

Ablation of Atrial Fibrillation

Transcatheter Radiofrequency Ablation of Atrial Fibrillation in Patients With Mitral Valve Prostheses and Enlarged Atria

Safety, Feasibility, and Efficacy

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OBJECTIVES	Few data have been published on transcatheter ablation of atrial fibrillation (AF) in patients with mitral valve prostheses. Thus, we sought to report our experience.
BACKGROUND	Ablation is an effective treatment for AF. Patients with prosthetic mitral valves represent a special group because of an increased risk from the ablation procedure due to the possibility of damage to the prosthetic valve.
METHODS	Between July 2001 and July 2003, 26 patients with mitral valve prostheses (MVP) underwent circumferential pulmonary vein ablation for AF. A matched group of 52 ablated patients without MVP acted as control subjects. After a blanking period of three months, a follow-up of 12 months was considered for MVP patients and controls. Holter recordings were performed in all subjects at 3, 6, and 12 months.
RESULTS	Radiation exposure was higher in the MVP group, with fluoroscopy times of 35.3 ± 21 min versus 20.9 ± 15 min in controls. At the end of follow-up, 73% of MVP patients were in sinus rhythm, compared with 75% of controls. Atrial tachycardia occurred in six (23%) MVP patients, requiring repeat ablation in three, and one (2%) control subject, which settled without treatment. One transient ischemic attack and one femoral pseudoaneurysm occurred in the MVP group. No complications occurred in the control group.
CONCLUSIONS	Ablation of AF in patients with MVP is feasible, with outcomes similar to those of standard patients. Complications were higher among MVP patients with a greater radiation exposure and a higher incidence of post-ablation atrial tachycardia. (J Am Coll Cardiol 2005;45:868–72) © 2005 by the American College of Cardiology Foundation

Many patients undergoing mitral valve surgery have or will subsequently develop atrial fibrillation (AF). Percutaneous catheter ablation of AF is becoming widely practiced, with success rates improving (1–6). Patients with mitral valve prostheses (MVP) represent a distinct group for whom appropriate nonpharmacologic therapy for AF has not yet been established due to a lack of published experience. Catheter-based ablation might be expected to carry a risk of prosthetic valvular damage. In addition, surgical patients have scarred atria. This, in combination with atrial myopathy from chronic mitral valve disease, might be expected to reduce the procedural success. This study describes our experience with circumferential pulmonary vein ablation (CPVA) in patients with MVP and reports the feasibility, safety, and outcomes in this important group.

METHODS

Patients. Between July 2001 and July 2003, 27 patients with mechanical mitral valves were listed for CPVA for paroxysmal (n = 14) or chronic (n = 13) AF. It was possible to determine the type of valve in 24 of 27 patients, and these were of the St. Jude type (n = 16), Sorin (n = 8), and Carbomedics (n = 3). For each MVP patient who underwent ablation, two control subjects were matched from our data base for (in rank order): left atrial (LA) diameter (± 3 mm), chronic or paroxysmal AF, duration of symptoms >2 years, age (± 3 years), gender, history of hypertension, and impaired left ventricular (LV) function (ejection fraction <45%). All MVP patients and control subjects were resistant to drug therapy with at least two anti-arrhythmic agents. Patients were asked to discontinue warfarin for three days before the procedure, and ablation was performed if the international normalized ratio (INR) was <1.5. A transesophageal echocardiogram was obtained in all patients with chronic AF before ablation to exclude LA appendage thrombus. The activated clotting time (ACT) was maintained between 300 and 350 s after the transeptal puncture.

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Abbreviations and Acronyms

ACT	= activated clotting time
AF	= atrial fibrillation
AT	= atrial tachycardia
CPVA	= circumferential pulmonary vein ablation
LA	= left atrial/atrium
LV	= left ventricular/ventricle
MVP	= mitral valve prosthesis

Venous sheaths were removed immediately after the ablation procedure, whereas the arterial sheath was removed once the ACT had fallen below 160 s. Intravenous heparin was infused overnight and titrated to maintain an ACT between 250 and 300 s. The following day, heparin was substituted by subcutaneous calciparin, and patients were discharged home on their usual dose of warfarin and instructed to discontinue the low-molecular-weight heparin once the INR was therapeutic.

