Outcomes for Surgical Treatment of Atrial Fibrillation Using Cryoablation During Concomitant Cardiac Procedures

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Background. **Surgical treatment of atrial fibrillation (AF) with heat-based therapies has been associated with a high rate of arrhythmia recurrence. We studied the short-term to medium-term outcomes with a unique biatrial linear ablation procedure for AF treatment using an argon-based cryoablation device during concomitant cardiac operations.**

Methods. **Between March 2005 and July 2008, 57 patients (47% men) with problematic AF underwent a linear endocardial ablation procedure (Star pattern) using the flexible argon-based cryoablation probe during concomitant cardiac operations. Procedures were performed with valve or coronary operations, including mitral valve replacement (25%), mitral valve repair (16%), coronary artery bypass grafts (21%), and congenital heart surgery (8%). Atrial fibrillation was persistent or long-standing persistent in 50.9% of patients.**

Results. **Kaplan-Meier survival curves (with the standard error) demonstrated 91% (3.9%) of patients were still free of their first recurrence at 6 months, 81% (5.6%) at 12 months, and 70% (6.8%) at 24 months. Time to first recurrence was not significantly associated with age ($p = 0.47$), gender ($p = 0.52$), or type of AF ($p = 0.69$). There were no complications attributed to the cryoablation procedure. There was one in-hospital death and one death after discharge. Twelve patients (21%) required permanent pacemaker implantation postoperatively. There were no early or late thromboembolic events.**

Conclusions. **This study demonstrated the medium-term efficacy of cryoablation with a unique biatrial pattern of linear lesions for the treatment of AF during a concomitant cardiac operation. Short-term to medium-term outcomes were at least equivalent to those reported for other energy modalities.**

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Atrial fibrillation (AF) is the most common clinically significant cardiac arrhythmia [1]. It is present in 1% of the general population and its incidence sharply increases with age [2]. AF is associated with an elevated risk of stroke in untreated patients [3, 4], with the risk of stroke increasing to 23.5% in AF patients aged 80 to 89 years [5]. It is also responsible for disabling symptoms, decreased cardiac output, palpitations, and congestive heart failure [6]. AF is an independent predictor of death [7].

The gold standard for the surgical treatment of AF remains the "cut-and-sew" Cox-Maze III procedure, and in the largest documented series, Cox and colleagues [8, 9] reported 95% freedom from AF in 308 patients at a median follow up of 3.7 years. Although the Cox-Maze procedure has produced excellent long-term results in a large percentage of patients, widespread use of this surgical technique has been limited by concerns about increased cardiopulmonary bypass and cross-clamp times, complexity of lesions, and bleeding complications [10, 11].

Further understanding of the pathogenesis of AF, particularly the role of pulmonary veins in paroxysmal AF initiation, has led to the development of different approaches to the surgical treatment of AF [10, 12]. A number of energy sources are now used to create transmural lesions that can both effectively block atrial conduction and reduce or eliminate the amount of cut-and-sew required. In this article, we report our results for a unique biatrial pattern of lesions, which we refer to the Star pattern, using argon-based cryoablation on patients undergoing concomitant cardiac operations. The aim of the Star pattern is to reduce isolated regions of myocardium, maintain craniocaudal atrial activation, and minimize disruption to the normal pattern of atrial activation.

Material and Methods

This study was approved by the Human Research Ethics Committee of Sydney West Area Health Service.

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Patients

All patients were considered for the Star procedure using cryoablation if they were undergoing a cardiac operation and had clinically important AF that had been resistant to medical therapy. Patients were included in this study if they had a complete Star pattern of lesions (both left and right side) and were aged older than 18 years. All procedures were performed at The Westmead Hospital, The Westmead Private Hospital, or The Sydney Adventist Hospital. Patients were categorized as having paroxysmal or persistent/long-standing persistent AF using international guidelines [13]. Demographics and perioperative and follow-up data were retrospectively analyzed.

Cryoablation

The Cryocath cryoablation device (SurgiFrost 7, Life Systems Medical Pty Ltd, Victoria, Australia) uses argon gas to achieve rapid cooling to temperatures as cold as −160°C. The flexible metal probe conforms to the cardiac contours around the heart structures. The device also has an adjustable insulation sheath that can cover the cryoablation segment. This offers an ablation zone between 0 and 60 mm.

