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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Catheter ablation of complex left atrial arrhythmias in patients after percutaneous or surgical mitral valve procedures

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Abstract

Background: Mitral valve defects are frequently associated with atrial arrhythmias. Percutaneous or surgical mitral valve procedures may reverse adverse haemodynamic consequences of the valvular defect but have little effect on the arrhythmia itself. With safety concerns and few outcome data, the role of catheter ablation in these patients has not been established yet.

Aim: To assess safety and efficacy of catheter ablation of complex left atrial arrhythmias in patients after percutaneous or surgical mitral valve procedures.

Methods: We studied 14 patients (mean age 55 ± 11 years; 9 females) with a history of percutaneous mitral commissurotomy (PMC; n = 5), surgical valvuloplasty (n = 3), or mitral valve replacement (n = 6) due to mitral stenosis (MS; n = 8) or mitral regurgitation (MR; n = 6). In surgically treated patients, concomitant pulmonary vein isolation was performed in 6 patients and tricuspid valvuloplasty in 4 patients. Atrial fibrillation (AF) was the only arrhythmia in 7 patients, including all 5 patients after PMC (paroxysmal AF in 2 patients, persistent AF in 4 patients, long-persistent AF in 1 patient). Left atrial tachycardia (AT) was the prevailing arrhythmia in 7 of 9 patients after surgical procedures (median of 2 morphologies per patient), lasting uninterrupted for 1 to 48 months before the ablation procedure. The ablation scheme was adjusted to the clinical and electrophysiological status and included pulmonary vein isolation, linear lesions and ablation of fragmented potentials. Atrial tachycardias were mapped and ablated using activation and entrainment mapping.

Results: Efficacy of ablation after a single procedure was 36%. A total of 25 ablations were ultimately performed in the study group. During 23 ± 13 months of follow-up, stable sinus rhythm (SR) was present in 10 (71.4%) patients, including 4 on antiarrhythmic drugs. No differences in the efficacy of ablation were seen between patients with MS and MR, with SR obtained in 5 of 8 patients and 5 of 6 patients, respectively (p = 0.57). Similarly, no differences in regard to SR maintenance were noted between patients previously treated by a percutaneous or surgical procedure (percutaneous treatment: SR in 3 of 5 patients; surgical treatment: SR in 7 of 9 patients, p = 0.58). SR was obtained in 5 of 7 patients in whom the original arrhythmia was AF and in 5 of 7 patients who had AT (p = 1.00). Patients in whom stable SR was obtained showed a significantly better functional status as assessed by the New York Heart Association classification, accompanied by a reduction of the left atrial dimension and an increase in the left ventricular ejection fraction.

Conclusions: Catheter ablation of complex left atrial arrhythmias in patients after percutaneous or surgical mitral valve procedures is an effective and safe therapeutic option. Recurrences after the first ablation are frequent and patients may require repeat ablations. Achieving stable SR significantly reduces complaints related to the arrhythmia and improves patient clinical status.

Key words: atrial fibrillation, atrial tachycardia, catheter ablation, mitral valve replacement, mitral valve repair, percutaneous mitral commissurotomy

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INTRODUCTION

Atrial fibrillation (AF), atrial flutter (AFL) and atrial tachycardia (AT) are common in patients with mitral valve disease [1, 2]. These arrhythmias usually aggravate preexisting haemodynamic disturbances. Both percutanous and surgical valve repair and valve replacement may reverse adverse haemodynamic effects of the valvular disease but this is usually not sufficient for restoration or maintenance of sinus rhythm (SR) [3–6]. In a significant proportion of patients, AF develops some time after the valve procedure [5, 6].

Combining a Maze procedure with valvular surgery significantly reduces the rate of AF during long-term follow-up [7, 8] but this option is available only in patients treated surgically. The rate of AF recurrences after antiarrhythmic surgery performed during valve replacement or repair may be up to 38% [8]. If possible, patients with mitral stenosis are currently offered percutaneous mitral commisurotomy (PMC) which is a highly effective procedure associated with a low complication rate and preferred by both patients and physicians due to its low invasiveness [9, 10]. However, it does not significantly reduce the rate of AF [6]. If antiarrhytmic drugs are ineffective, as is often the case in this patient group, SR may be restored or maintained by ablation of AF substrate [11]. Percutaneous transcatheter ablation may also be offered to surgical patients in whom AF occurred or recurred after the surgery, or who developed post-incisional tachycardia.