Ablation technique. The procedure of CPVA has been described in detail elsewhere, but in brief, using a three-dimensional electroanatomic mapping system (CARTO, Biosense-Webster, Diamond Bar, California) and an 8-mm mapping/ablation catheter (Navi-Star, Biosense-Webster) connected to a radiofrequency generator set to a 62°C temperature limit and a maximum power output of 100 W, circumferential lesions were created around the pulmonary vein ostia to create local voltage abatement of >80%, with absence of electrical activity within the ostium (<0.05 mV bipolar electrogram), as measured with the ablation catheter at several points within each ostium. In 21 (81%) of 26 MVP patients and 42 (81%) of 52 control subjects, additional lines were placed between the lateral mitral valve annulus and the left-inferior pulmonary vein (mitral isthmus), and posterior lines joining the contralateral superior and inferior veins, respectively (6) in an attempt to prevent post-ablation incisional tachycardias. Three (12%) of 26 and 7 (13%) of 52 had a mitral isthmus line only, and 2 (8%) of 26 and 3 (6%) of 52 had no additional lines. Additional lines were not performed in all patients, as during the period in which these ablation procedures were performed, we were still assessing the potential benefit of these lines in preventing atrial tachycardias. All patients underwent ablation of the cavotricuspid isthmus for prevention of atrial flutter. The procedure was performed in the patients' presenting rhythm, and if necessary, direct cardioversion was performed at the end of the procedure. In order to minimize the risk of valve damage in patients with prostheses, one operator monitored the position of the ablation catheter relative to the valve and the leaflet motion by fluoroscopy, while the operator controlling the catheter monitored the position on CARTO.

Follow-up. Patients were given a transtelephonic electrocardiographic recording device. Holter recordings were performed in all patients at the end of the blanking period and at 3, 6, and 12 months of follow-up. All MVP patients

Table 1. Baseline Clinical Variables of Patients Undergoing Ablation

	MVP Patients (n = 26)	Control Subjects (n = 52)	p Value
Age (yrs)	57 ± 9	55 ± 10	0.71
Gender (men/women)	10/16	26/26	0.33
Left atrial diameter (mm)	55 ± 5	55 ± 5	0.65
Arrhythmia (PAF/CAF)	13/13	26/26	1.00
Previous amiodarone	13 (50%)	22 (42%)	0.70
Patients previously cardioverted	15 (58%)	34 (67%)	0.51
Duration of AF >2 yrs	22 (85%)	36 (69%)	0.14
Hypertension	6 (23%)	27 (52%)	0.06
Left ventricular hypertrophy	2 (8%)	6 (12%)	0.59
Duration of MV disease (yrs)	16 ± 7	—	
Years with prosthetic MV	6 ± 5	—	

Data are presented as the mean value ± SD or number (%) of patients or control subjects.

AF = atrial fibrillation; CAF = chronic atrial fibrillation; MV = mitral valve; MVP = mitral valve prosthesis; PAF = paroxysmal atrial fibrillation.

had a transthoracic (or transesophageal) echocardiogram before and after ablation to exclude procedure-induced prosthetic valve dysfunction. All MVP patients and controls were discharged on amiodarone (unless contraindicated, in which case, flecainide was used [n = 1]), with a 200-mg/day maintenance dose and discontinued after three months if sinus rhythm was maintained. Patients with MVP were maintained on long-term warfarin, whereas patients in the control group discontinued warfarin if sinus rhythm was maintained for three months.

A 12-month follow-up after a three-month blanking period, in which anti-arrhythmic treatment was administered, was considered for each subject.

Statistical analysis. Continuous variables were compared by the Student *t* test and categorical variables by the chi-square or Fisher exact test. For patients with and without prosthetic mechanical mitral valves, the Kaplan-Meier procedure was used to calculate arrhythmic event-free survival, which was compared by the log-rank test. Cox regression analysis was used to determine the presence of independent predictors of recurrence of AF. Data are expressed as the mean value ± SD, unless otherwise specified. Significance was defined as a value *p* < 0.05. Statistical analysis was performed with SPSS for Windows (version 12.0.1, SPSS Inc., Chicago, Illinois).

RESULTS

There were no significant differences between groups in terms of age, duration of AF, LA diameter, gender, LV hypertrophy, or LV impairment (Table 1).

