non-Inducible + Exit Block

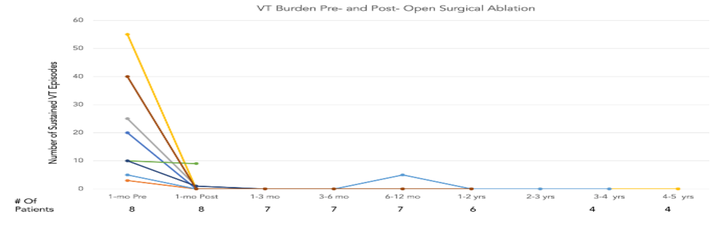
†Includes total surgical time
LV=Left Ventricle; VT=Ventricular Tachycardia

Table 3: Follow-Up

Patient	Post-Procedure Length of Stay (days)	Recurrent VT	Recurrence with Incessant VT	Time to VT Recurrence (days)	Repeat Catheter Ablation	Time to Orthotopic Heart Transplant (days)	Alive at Last Follow-Up	Time to death (years)
1	5	No	--	--	--	--	Yes	--
2	7	No	--	--	--	--	Yes	--
3	21	Yes	No	7	--	118	Yes	--
4	4	No	--	--	--	--	Yes	--
5	5	Yes	No	332	Yes	--	No	3.2
6	22	Yes	Yes	1	--	12	Yes	--
7	121	Yes	No	1	--	--	No	1.2
8	9	No	--	--	--	--	Yes	--

VT=Ventricular Tachycardia

Figure 1: VT Burden



Discussion

- 62.5% of our patients experienced VT freedom for nearly a year post-SurgAbl and experienced a 90% reduction in VT burden (median 15 occurrences per month reduced to median 0 times per month).
- Transplant-free survival occurred in 6 (75%), and survival free from VT storm in 7 (88%).
- We observed a reduction in amiodarone dose, from a mean 577±204 mg pre-SurgAbl to 286±146 mg post-SurgAbl, p=0.016, conferring an additional benefit in SurgAbl.
- Surgical ablation guided by intra-operative, contemporary electroanatomic mapping can help to refine ablation strategy and may improve outcomes in patients with limited treatment options for VT management.
- Surgical ablation with EP mapping should be considered for those with refractory epicardial or mid-myocardial ventricular arrhythmias and structural heart disease, and for whom transcutaneous epicardial access is limited or concurrent cardiac surgery is planned[9-11].
- We had similar VT recurrence compared to other studies[1, 4, 7], in both patients with and without concurrent LVAD implantation, as 29% had VT recurrence after SurgAbl and LVAD implantation in one study [7] and recurrence in half in a study without LVAD implantation.[4]

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