

Outcome of Circumferential Pulmonary Vein Isolation for Ablation of Atrial Fibrillation: A Single Center Experience

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Background: Atrial fibrillation (AF) is the most common heart rhythm disorder in adults. Currently, use of the circumferential pulmonary vein isolation (CPVI) technique is the cornerstone of ablation therapy for paroxysmal atrial fibrillation. In this report, we described our ablation strategy and outcomes when treating a limited number of AF patients.

Methods: This study enrolled patients with paroxysmal or persistent AF that were resistant to at least one anti-arrhythmia drug. We used the CARTO XP system for electro-anatomic mapping, facilitated by left atrium multi-slice computed tomography imaging. The ablation strategy was to obtain CPVI by using an irrigation catheter and the end-point was complete entry and exit block at each pulmonary veins. AF recurrence was defined through review of symptoms and AF documentation via electrocardiography (ECG) or Holter ECG.

Results: From 2007 to 2011, 108 patients (76% paroxysmal AF) received ablation by means of our standard procedures, and the AF recurrence rate was 22% during a mean follow up of 20.6 ± 10.2 months. The major complication rate was less than 3% in all the patients that received AF ablation in our center.

Conclusions: Our AF ablation results were comparable to those results reported in major electrophysiology centers, with acceptable complication rates.

Key Words: Ablation • Atrial fibrillation • Pulmonary vein isolation

Atrial fibrillation (AF) is the most common rhythm disorder in adults, and it affects approximately 1% of the population according to western literature,¹ and 1.4% of men and 0.7% of women in Taiwan.² AF without proper medical management can cause severe symptoms, including heart failure and embolic stroke.^{3,4} Proper management of atrial fibrillation includes underlying disease

treatment, consideration of rhythm or rate control, and prevention of embolic stroke.^{3,4} For rhythm control, radiofrequency catheter ablation (RFCA) had become a mainstay of therapy for paroxysmal atrial fibrillation (pAF), in addition to anti-arrhythmia drugs.⁵

The option of ablation of AF was presented to the general medical community more than a decade ago. Pulmonary ostial ablation and circumferential pulmonary vein isolation (CPVI) were developed initially to eliminate ectopic foci at the pulmonary vein.⁶⁻⁹ Later on, various techniques and technologies were developed to address concerns presented in particularly difficult cases, and for persistent AF. Despite many new techniques, CPVI has remained the cornerstone for initial ablation of pAF.¹⁰ Our center (National Taiwan University Hospital, Cardiology Division) has been performing abla-

Received: January 30, 2013 Accepted: June 5, 2013

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tion of pAF using three-dimensional electroanatomic mapping since 2004. In this article, we reported on the specifics of our strategy for ablation of AF, and treatment outcomes which we have observed.

MATERIALS AND METHODS

Starting in 2004, patients with pAF or persistent AF were admitted to our facility for radiofrequency catheter ablation. Patients were included if they had already taken more than one anti-arrhythmia drug and remained symptomatic. Warfarin was prescribed to address coagulation issues, with a target international normalized ratio of 1.5x to 2.5x. Electrocardiography (ECG)-gated cardiac multi-slice computed tomography (MSCT) was performed before the procedure. Additionally, trans-esophageal echocardiography was performed to exclude the presence of significant structural heart disease or left atrial (LA) appendage thrombi. Starting in 2007, three-dimensional electroanatomic mapping was performed using the CARTO XP[®] system (Biosense-Webster, Diamond Bar, CA, USA) with the assistance of inte-

grated LA MSCT images (Figure 1). After mapping the anatomic structure and electric signals of the LA, CPVI was performed using an irrigation catheter (Thermo-cool[®], Biosense-Webster, Diamond Bar, CA, USA). The ablation energy setting was 30 watts at posterior LA and 35 watts at the other sides. After CPVI was performed, we checked the exit and entry block of each pulmonary vein by Lasso circular mapping catheter (Biosense Webster, Diamond Bar, CA, USA). After completing CPVI, we did cardioversion if the rhythm was still AF. We did not perform other linear ablation procedures such as roof line creation or substrate modification. In sinus rhythm, we gave the patients isoproterenol intravenous infusion, up to 20 micrograms/min to locate the atrial premature beat origin (if inducible), and to test if the atrial premature beat would beget AF.¹¹ The ablation end-points were complete entry and exit block at pulmonary veins. To keep activated clotting time greater than 300 seconds, heparinization by heparin bolus was performed after trans-septal puncture until the end of the procedure.

