Predictors of Sinus Rythm Restoration by Radiofrequency Ablation for Atrial Fibrillation in Patients Undergoing Heart Valve Surgery

Kalp Kapak Cerrahisi Yapılan Atrial Fibrilasyonlu Olgularda Radyofrekans Ablasyon Yöntemi ile Sinus Ritminin Sağlanmasının Belirteçleri

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ABSTRACT Objective: The radiofrequency ablation procedure for the surgical treatment of atrial fibrillation in patients with heart valve disease has recently been introduced as an effective treatment modality. The aim of this study is to determine the efficacy of intraoperative radiofrequency ablation performed during heart valve surgery and to investigate the risk factors that may adversely affect sinus rhythm restoration. **Material and Methods:** A total of 64 consecutive patients (24 men, mean age 45.2 ± 8.5 years) underwent mitral valve surgery and concomitant radiofrequency ablation for chronic atrial fibrillation in our clinic between November 2002 and January 2006. Statistical analysis of 19 potential predictors of sinus rhythm restoration was conducted. **Results:** Duration of atrial fibrillation ranged from 12 to 61 months (mean, 42.1 ± 11.6 months). The recovery of sinus rhythm (SR) was 87.5 % in the first postoperative day which was 89% on discharge. At a mean follow-up time of 18 ± 7.8 months (range, 3 to 38 months), 48 of the 60 patients (80%) were in sinus rhythm. **Conclusions:** The radiofrequency ablation seems to be very effective and safe procedure which prolongs the surgical procedure a little. The preoperative left atrial size, duration of atrial fibrillation, amplitude of atrial fibrillatory wave, and age are primary predictors of sinus rhythm conversion by the radiofrequency ablation procedure for patients with permanent atrial fibrillation and heart valve disease.

Key Words: Atrial fibrillation; catheter ablation

ÖZET Amaç: Kalp kapak hastalığı sebebiyle ameliyat olacak atriyal fibrilasyonlu hastalarda uygulanan radyofrekans ablasyon son yıllarda etkin bir tedavi yöntemi olarak kabul görmektedir. Bu çalışmanın amacı kalp kapak cerrahisine ek olarak uygulanacak radyofrekans ablasyonun etkinliğini ve sinüs ritmini yeniden sağlamak konusundaki risk faktörlerini araştırmaktır. **Gereç ve Yöntemler:** Kasım 2002 ile Ocak 2006 tarihleri arasında mitral kapak cerrahisine ek olarak radyofrekans ablasyon uygulanan 64 ardışık hasta çalışmaya alındı. Sinüs ritmini yeniden sağlamanın olası 19 belirteci istatistiksel olarak incelendi. **Bulgular:** Atriyal fibrilasyon süresi 12 ile 61 ay (ortalama 42,1±11,6 ay) arasındaydı. Postoperatif birinci günde hastaların %87,5'i, taburcu olurken %89'u sinüs ritmindeydi. Ortalama 18±7,8 aylık takipte ulaşılabilen 60 hastanın 48'i (%80) sinus ritmini sürdürüyordu. **Sonuç:** Radiyofrekans ablasyon cerrahi işlemin süresini minimal uzatan etkin ve güvenli bir yöntemdir. Preoperatif sol atriyum çapı, atriyal fibrilasyonun süresi, atriyal fibrilasyon dalgasının amplitüdü ve yaş, kalp kapak hastalığı ve atriyal fibrilasyonu olan hastalarda radyofrekans ablasyon ile sinüs ritmi sağlanmasının primer belirtecidirler.

Anahtar Kelimeler: Atrial fibrilasyon; kateter ablasyon

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The prevalence of atrial fibrillation (AF) is 0.4% in general population and about 5% in people older than 60 years.[1] Chronic AF was present in approximately 30% to 40% of patients undergoing mitral valve operation and in most patients the arrhythmia persists after correction of the primary disease,[2,3] and adversely affect the survival.[4,5] The detrimental sequ-

els of AF are symptoms of irregular heart beat, hemodynamic compromise due to atrioventricular asyncrony, and systemic thromboembolic events.[6]

Medical treatment and cardioversion aimed at either rhythm or rate control does not yield satisfactory results.[7] Cox and co-workers have described the Maze procedure as a surgical treatment of AF.[6] However, the complexity and time associated with Maze procedure have prevented its widespread application.[8] The saline-irrigated radiofrequency (RF) ablation may restore sinus rhythm and atrial transport function in > 80% of the patients with persistent AF and mitral valve disease.[9,10]

Determinants of sinus rhythm restoration are well defined for surgical Maze procedure.[11] However predictors of success by RF ablation (RFA) are less clear. The aim of this study is to determine the efficacy of intraoperative RFA performed during heart valve surgery and to investigate predictors of sinus rhythm restoration.