Ablation data. Overall, 28% of patients were in sinus rhythm at the time of catheter ablation. Of the remaining 72%, 31% converted to sinus rhythm during the procedure and 41% were electrically cardioverted at the end of the procedure. There was a nonsignificant trend toward a longer procedure time in the MVP group (134 vs. 125 min); however, there was a significant increase in the total

Table 2. Procedural Data and Follow-up

	MVP Patients (n = 26)	Control Subjects (n = 52)	p Value
Procedure duration (min)	134 ± 25	125 ± 31	0.24
Fluoroscopy time (min)	35 ± 21	219 ± 15	<0.001
Complications	3 (11%)	0	0.01
AF recurrence	7 (27%)	13 (25%)	1.00
Chronic AF	4 (15%)	8 (15%)	1.00
Paroxysmal AF	3 (12%)	5 (10%)	1.00
Atrial tachycardia	6 (23%)	1 (2%)	0.005
Mean follow-up* (min-max) (months)	9.8 (1-12)	10.1 (2-12)	0.78

*By Kaplan-Meier analysis. Data are presented as the mean value ± SD or number (%) of patients or controls.

Abbreviations as in Table 1.

fluoroscopy time (35 vs. 21 min, $p < 0.001$). In the MVP group, one patient had a transient ischemic attack with left-sided weakness 8 h after the procedure, at which time he was receiving a heparin infusion and had an ACT of 220 s. The computed tomographic scan showed old lacunar infarcts but no acute changes. There was complete neurologic recovery. One patient with Marfan's syndrome developed a femoral pseudoaneurysm, which was successfully treated with thrombin injection. In another patient, it was impossible to perform the transseptal puncture, despite repeated attempts, with the Brockenbrough needle entering the aorta, although there were no adverse events associated with this. The procedure was abandoned, and this patient has been excluded from outcome analyses, as we do not think that the failure to perform the transseptal puncture was due to previous surgery or the presence of a prosthetic valve, but was due to cardiac rotation. However, this patient has been included in the statistical analysis of complications. There were no procedure-related complications in the control group.

Recurrences of AF. Procedural and follow-up data are described in Table 2. After the blanking period, during the 12-month follow-up, 7 (27%) of 26 MVP patients had recurrences of AF, as compared with 13 (25%) of 52 controls. In MVP patients and controls, chronic AF recurrence was more common than paroxysmal AF, as expected. The Kaplan-Meier procedure showed that arrhythmic event-free survival for patients with and without prosthetic mechanical mitral valves did not attain statistical significance by log-rank testing (Fig. 1). Moreover, the Cox regression model showed that there was no predictor of outcome. If an intention-to-treat analysis is performed, including the patient with paroxysmal AF in whom it was not possible to perform a transseptal puncture, the recurrences rise to 5 (18%) of 28 controls and 4 (29%) of 14 MVP patients with paroxysmal AF, and 24% of controls and 29.6% of MVP patients overall, as neither of the selected controls for this patient had recurrences. However, even in this case, arrhythmic event-free survival for patients with and without prosthetic mechanical mitral valves did not

attain statistical significance by log-rank testing ($p = 0.33$ for paroxysmal AF; $p = 0.26$ overall).

Post-ablation atrial tachycardia. Atrial tachycardia (AT) occurred in six MVP patients (23%) and one control subject (2%) ($p = 0.005$). All patients with AT had had additional lines at the mitral isthmus and/or posterior wall at the time of the initial procedure, which were designed to prevent AT. This gives an incidence of AT of 2% ($n = 1$) in control subjects and 29% ($n = 6$) in MVP patients ($p = 0.005$). Repeat ablation was required in three MVP patients for prolonged, incessant, and highly symptomatic episodes. Two (10%) of 21 these patients had both mitral isthmus and posterior lines, and 1 (33%) of 3 patients had only the mitral isthmus line. The control subject with AT who had only had a mitral isthmus line also required repeat ablation (1 [14%] of 7). As all of these patients also had episodes of AF, standard CPVA and additional lines were repeated. Atrial tachycardia was transient in three patients: two patients who also had post-ablation paroxysms of AF, and one patient who had a documented episode of AT during the blanking period and required no specific treatment. None of the study patients had a preprocedural diagnosis of AT, suggesting that these arrhythmias were a consequence of the ablation procedure. No embolic events occurred in any patient during follow-up.

Management of recurrences. In the MVP group, four of seven recurrences required repeat ablation for AF (three of these also had AT). The other three patients were managed with anti-arrhythmic medication, and one of these three also had an anti-tachycardia pacemaker implanted in another center. In the control group, 6 of 13 subjects had repeat procedures, and the remaining subjects were maintained on anti-arrhythmic medication.