The patients were followed-up through routine visits to an outpatient clinic. Anti-arrhythmia drugs and anticoagulants were only continued for 6 months, if the

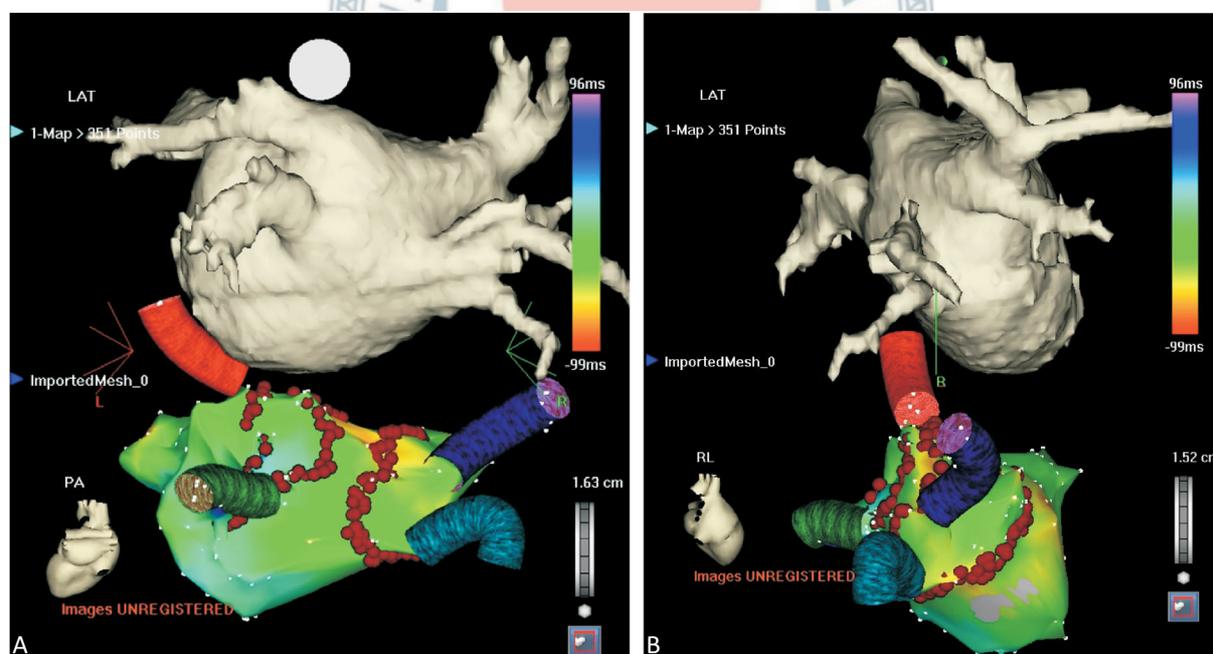


Figure 1. Depicted our ablation strategy for atrial fibrillation. We did three-dimensional electroanatomic mapping by using CARTO XP[®] system (Biosense-Webster, California, USA) with the assistance of integrated cardiac multi-slice computed tomography images (A and B, upper panel: volume rendering computed tomography images of left atrium; lower panel, CARTO mapping; A posterior anterior view, B right lateral view). After mapping the anatomic structure and electric signals of left atrium, circumferential pulmonary vein isolation was performed using irrigation catheter (ablation points denoted by red dots).

patient remained in normal sinus rhythm, as determined by routine surface 12-lead ECG done at the outpatient clinic. Recurrence of AF was based on patient symptoms, which were defined as recurrence of symptoms and documentation of AF rhythm either by 12-lead ECG or 24 hour Holter ECG monitoring.

RESULTS

From 2004 to 2011, there was a total of 195 patients receiving AF ablation. From 2007 to 2011, 108 AF patients (88 male, 20 female) received AF ablation according to our standard procedures (CARTO XP and MSCT) described in Methods above. The baseline characteristics of the patients were listed in Table 1. The average age of patients in our study was 56.7 ± 10.9 years of age. The diagnoses were paroxysmal AF in 82 (76%) of the subjects, and persistent AF in 26 (24%). The patients were followed until August 2011, and the mean follow-up duration was 20.6 ± 10.2 months. Recurrence of AF was documented in 24 (22%) of the patients, and the duration of time between RFCA and recurrence was 3.2 ± 3.9 months.