The aim of the study was to evaluate safety and efficacy of percutaneous radiofrequency (RF) current ablation of complex left atrial arrhythmias in patients after percutaneous or surgical mitral valve procedures.

METHODS

Study population

We studied 14 patients (9 women, 5 men; mean age 55 ± 11 years) with complex left atrial arrhythmias (AF, AFL, AT) who previously underwent mitral valve procedure due to mitral stenosis (8 patients) or mitral regurgitation (6 patients). In 5 patients, the only mitral valve procedure was PMC, 3 patients underwent surgical valvuloplasty with insertion of an annuloplasty ring, and 6 patients underwent mitral valve replacement (MVR) (preceded by PMC in 1 patient and surgical valvuloplasty in another patient). In surgically treated patients, mitral valve procedure was associated with intraoperative pulmonary vein isolation in 6 cases, and concomitant tricuspid valvuloplasty in 4 patients. AF was the only or predominant arrhythmia in 7 patients (paroxysmal AF in 2 patients, persistent AF in 4 patients, and long-persistent AF in 1 patient). Only AF was observed in patients after PMC. In 7 of 9 surgically treated patients (MVR in 5 patients, mitral valvuloplasty in 2 patients), the predominant arrhythmia was left atrial AT ($p = 0.027$). Uninterrupted AT episodes persisted for 1 month to 4 years before ablation, and on average 2 different AT morphologies per patient were observed (range 1–3). The mean duration of arrhythmia before ablation in the overall study population was 7 ± 4.1 years (range 1.5–14 years). The mean number of ineffective antiarrhythmic drugs used before ablation was 2.2 ± 1.2 (range 1–4). Mean left atrial dimension by echocardiography was 52 ± 5.8 mm (range 40–61 mm), and mean ejection fraction was 58.8 ± 8.7% (range 35–70%). Average mean and peak mitral gradient was 4.67 ± 1.09 mm Hg (range 3–7.2 mm Hg) and 11.6 ± 3 mm Hg (range 7.6–19.3 mm Hg), respectively. The mean time from the last mitral valve procedure to the initial ablation procedure was 5.8 ± 5.5 years (range 0.5–21 years). Computed tomography of the left atrium was performed in all patients before ablation to exclude presence of left atrial thrombi, evaluate atrial size and anatomy, and assess the size of pulmonary vein ostia. Detailed characteristics of the study group, including types of procedures and implanted valves, are shown in Tables 1 and 2.

AF was defined as irregular arrhythmia with varying *f* wave morphology in surface electrocardiogram (ECG). AFL was defined as regular arrhythmia circulating around the tricuspid annulus and characterised by a typical ECG pattern, in which the cavotricuspid isthmus was the integral part of the reentry circuit. AT was defined as all other arrhythmia regardless of its mechanism (ectopic focus/reentry) and cycle length, characterised by constant morphology of the P wave, if the cavotricuspid isthmus was not the part of the reentry circuit. Arrhythmia was defined as persistent if it lasted more than 7 days, or lasted less than 7 days but required pharmacological or electrical cardioversion to interrupt. Long persistent arrhythmia was defined as arrhythmia lasting for more than a year before ablation. Significant ablation-related complications included death, stroke, transient ischaemic attack, peripheral embolism, cardiac tamponade or perforation, valve damage, arteriovenous fistula requiring surgical intervention, and large vascular access site haematoma resulting in a haemoglobin level drop by 2 g/dL.

Before the procedure, all patients received full oral anticoaculation (international normalised ratio [INR] > 2). In the first 10 patients, this therapy was replaced in the periprocedural period with enoxaparin 1 mg/kg twice daily, and in 4 patients the ablation procedure was performed during therapeutic oral anticoagulation (INR 2–3) [12]. In patients receiving chronic antiarrhythmic therapy, this treatment was continued in the periprocedural period and for at least 3 months after the ablation procedure. All patients gave written consent for the procedure, and the informed consent form was approved by the local bioethics committee.