MATERIAL AND METHODS

PATIENTS

A total of consecutive 64 patients [24 male (37.5%) and 40 female (62.5%)] underwent RF ablation for chronic AF during heart valve operation in our clinic between November 2002 and January 2006. The mean age of the patients was 45.2 ± 8.5 years ranging from 21 to 58. Patients undergoing surgery associated with the left ventricle or aortic aneurysm, emergency surgery due to prosthetic valve thrombosis, and who had calcified atria were excluded from the study. Medical records of these patients were reviewed for clinical data. The study was approved by the institutional review board.

OPERATIVE TECHNIQUE

All patients were operated on under general anesthesia. All operations were performed through median sternotomy and under cardiopulmonary bypass and moderate hypothermia. The heart was arrested with antegrade isothermic hyperkalemic blood cardioplegia after cross-clamping of the aorta. Standard left atriotomy was done through the interatrial groove. The left atrial appendage was excised first. The amputation site was sutured after completion of the ablation procedure.

The left atrial ablation procedure was done before the heart valve surgery. RF energy was used to create long continuous endocardial lesions with a cooled tip probe irrigated with saline solution. The Cardioblate (Medtronic Inc, MN, USA) unipolar RF ablation device which consists a power generator and a pen was used for the ablation procedure. The electrode tip is irrigated with saline that provides a low impedance path. A power output ranging from 20 to 30 watts / 5 cc irrigation / min was used for the ablation procedure. The right and the left pulmonary veins were isolated by encircling with the ablation catheter. These pulmonary vein islands were interconnected with an additional ablation line. And additional ablation line was performed from the left pulmonary vein island to the left atrial appendage amputation site. An ablation line was performed which connected the left pulmonary veins to the P2–P3 segment of the posterior mitral annulus. An ablation line from the middle of the mitral annulus to the line encicling the left pulmonary veins was performed to prevent re-entry pathways moving between the atria via the coronary sinus (Figure 1). Additional procedures were performed only after completing the left-sided ablation.

POSTOPERATIVE MANAGEMENT

Antiarrhythmic prophylaxis with amiodarone was started routinely. All patients were received intravenous bolus of 300 mg, followed by a continuous infusion of 1,200 mg/d for 24 hours; and oral administration of 200 mg every 8 hours until discharge, followed by 200 mg/d as maintenance for at least 6

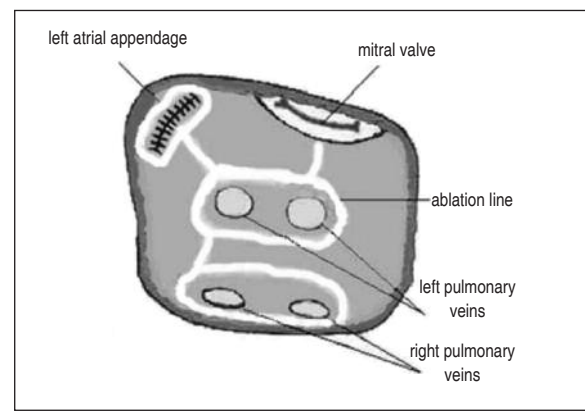

FIGURE 1: The left atrial ablation procedure (View inside left atrium: Incision through the interatrial groove).

months. Amiodarone was stopped in the presence of a stable sinus rhythm (SR). After hospital discharge, patients received monthly follow-up for cardiac rhythm evaluation with 12 lead surface ECG. Transthoracic echocardiography was performed two months later to assess the diastolic flow pattern (i.e. the presence or absence of 'a' waves).

STATISTICAL ANALYSIS

Statistical analysis was done with SPSS 10.0 statistical software program (SPSS, Chicago; IL, USA). Nominal variables were analyzed by Chi-square and Fisher-Exact test and results were expressed as n (%). Distribution of the continuous variables have been controlled by skiwness and kurtosis values and seen as normal (Table 1). Continuous variables were compared by Student's -t test and results were expressed as the mean± standard deviation and minimum-maximum values. p values less than 0.05 were considered to be statistically significant.

RESULTS

Sixty-four patients underwent left atrial ablation procedure besides heart valve surgery. The duration of the AF was documented with 12- lead ECG and ranged between 12 and 61 months (mean 42.1 ± 11.6 months). The mean amplitude of atrial fibrillatory waves was 1.1 ± 0.2 mm, ranging from 0.7 to 1.5 mm. Mean diameter of the left atria was 56 ± 4.8 cm and mean left ventricular ejection fraction was 48.5 ± 8%. Preoperative characteristics of the patients were given in Table 2.