Surgical Procedure

All operations were performed through a median sternotomy. The Star procedure was performed using the Cryocath to create linear lesions (ablation time of 60 seconds at each lesion site, as specified by the manufacturer at that time). Lesions were created from the posterior inferior mitral annulus opposite the left pulmonary veins and around the left pulmonary veins, from the posterior and inferior mitral annulus opposite the right pulmonary vein, and around the right pulmonary veins using the atrial access incision as part of the isolation.

The left atrial appendage was oversewn from within the left atrium. The right-sided cryocatheter freezes were performed from the superior vena cava to the inferior vena cava posteriorly, from the posterior inferior tricuspid annulus (isthmus lesion) to the coronary sinus, down the coronary sinus for 2 cm, and then from the coronary sinus to the inferior vena cava. This completes the Star lesions (Fig 1). It takes approximately 15 minutes to complete all the freezes. These lesions are used to prevent macroreentry while maintaining a physiologic activation sequence. Further, the lesions interrupt known common pathways of macroreentry in the left and right atria. The Star procedure was not performed as a lone procedure on any of the patients. The concomitant procedures are listed in Table 1.

Postoperative Management

Unless there were contraindications, patients received anticoagulation therapy on discharge for a minimum of 3 months. Long-term warfarin was recommended for patients with mechanical valves or a $CHADS_2$ (Congestive heart failure, Hypertension >140/90 mm Hg or treated with medication, Age >75 years, Diabetes mellitus, Stroke or transient ischemic attack) score exceeding 1.

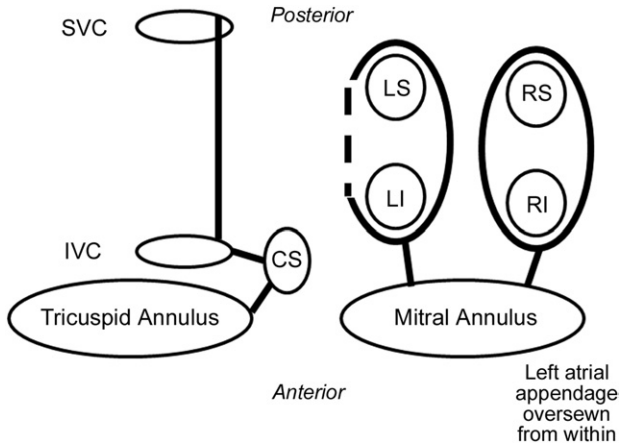

Fig 1. The Star pattern of lesions is designed to allow normal activation to radiate out from the sinus node with as little disruption as possible to normal activation. (Solid line = cryoablation; dashed line = surgical incision; CS = coronary sinus; IVC = inferior vena cava; LI = left inferior; LS = left superior; RI = right inferior; RS = right superior; SVC = superior vena cava.)

Antiarrhythmic medication, amiodarone or sotalol, was prescribed to patients if postoperative AF developed. Antiarrhythmic medications were discontinued within the first 3 to 6 months postoperatively at the discretion of the treating cardiologist.

Follow-Up

After discharge from the hospital, patients were reviewed by the treating surgeon. They were also examined by their treating cardiologist after discharge, again at intervals of 3, 6, and 12 months, and then as required according to symptoms. Patients were evaluated using electrocardiograms, direct physical examination, and 24-hour Holter monitoring if paroxysmal AF was suspected but not identified on the electrocardiogram. Patient rhythms were recorded from discharge and over periods of 1 to 3 months, 3 to 6 months, 6 to 12 months, 1 to 2 years, and 2 to 3 years. Medical records were examined and telephone interviews were conducted to complete the data. Any documented episode of AF or atrial tachycardia lasting longer than 30 seconds was considered an arrhythmia recurrence.

Results

From March 2005 to July 2008, 57 patients (53% women) underwent the Star procedure using cryoablation for AF treatment during a concomitant cardiac operation, which is detailed in Table 1. The patients were a mean age of 62.9 ± 13.2 years (range, 21 to 83 years). Twenty-eight patients (49%) had paroxysmal AF, and 29 (51%) had persistent or long-standing AF. The mean duration of AF was 35.5 ± 38.5 months. The mean left atrial size was 54.4 ± 8.8 mm and calculated from 48 patients (84%) for whom we could retrieve this data (Table 2). Complete Star lesion sets were performed endocardially. The mean cardiopulmonary bypass time was 118.8 ± 30.5 minutes, and mean cross-clamp time was 92.8 ± 28.9 minutes.