Endoaneurysmorrhaphy and Cryoablation for Postinfarction Left Ventricular Aneurysm with Ventricular Tachycardia

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Background: Early reperfusion in the acute phase of myocardial infarction and better medical treatment of consequent heart failure and tachyarrythmia have decreased the incidence of massive myocardial infarction, left ventricular (LV) aneurysm and also postinfarction-sustained ventricular tachycardia (VT). However, for a number of patients, surgical ablation combined with aneurysm resection and myocardial revascularization remains a possible curative procedure. In this study, the efficacy of endoaneurysmorrhaphy and cryoablation was evaluated in patients with postinfarction LV aneurysm with VT.

Methods: The medical records of 9 patients who underwent LV endoaneurysmorrhaphy and cryoablation for VT at Taipei Veterans General Hospital between January 1995 and August 2005 were reviewed retrospectively.

Results: There were 8 men and 1 woman, with a mean age of 69.7 years (range, 52–77 years). Preoperative VT and LV aneurysm were found in all patients, who underwent extensive cryoablation at the transitional zone of scar and viable tissue without intraoperative mapping and LV remodeling with prosthetic patch. Associated procedure included coronary artery bypass grafting in 8 patients. During follow-up, no surgical or inhospital mortality were noted. There was 1 late sudden death at home 1.7 months after the operation. No recurrent VT was detected, and all patients showed improvement in New York Heart Association functional class (mean, 2.33 *vs.* 1.67; $p = 0.025$) and LV ejection fraction (mean, 26.3% *vs.* 34.1%; $p = 0.021$).

Conclusion: In patients suffering from postinfarction LV aneurysm complicated with VT, combining cryoablation and endoaneurysmorrhaphy offers good arrhythmia control and clinical outcome. [*J Chin Med Assoc* 2007;70(3):117–120]

Key Words: cryoablation, endoaneurysmorrhaphy, ventricular tachycardia

Introduction

The association between ventricular tachycardia (VT) and postinfarction left ventricular (LV) aneurysms has been noted since the 1930s. Since ventricular arrhythmia caused more than 50% death in remodeled ventricles after myocardial infarction, surgical treatment with nondirected aneurysmectomy was attempted and reported in the late 1970s and 1980, but achieved only limited success.[1,2] That may be due to most VTs arising from the border of the aneurysm, which is rarely excised during operation.[3] Over the past decade, surgical interventions for VT have become safer and more effective, however, the number of patients considered for surgery decreased. This is because aggressive thrombolytic therapy and percutaneous recanalization procedures, and the availability of other techniques such as catheter ablation with radiofrequency and implantable cardioverter defibrillator (ICD), have decreased the incidence of postinfarction LV aneurysm and VT. But for a number of patients, surgical ablation combined with aneurysm resection and myocardial revascularization remains a possible curative procedure.[4,5] Currently, there are 2 major approaches for VT surgery: (1) ablation or resection of arrhythmogenic foci after localization by intraoperative mapping;[6–8] (2) extensive ablation without

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mapping.[4, 9–13] In this study, we analyzed our results of the patients with postinfarction LV aneurysm who underwent Dor operation combined with blind cryoablation in the borderzone between healthy and scar tissue.

Methods

Patients

Between January 1995 and August 2005, 52 patients underwent Dor operation for postinfarction LV aneurysm in Taipei Veterans General Hospital. Nine were found to have spontaneous VT before the operation, so cryoablation was performed. There were 8 men and 1 woman, with a mean age of 69.7 years (range, 52–77 years). The preoperative study protocol included electrocardiogram (ECG), echocardiography, cardiac catheterization, coronary angiography, ejection fraction and wall motion by nucleotide method, and electrophysiologic study (EPS) if obtained. All of the patients had anterior wall aneurysm. Two patients suffered from single-vessel disease, 2 had double, 4 had triple and another patient had left main plus triple-vessel disease. Mean preoperative left ventricular ejection fraction (LVEF) was 26.3 ± 7.0% (range, 18–43%). Four patients had the concomitant symptom of angina. Six of them were New York Heart Association (NYHA) class II for dyspnea, and the other 3 were class III. All of them had palpitations or presyncope, and 3 patients suffered from syncope. There were no patients who required preoperative endotracheal intubation or mechanical assistive device (intra-aortic balloon pump [IABP] or extracorporeal membrane oxygenation [ECMO]).