DISCUSSION

Feasibility. Our experience is that the CPVA procedure is technically feasible in patients with prosthetic mechanical mitral valves, although longer fluoroscopy times are required to check the position of the ablation catheter relative to the valve, particularly when recreating the atrial anatomy during the mapping phase, to ensure accurate localization of the mitral annulus. Normally, in the presence of native valves, after acquisition of the four main veins, the rest of the atrial geometry can be reconstructed without fluoroscopy. In addition, when ablating near the mitral annulus and left-sided pulmonary veins, it is necessary to use fluoroscopy to see whether the ablation catheter is interfering with the valve leaflets. The electrogram signal shows mechanical artifact when the ablation catheter is in contact with the leaflets or valve structure (Fig. 2). There is at least one case report of prosthetic mitral leaflet embolization as a consequence of trauma from ablation catheters (7), and the risk of damaging the valve or trapping the ablation catheter is significant. Patients with prosthetic valves are at increased risk of embolic events. Nonetheless, given the small sample

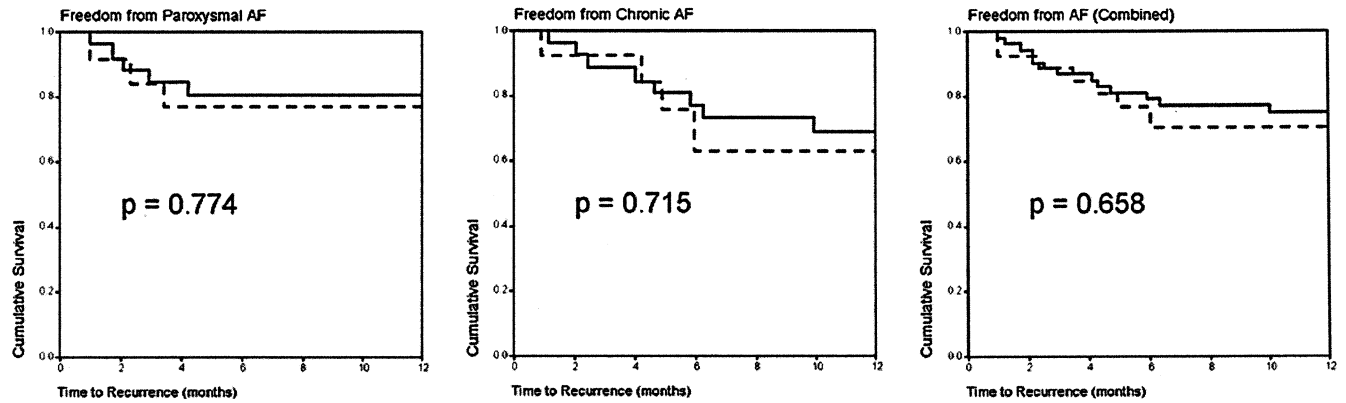


Figure 1. Arrhythmic event-free survival for patients with and without prosthetic mechanical mitral valves. Patients have been stratified according to whether atrial fibrillation (AF) before ablation was paroxysmal (**left panel**) or chronic (**middle panel**). The **right panel** gives the results for all patients combined. **Broken lines** = mitral valve prosthesis (MVP); **solid lines** = no MVP.

size of this study, it may be that the transient ischemic attack suffered by one patient was coincidental and not directly related to the presence of a mechanical valve. Nonetheless, it would appear that the complication rate, overall, is higher in patients with MVP.

Efficacy. In this study, both the MVP and control groups were at the extreme end of the spectrum of atrial disease, with grossly enlarged atria and a high proportion of chronic AF. For this reason, freedom from AF is lower than that described in previous series. Our data would suggest that patients with prosthetic mitral valves who undergo percutaneous LA ablation of AF have an outcome similar to that of closely matched controls. Atrial tachycardia seems to be

a more common occurrence after ablation in these patients and may require a repeat procedure. The increased incidence of AT may be due to the presence of surgical scarring in these patients, as well as an inability to create adequate block at the mitral isthmus because of an inability or fear of getting close to the mitral prosthesis. It is well recognized that the creation of incomplete lines of block will facilitate macro-re-entrant arrhythmias (8), and this brings into question the appropriateness of attempting such lines to close the mitral isthmus in these patients. Our outcome data are inferior to published surgical series of intraoperative therapy for AF during concomitant mitral surgery, which quote success rates of 70% to 96%, with various different