Since we started RFCA for AF in 2004, we have encountered several complications in the 195 patients who underwent the procedure. Two patients (1%) had cardiac tamponade during the procedure, and recovered after pericardiocentesis without surgical intervention. One patient (0.5%) had ischemic (embolic) stroke during the procedure. The source of emboli was presumed to be the trans-septal sheath. Subsequent to that event, we adjusted our procedure and started to flush the sheath continuously by heparinized saline. One patient (0.5%) had right phrenic nerve paralysis, and one patient (0.5%) had gastroparalysis. Overall, the complication rate was 2.6%.

DISCUSSION

In this report, we have presented our experiences with AF ablation. For the most part, our ablation work focused on pAF and some persistent AF. We used CARTO XP[®] system for electro-anatomic mapping, which was facilitated by LA MSCT images. The ablation strategy we used was CPVI by using irrigation catheter, and the abla-

tion end-points were complete entry and exit block at the pulmonary veins. Post-procedure, the AF recurrence rate was 22% during a mean follow-up of 20.6 ± 10.2 months; the major complication rate was less than 3%.

Since the first report by Haissaguerre et al.,⁸ catheter ablation of AF has become a booming field in cardiac electrophysiology. The efficacy of RFCA in pAF that was refractory to at least one anti-arrhythmia drug has been proven in clinical trials.¹²⁻¹⁴ From these trials, it has been demonstrated that RFCA is superior to drug therapy in maintaining sinus rhythm,^{13,14} and it also improved quality of life,¹⁴ and improved left ventricle function in cases of congestive heart failure.¹² Recent American and European guidelines had incorporated RFCA as a suggested treatment for symptomatic, pAF or persistent AF resistant to one or more anti-arrhythmia drugs.^{10,15,16}

Indications for ablation and ablation techniques are different and varied in most centers. The large majority of centers ablated paroxysmal and persistent AF; in experienced centers, long-standing persistent AF was also ablated.^{17,18} CPVI was the cornerstone for initial ablation of AF,^{6,9,10} and some operators would add another ablation line, like mitral isthmus line or roof line. However, the results of these linear ablations were conflicting.

The efficacy of AF ablation has varied in reports. The reported efficacy depended on patient selection, ablation strategy, ablation tools and definition of recurrence. The efficacy reported in randomized controlled trials varied from 66% to 86%.¹⁰ In a worldwide survey for pAF, during a follow-up of 10 ± 8 months, the effi-

Table 1. Baseline characteristics of the patients

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|----------------------------------|----------------------|
| Age | 56.7 ± 10.9 year |
| Gender (male) | 81% |
| Paroxysmal atrial fibrillation | 76% |
| Diabetes mellitus | 17% |
| Coronary artery disease | 11% |
| Hypertension | 45% |
| Valvular heart disease | 2% |
| Cerebral vascular accident | 7% |
| Left ventricle ejection fraction | $62 \pm 9\%$ |
| Anti-arrhythmia drug use | |
| Amiodraone | 37% |
| Sotalol | 12% |
| Rytmonorm | 61% |
| Quinidine | 14% |
| Beta-blockers | 41% |

cacy rate free of antiarrhythmic drugs was 70% and, in the presence of previously ineffective antiarrhythmic drug, 80%. To achieve this type of efficacy, every third patient required a second procedure.^{10,18} For persistent and long-standing AF, the efficacy was much lower.¹⁰ Our result, based on our patient population (mostly pAF) and our ablation strategy (CPVI) was comparable to that reported in the literature.

For some time, ablation had not been adopted as first-line therapy for pAF due to complications arising from AF ablation. In our experience, we encountered 1 ischemic stroke, 2 cardiac tamponade, 1 phrenic nerve paralysis and 1 gastroparesis in the total 195 patients we ablated for AF. The reason for gastroparesis is probably due to thermal injury to peri-esophageal nerves.¹⁹ In an earlier worldwide survey, around 4.5% of patients experienced major complications.^{10,17,18} However, the incidence of complications may decrease as clinical experience with ablation increases. Our complication rate was comparable to those reported in the literature^{5,10,17,18} and in high volume centers,^{10,20} and there was no mortality or severe morbidity due to pulmonary vein stenosis or atrio-esophageal fistula in our patients. However, this was possibly due to our commitment to the CPVI strategy, and usage of irrigation catheter for ablation. Also, 3-dimensional mapping integrated with MSCT images can help us better identify the atrial geometry and delineate the ablation lesion.

CONCLUSIONS

Our study suggests that the efficacy for ablation of pAF based on our current strategy (CPVI by irrigation catheter) is comparable to that reported in major electrophysiology centers, with a rate of success and acceptably low complication rates. For patients who are refractory to at least one anti-arrhythmic drug, ablation is now regarded as one of the customary treatment choices in our center.

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