Operative technique

All operations were carried out via median sternotomy. Cardiopulmonary bypass was started via cannulation of the ascending aorta and right atrium. Moderate hypothermia was achieved, and the aorta was cross-clamped. Initially, antegrade warm bloody cardioplegia was given, followed by cold potassium cardioplegia for cardiac arrest. After aneurysmotomy, the LV cavity was explored and the thrombus was removed. The transitional zone of viable and scar tissue was identified and continuous encircling cryoablation was applied (Figure 1).

Remodeling of the LV cavity was then performed as described by Dor et al.[14] A purse-string suture was placed along the transitional zone, and a Dacron patch was sutured inside the ventricle to exclude the scarred portion from the effective residual cavity of the LV. After aneurysmectomy, the ventriculotomy was closed and strengthened using Teflon filters. Additional coronary artery bypass grafting (CABG) was performed after the cryosurgery and LV repair if indicated.

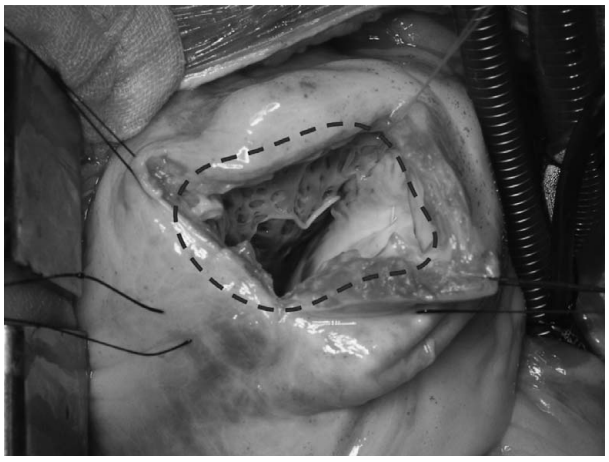

Figure 1. Cryoablation of transitional zone between infarcted and ischemic area. After the left ventricular aneurysm was opened, the transitional zone (dashed line) was identified and encircling cryoablated.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation. Difference between preoperation and postoperation was analyzed with Wilcoxon signed rank test. A p value of < 0.05 was considered to be statistically significant.

Results

All patients showed spontaneous VT preoperatively and were recorded by 12-lead ECG or continuous ECG monitor. For antiarrhythmia, amiodarone was given in 2 patients, diltiazen in 1 patient and digoxin in 2 patients preoperatively. Two patients received EPS before operation, and both showed polymorphic VT. After operation, only 2 patients received diltiazen short-term for heart rate control. There were 5 patients who received angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) before and after surgery (Table 1).

All 9 patients received the Dor procedure, and concomitant CABG was performed in 8, but not in the remaining 1 whose left anterior descending coronary artery-first diagonal branch (LAD-D1) was the only lesion and failed to bypass. Among the 8 patients who received CABG, LAD territory was bypassed in 7 patients and left internal mammary artery (LIMA) was used in 3 patients. Mean bypass time was 186 ± 53 minutes (range, 130–280 minutes), and mean ischemia time was 116 ± 39 minutes (range, 70–183 minutes).

Table 1. Characteristics of patients

Case	Age (yr)	Gender	Underlying disease	Medication		Pre-op EPS	NYHA Fc		LVEF (%)	
				Pre-op	Post-op		Pre-op	Post-op	Pre-op	Post-op
1	74	Male		Digoxin, ACEI	ARB		3	2	22	32
2	70	Male	Hypertension	Digoxin, ACEI	ACEI		3	2	27	25
3	64	Male				Polymorphic VT	2	2	23	26
4	77	Female	Hypertension				2	1	18	35
5	76	Male	Hypertension		ARB		2	1	24	33
6	73	Male		Diltiazen		Polymorphic VT	2	1	23	44
7	52	Male	Hypertension	Amiodarone, ARB	ARB		3	2	24	36
8	75	Male	Hypertension, DM	Amiodarone, ACEI	ACEI		2	2	29	35
9	66	Male	Hypertension				2	1	43	45

op = operation; EPS = electrophysiologic study; NYHA Fc = New York Heart Association functional class; LVEF = left ventricular ejection fraction; ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; VT = ventricular tachycardia; DM = diabetes mellitus.

No mechanical assistive device (IABP or ECMO) was needed before or after surgery.