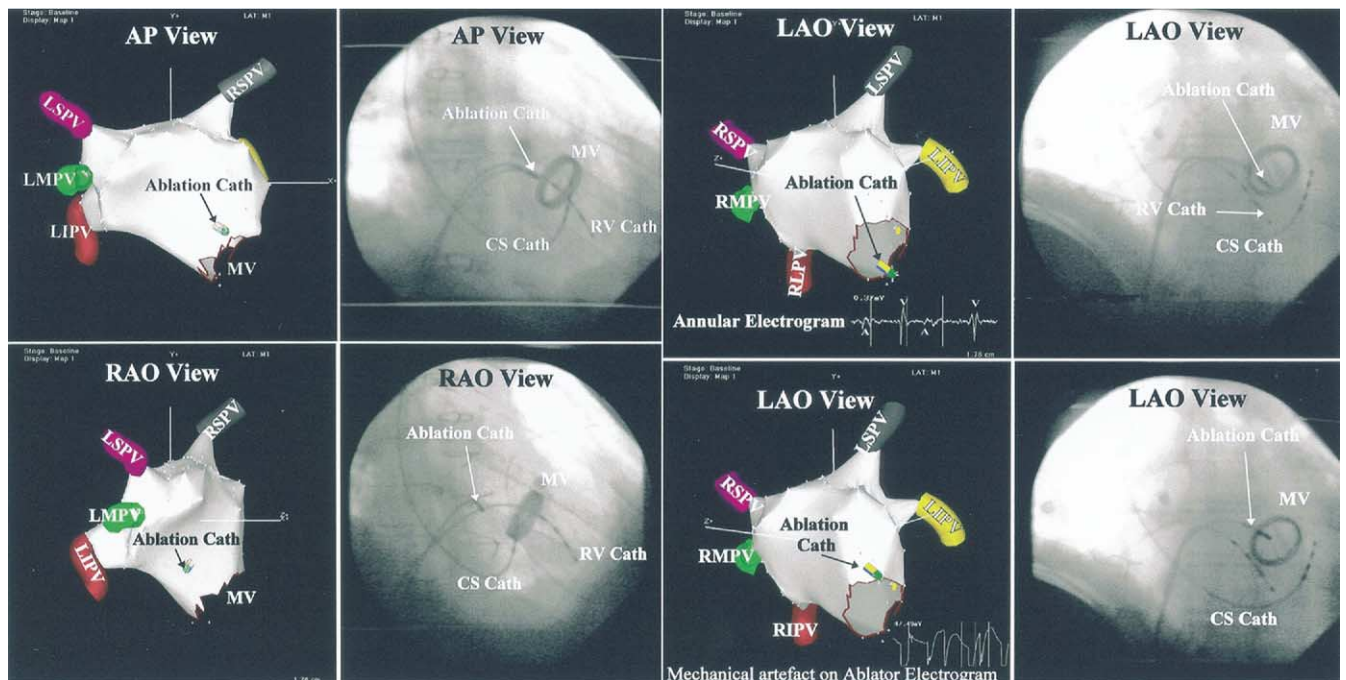


Figure 2. Simultaneous images of catheter positions as seen on fluoroscopy and CARTO. The fluoroscopy helps establish the precise location of the mitral valve ring in relation to the CARTO map. CARTO has the advantage of being able to see the catheter tip position in multiple views simultaneously. However, with fluoroscopy, the valve leaflets are clearly visible, and contact between the catheter and the leaflets can be readily identified. The **electrogram inset in the panels in the third column** shows the typical appearance of a mitral annular electrogram recorded from the ablation catheter, whereas the **inset just below it** shows the characteristic artifact seen when the catheter is in contact with the mechanical leaflets.

techniques and technologies (8-16). Intraoperative ablation also has the advantages of being able to visualize the lesions created, and catheter manipulation is less restricted.

A reduction in morbidity and mortality after CPVA has been previously demonstrated (4), with a substantial reduction in cardiovascular events, in particular, ischemic stroke and sudden death. Long-term follow-up of patients after mitral valve surgery and a Maze procedure suggest that maintenance of sinus rhythm will significantly reduce the risk of stroke in these patients, regardless of the presence of mandatory anticoagulation, emphasizing the potential benefit of ablative treatment for AF (12).

Study limitations. Every attempt has been made to select suitably matched control subjects for this study; nonetheless, the case-control nature of this study and the relatively small population size are limitations. As ours is a high-volume center with considerable experience with CPVA, our results may not be representative of all hospitals performing this procedure.

Conclusions. The procedure of CPVA can be performed in patients with prosthetic valves, although in our experience, these patients represent the extreme end of the spectrum of patients with AF, and this is reflected in the higher recurrence rate. Nonetheless, the presence of MVP, per se, is neither a contraindication nor a marker of poor outcome. A higher incidence of incisional AT was documented in patients with mitral prostheses after the initial procedure, which may relate to incomplete block at the mitral isthmus. Where possible, it would be preferable to perform ablation of AF at the time of cardiac surgery in centers where this is an option.

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