Electrophysiological testing and ablation

Catheters were inserted into the heart under local anaesthesia and antibiotic coverage using the right femoral vein access. Twelve-lead chest surface ECG and biopolar electrograms from the intracardiac leads were recorded using the electrophysiological system (EP MedSystems, West Berlin, New Jersey, USA; or Bard, Bard Electrophysiology Division

Table 1. Clinical characteristics of the study patients

Pts. no.	Gender	Age	EHRA	Valvular disease	Arrhythmia	Duration of arrhythmia [years]	Valvular procedures	Time from last valvular procedure to ablation [years]
1	M	54	3	MS	AF parox	10	PMC	9
2	F	64	2	MS	AF parox†	11	PMC	21
3	F	48	3	MS	AF pers	3	PMC	2
4	F	60	2	MS	AF pers 12*	6	PMC	2
5	F	54	2	MS	AF pers 1*	12	PMC	11
6	M	70	3	MR	AT pers 48*	3	STV, MVR, PVI	3
7	F	27	3	MR	AT pers	4	SMV > MVR	11
8	F	58	3	MS	AT pers 12†*	8	PMC > MVR	6
9	M	55	2	MR, TR	AF/AT pers	3	STV, MVR, PVI	2
10	F	44	3	MS	AT/AF pers	1.5	STV, SMV, PVI	0.5
11	M	60	2	MR	AT pers 6*	14	SMV, PVI	4
12	M	68	2	MR, TR	AF/AT pers 12*	8	SMV, STV	1.2
13	F	55	4	MS, MR	AT pers 6*	5	MVR, PVI	5.5
14	F	60	3	MR	AF/AT pers	12	MVR, PVI	4

*Number of months of uninterrupted arrhythmia before ablation; †typical atrial flutter was also noted clinically; AF — atrial fibrillation; AT — atrial tachycardia; EHRA — severity of symptoms of arrhythmia in the EHRA scale (score from 0: no symptoms to 4: severe symptoms precluding normal patient functioning); PVI — surgical pulmonary vein isolation simultaneously with valvular procedure; F — female; MR — mitral regurgitation; TR — tricuspid regurgitation; M — male; parox — paroxysmal arrhythmia; pers — persistent arrhythmia; PMC — percutaneous mitral commisurotomy; SMV — surgical mitral valvuloplasty; STV — surgical tricuspid valvuloplasty; MS — mitral stenosis; MVR — mitral valve replacement

Table 2. Mitral valve area and gradient and computed tomography (CT) data before ablation

Pts. no.	Mitral valve area before ablation	Mitral valve gradient [mm Hg] (max/mean)	LA by CT [mm] AP/RL/SI
1	1.6 cm^2	11/5.5	52/86/87
2	2.4 cm^2	12/6	39/52/45
3	2.4 cm^2	13/3	50/85/60
4	1.7 cm^2	11/4	56/79/68
5	1.6 cm^2	12/5	50/91/73
6	SJM 29 mm	11/5	55/72/58
7	SJM 25 mm	13/6	60/93/78
8	SJM 31 mm	10/5	52/78/64
9	ATS 33 mm	9/4	54/85/82
10	Ring 32 mm	19/8	47/74/66
11	Ring 34 mm	8/3	51/68/56
12	Ring 34 mm	11/5	59/69/62
13	Sorin-Bicarbon 29 mm	10/3	47/76/63
14	SJM 29 mm	15/8	48/67/57

SI — superior-inferior dimension; LA — left atrium; AP — anterior-posterior dimension; RL — right-left dimension; SJM — St. Jude Medical mechanical mitral valve prosthesis; ATS — ATS mechanical mitral valve prosthesis