There was no surgical or inhospital mortality. The mean intensive care unit (ICU) stay after the operation was 4.9 ± 2.7 days (range, 2–11 days), and the mean hospital stay was 15.1 ± 10.4 days (range, 8–41 days). Mean follow-up after discharge was 49.6 ± 42.1 months (range, 1.7–128.4 months). There was 1 late sudden death at home 1.7 months after the operation. Another patient was well before his loss to follow-up 47.6 months postoperation. The remaining patients continue to be followed up in our outpatient clinic. During the postoperative hospital stay and follow-up, no recurrent VT was detected, and no ICD implantation was done. All of them showed improvement in NYHA functional class (mean, 2.33 *vs.* 1.67; $p = 0.025$) and LVEF (mean, 26.3% *vs.* 34.1%; $p = 0.021$) after the operation.

Discussion

Late mortality due to postmyocardial infarction has been shown to be associated with LV size[15] and ventricular arrhythmias, which may cause sudden death.[16] LV aneurysm repair reduces the LV size, and also results in decreased wall tension and oxygen demand, which is thought to contribute to the development of arrhythmia. Therefore, some reports suggested that LV aneurysm repair might be a reliable treatment for refractory malignant ventricular arrhythmia.[1] However, the incidence of late sudden death was not satisfactory. Bechtel et al[17] reported a series of 147 patients who underwent LV aneurysm repair without concomitant antiarrhythmic therapy. There were 7 (37%) sudden deaths among the 19 late-death patients, and a significant association between late sudden death and early postoperative ventricular tachyarrhythmia was observed. This indicates that arrhythmogenic foci may still remain even after LV aneurysm repair, which was supported by some reports showing that recurrent ventricular arrhythmias involved an anatomic substrate, usually within the border zone of the infarction.[3,18] Today, many groups combine LV aneurysm repair with endocardial resection and/or cryoablation in patients with clinical or inducible VT. Di Donato[19] demonstrated 9 (19%) sudden deaths of 48 late deaths in a total of 382 patients who underwent surgical ventricular reconstruction combined with nonguided endocardiectomy and cryosurgery if spontaneous/inducible VT was detected. In our series, there was 1 sudden death 7 weeks after the operation, and the rest of the 8 patients were free from ventricular arrhythmia. Combined cyroablation in LV aneurysm surgery has been shown to improve the incidence of late sudden death.

Generally, map-guided procedures have been used for VT surgery. However, there is an ongoing debate on the use of intraoperative cardiac mapping. In prior studies, 20–40% of patients who underwent subendocardial resection for VT could not be mapped intraoperatively because the VT was either noninducible or nonmappable, or led to hemodynamic collapse following the ventriculotomy. This encouraged the non-guided method, including extended blind cryoablation, which leads to a favorable outcome compared with map-guided procedures.[4,5,11,13,19] Thakur et al[11] demonstrated that preoperative cardiac mapping was useful in defining a surgical plan, but that intraoperative mapping was not crucial to the success of encircling endocardial cryoablation. Additionally, it is a simple surgical technique, reproducible in most cardiac centers where any 1 cryosource is available, and does not need an extended perioperative EPS. However, some reports suggested that careful patient selection should be obtained for blind cryoablation. Those

without a well-delineated aneurysm are best treated with other therapeutic modalities.[20] Also, the long-term results were associated with the correction of additional abnormalities, i.e. complete coronary bypass grafting for myocardial ischemia, mitral valve surgery, etc.[21]

In our studies, overall survival was 88.9% in 5 years without inhospital mortality. Postoperative NYHA functional class and LVEF also improved, and may have been due to the restoration of the LV shape and decreased LV volume by the Dor operation and the achievement of revascularization by CABG.[22] Neither mechanical assistive device nor prolonged use of mechanical ventilator was needed, and none of the 9 patients received ICD implantation after surgery, since there was no recurrent spontaneous VT detected. However, the cause of the only late sudden death was unknown, and thus life-threatening VT could not be ruled out. Some groups carried out ICD implantation in patients who showed inducible VT during postoperative EP testing, but sudden death could still not be avoided.[4,20] In general, Dor operation combined with encircling endocardial cryoablation is safe and effective, and leads to good long-term results.

In this study, postoperative EPS was not recorded, and life-threatening VT as a cause of late sudden death could not be ruled out. Further studies should include postoperative EPS for detection of inducible VT, which could be managed by ICD implantation, in order to achieve better outcome. Also, the case number was relatively small. More cases should be included to reinforce the conclusion.

In conclusion, in patients with postinfarction LV aneurysm and clinical VT, a simplified surgical procedure including LV remodeling and encircling endocardial cryoablation can achieve good arrhythmia control and clinical outcome.

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