TABLE 1: This table has shown median of the data and skiwness and kurtosis parameters. Distribution of variables have been seen as normal.

	median	skewness	kurtosis
AGE	47.5	-0.9	0.822
NYHA	3.0	0.028	-0.128
PREEF	45.0	0.103	-1.112
POSTEF	50	0.380	0.883
PRELA	56	-0.360	-0.218
POSTLA	50.0	-.0.570	-0.218
DAF	43.0	-0.540	-0.100
AMPLITUD	9.0	-.0.658	-0.658
ACC	68.5	0.539	-1.072
TPT	15.0	1.4	1.4
FOLLOW-UP	15.0	1.5	1.5

NYHA: New York Heart Association, PREEF; Preoperative ejection fraction, POSTEF; Postoperative EF, PRELA; Preoperative left atrium, POSTLA; Postoperative left atrium, DAF; Duration of follow-up, ACC; Aortic cross-clamp,TPT; Total bypass time.

TABLE 2: Preoperative characteristics of the patients.

	Number	Percent
Patients	64	100
Men	24	37.5
Female	40	62.5
Co-existing pathologies		
Hypertension	17	26.5
Diabetes	6	9.4
Renal failure	1	1.6
Smoking	18	28.1
COPD	7	10.9
NYHA		
II	16	25
III	41	64.1
IV	7	10.9
Clinical Presentation		
MS	20	31.2
MS+MR	28	43.7
MS+MR+TR	9	14.1
MS+MR+AR	2	3.1
MS+CAD	5	7.8
Prior MI	3	4.7
History of endocarditis	6	9.4
Previous embolism	5	7.8

ARF= Acute rheumatic fever; COPD=chronic obstructive pulmonary disease; NYHA=New York Heart Association; MS= mitral stenosis; MR= mitral regurgitation; TR= tricuspid regurgitation; AR= aortic regurgitation; CAD=coronary artery disease; MI=myocardial infarction

Mean ablation duration was 13.8 ± 1.7 minutes (range, 11 to 20 minutes). The mean aortic cross-clamp time was 74.3 ± 16.2 minutes (range; 55 to 110 minutes) and Cardiopulmonary Bypass (CPB) time was 111.3 ± 30 minutes (range; 70 to 200 minutes). There was no in-hospital mortality. Concomitant procedures were mitral repair in 12 (18.7%) patients, mitral valve replacement in 36 (56.2%), mitral valve replacement + tricuspid repair in 9 (14.1%), mitral valve replacement + aort valve replacement in 2 (3.2%), and mitral valve replacement + coronary artery bypass grafting in 5 patients (7.8%).

Mean hospitalization time was 6.2 ± 2.7 days (range, 5 to 16 days). Conversion to sinus rhythm (SR) was 87.5% on the first postoperative day which was 89% on discharge. One patient had junctional rhythm and one had AF which turned to SR on the fifth postoperative day. The rhythm of the other 7

patients persisted as AF throughout their hospitalization time. No patient required implantation of a permanent pace-maker at any time after surgery.

Sixty patients out of 64 (93.7%) attended further follow-up visits. At a mean follow-up time of 18 ± 7.8 months (range, 3 to 38 months), 48 of 60 patients were in sinus rhythm (80%). Ten patients had returned to AF and 2 patients had typical atrial flutter. Atrial contraction was detected by transthoracic echocardiography in 43 patients (71.7%) according to the presence or absence of 'a' waves in transmitral Doppler recordings. During follow-up 2 patients died. These deaths were due to intracerebral hemorrhage in one patient and to pneumonia, complicated by respiratory failure in one patient.

Preoperative and postoperative variables which were potentially predictors of sinus rhythm conversion are seen in Table 3 and Table 4. Age, preoperative left atrial size, duration of atrial fibrillation, and amplitude of atrial fibrillatory waves were found to be statistically significant between the two groups in terms of sinus conversion.