C.R. Bard, Inc. Lowell, MA, USA). During each procedure, we also used an electroanatomic mapping system (CARTO, Biosense Webster, Inc., Diamond Bar, CA, USA; or EnSite NavX, St. Jude Medical, St. Paul, Mn, USA) that allowed creation of anatomic, potential, and activation maps. In each patient, we used a steerable 4-pole diagnostic catheter that was placed in the coronary sinus at the beginning of the procedure. After transseptal puncture, an ablation catheter and a diagnostic circumferential catheter (Lasso, Biosense Webster, Diamond Bar, CA, USA) used for mapping and confirmation of pulmonary vein isolation were introduced into the left atrium. After catheter insertion into the left atrium, heparin was given initially at 100 U/kg and then 1000–1500 U every hour. In patients with therapeutic INR values, heparin dose was reduced by about 30%, and activated clotting time was kept at 300–400 s. In all patients, ablation was performed using a cooled catheter with an open-irrigated system (Navistar, Thermocool, Biosense Webster, Diamond Bar, CA, USA; or Thermocool, Biosense Webster, Diamond Bar, CA, USA). Maximum power output during ablation did not exceed 35 Watt during pulmonary vein isolation, and 42 Watt during creation of ablation lines and ablation of complex fractionated atrial electrograms (CFAE) within the right and left atrium, except for the posterior wall of the left atrium and the coronary sinus, where the maximum power output was set at 20–25 Watt. The extent of the procedure depended on the clinical situation and was left to the discretion of the operator. In patients with AF, the

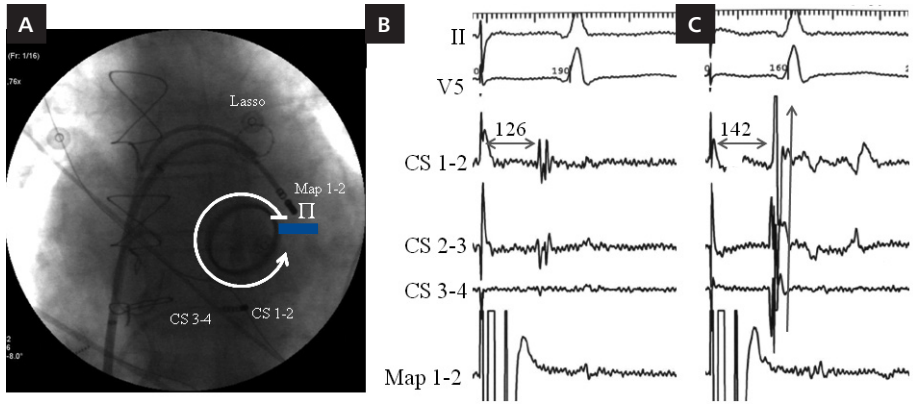

Figure 1. Status post pulmonary vein isolation and ablation of reentrant tachycardia around the mitral annulus. Left anterior oblique (40 degrees) view with intracardiac and surface electrograms to evaluate conduction block within the mitral isthmus after ablation line was created in this area in a patient after mitral valve replacement. The lasso catheter is in a left pulmonary vein (**A**). During recording of the electrograms shown, the CS catheter was in the coronary sinus, and pacing was by a mapping catheter (MAP 1-2) located laterally and above to the ablation line marked schematically with blue colour. Although the catheters are close to each other, activation wave needs more than 120 ms to get to the coronary sinus catheter from the pacing site, reaching distal (CS 1-2) and proximal (CS 3-4) rings more or less at the same time (**B**). This is due to a significant slowing of conduction within the mitral isthmus, with activation wave reaching the middle part of the coronary sinus simultaneously from both sides — through the ablation line (slowed conduction) and also around the mitral annulus. After additional current application in this area, a change in the direction of activation was noted, with increase in conduction time to the distal rings of the coronary sinus catheter (**C**). This was due to creation of a complete conduction block with the mitral isthmus, so the activation wave must now run around the mitral annulus to reach the other side of the ablation, as schematically shown on the fluoroscopic image

mainstay of the therapy was electrical isolation of pulmonary vein ostia, performed singularly or in pairs under the control of a diagnostic lasso catheter placed in a given ostium, with the endpoint of a bidirectional conduction block between the vein and the atrium. During ablation of AT and AFL, RF current application sites were selected based on the analysis of intracardiac activation and entrainment mapping. In patients in whom ablation lines were created within the left atrial roof (between the two upper pulmonary veins), the mitral isthmus (between the mitral valve and the lower left pulmonary vein), or the cavotricuspid isthmus within the right atrium (between the tricuspid valve and the inferior vena cava), the endpoint was a bidirectional conduction block in these areas (Fig. 1) [11]. CFAE were defined as potentials recorded during AF that were characterised by a significant fragmentation (≥3 deflections from the isoelectric line), low amplitude (< 0.25 mV), long duration (≥ 100 ms or continuous electrical activity) and/or a very short cycle (< 140 ms). Ablation sites were selected based on visual assessment and measurements on the screen of the electrophysiological system monitor [11]. CFAE ablation was performed until reduction of local potentials by at least 50% or up to 40 s. If possible, the goal was to terminate the arrhythmia by ablation. If no SR return was observed after 3 h of the procedure or a total of 70 min of RF current application, SR was restored by intravenous propafenone up to 2 mg/kg or by electrical cardioversion. After SR restoration in patients with persistent or long-persistent AF, we did not evaluate inducibility of the arrhythmia and only verified the completeness of pulmonary vein isolation and creation of ablation lines. In the remaining patients, we evaluated arrhythmia inducibility by rapid pacing from the coronary sinus down to the cycle length of 220 ms or equal to the atrial refraction period.