TABLE 3: Variables potentially predictors of sinus rhythm conversion

	Sinus Conversion (+) (patients/ %) n=56	Sinus Conversion (–) (patients/%) n=8	p value
Preoperative variables			
Female	37/ 66.1	5/ 62.5	ns
NYHA			
Class II	15/ 26.8	1/ 12.5	ns
Class III	36/ 64.3	5/ 62.5	ns
Class IV	5/ 8.9	2/ 25	ns
COPD	6/ 10.7	1/ 12.5	ns
Hypertension	14/ 25	3/ 37.5	ns
Diabetes mellitus	5/ 8.9	1/ 12.5	ns
Acute rheumatic fever	36/ 64.2	7/ 87.5	ns
Previous embolism	4/ 7.2	1/ 12.5	ns
Operative variables			
Tricuspid valve intervention	7/ 12.5	2/ 25	ns
Aortic valve intervention	1/ 1.8	1/ 12.5	ns
CABG	4/ 7.2	1/ 12.5	ns

ns=not significant; NYHA=New York Heart Association; COPD=chronic obstructive pulmonary disease; CABG= coronary artery bypass grafting.

DISCUSSION

Atrial fibrillation commonly accompanies ischemic and valvular heart disease with a high risk of morbidity and mortality.[12] Sixty percent of patients admitted for mitral valve surgery have chronic AF[13] and 80% of these patients will remain so thereafter.[2,3] AF is an independent risk factor for stroke; it is associated with a fourfold to fivefold higher stroke risk than general population.[5,12,14] Even with the extensive use of antiarythmic medications and aggressive electrical cardioversion, reported rates of late sinus rhythm maintenance remain below 25%.[15] Surgical Cox maze procedure offers a 90% success rate[16] but it is an extensive and time consuming technique, which precludes its widespread application. Therefore radiofrequency ablation for AF represents a valuable adjunctive procedure for patients undergoing heart valve surgery.

In one study, freedom from AF at six and twelve months was found to be 87.2% and 93.6%, respectively in the combined procedure of valve surgery and RF ablation and 9.4% in the valve sur-

TABLE 4: Numerical variables potentially predictors of sinus rhythm conversion.

	Sinus Conversion (+) (x ± sx (min- max) n= 56	Sinus Conversion (–) (x ± sx (min- max) n= 8	p value
Age (mean, years)	44.4 ± 8.5 (21-58)	51.1 ± 5 (43-58)	p<0.001
Duration of AF (mean, month)	39.2 ± 10.9 (12-60)	54.6 ± 5.8 (42-60)	p<0.001
Bypass time (mean, minute)	109.2 ± 30 (70-200)	126.6 ± 24 (85-167)	ns
ACC time (mean, minute)	73.1 ± 15.8 (55-110)	83 ± 16.4 (55-105)	ns
LVEF (%)	48.5 ± 8 (35-60)	47.5 ±8.3 (40-60)	ns
LAD (mm)	56 ± 4.8 (45-64)	63 ± 1.3 (60-64)	p<0.001
FWA (mm)	1.1 ± 0.2 (0.7-1.5)	0.7 ± 0.03 (0.7-0.8)	ns

ns=not significant; AF= atrial fibrillation; ACC=aortic cross-clamp; LVEF=left ventricular ejection fraction; LAD= left atrial diameter; FWA=fibrillatory wave amplitude

gery alone.[17] In this study, we found that the saline-irrigated RF modified Maze procedure was successful in 87.5% of patients in early period in terms of restoring sinus rhythm.

The duration of AF before surgery was found to be an independent predictor of sinus conversion by RF Maze procedure: every 1-month increase in the duration of AF corresponds to a 2.2% risk for persistent AF after surgery.[18] In this study, we performed RF ablation for AF sustained more than 1 year and found that long duration of AF in patients with heart valve disease is a predictor of persistent AF after surgical intervention.

Chen and colleagues declared that preoperative left atrial size and duration of AF are primary predictors of sinus conversion by RF ablation for patients with persistent AF and mitral valve disease.[18] In this study, enlarged left atrial size was associated with high incidence of failure, which is comparable with the results of other studies.[18,19]

In surgical Maze groups, fine atrial fibrillatory waves as less than 1 mm on a standard 12- lead electrocardiogram found to be associated with poor conversion rate.[20] There is no study about effectiveness of RF ablation for patients with low amplitude fibrillatory waves. In our study, we found that a fine atrial fibrillatory wave on a standard 12- lead ECG was associated with poor conversion rate.

Consequently, the recovery of the SR by RF ablation seems to be long lasting and cost effective in patients undergoing heart valve surgery. In our experience, the radiofrequency ablation is effective and safe which prolongs the surgical procedure a little.

The preoperative left atrial size, duration of atrial fibrillation, amplitude of atrial fibrillatory wave, and age are primary predictors of sinus rhythm conversion by the RF ablation procedure for patients with permanent atrial fibrillation and heart valve disease.

A limitation of this study is the lack of a control group. Comparative studies are needed to identify more precise determinants of sinus rhythm restoration and the superiority of RF ablation over other management strategies.

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