Long-term evaluation after the procedure

After the procedure, patients were monitored for its efficacy at 4 weeks and then every 3–6 months. ECG was recorded during each visit, and Holter monitoring was performed at least twice a year. In addition, standard ECG and/or Holter monitoring was performed whenever patients reported recurrence of palpitation. Arrhythmia recurrence was defined as a recurrence of AF, AFL or AT recorded by ECG and lasting more than 30 s, or any palpitation of similar nature as before ablation, lasting more than 3 min and occurring more than 3 months after ablation. Arrhythmia recurrences within 3 months after ablation were considered associated with the healing process and were not deemed ablation failures. Follow-up echocardiographic studies were performed after each ablation procedure and at least once in 2 years during long-term follow-up.

Statistical analysis

Continuous variables were shown as means ± standard deviation. For some variables, ranges and percentage proportions were also given. Continuous variables were compared using the Mann-Whitney test or the Student *t* test depending on

variable distribution. The exact Fisher test was used to evaluate relations between two qualitative variables. $P > 0.05$ was considered statistically significant. Statistical analyses were performed using the Statistica 5.0 software (StatSoft, Inc., Tulsa, OK, USA).

RESULTS

Overall, 25 ablation procedures were performed without major complications in the 14 studied patients (range 1–3 procedures per patient). This allowed SR maintenance during long-term follow-up (mean 23 ± 13 months, range 10–46 months) in 10 (71.4%) patients including 4 on antiarrhythmic drugs (amiodarone 100 mg/day in 1 patient, sotalol in 1 patient, propafenone in 2 patients). A single ablation procedure was sufficient for long-term SR maintenance in 5 (36%) patients. Arrhythmia become permanent in 3 patients (#3, 5, and 6), including one patient after PMC with progression of valvular disease requiring valve replacement. In another patient (#10) after mitral valvuloplasty, recurrent arrhythmia in the form of AT occurred significantly less frequently than before ablation (once in about 8–12 weeks) and the patient was unwilling to undergo another ablation procedure. The mean duration of the procedure, fluoroscopy, and RF current application during ablation was 182 ± 68, 17 ± 6.2 and 45 ± 19 min, respectively. Detailed data regarding the number, extent, and immediate results of ablation procedures are shown in Table 3. Ablation efficacy did not differ significantly between patients with mitral stenosis and mitral regurgitation, with SR obtained in 5 of 8 patients and 5 of 6 patients, respectively ($p = 0.57$). Similarly, no differences in regard to SR maintenance were noted between patients previously treated by a percutaneous or surgical procedure (percutaneous treatment: SR in 3 of 5 patients; surgical treatment: SR in 7 of 9 patients, $p = 0.58$). SR was obtained in 5 of 7 patients in whom the original arrhythmia was AF and in 5 of 7 patients who had mostly AT ($p = 1.00$). In all 6 patients who previously underwent surgical pulmonary vein isolation during the valvular procedure, a return of conduction was noted between the atrium and at least one pulmonary vein. Arrhythmia recurring after percutaneous ablation included AF only in 2 cases, AF and AT in 1 case, and AT only in 4 cases. In patients with AT recurrences, on average 2 different arrhythmia morphologies per patient (range 1–3) were observed during the next procedure.

Patients in whom stable SR was obtained showed a significant reduction of arrhythmia-related complaints as assessed by the European Heart Rhythm Association (EHRA) score and a significantly better functional status as assessed by the New York Heart Association (NYHA) classification, accompanied by a reduction of the left atrial dimension and an increase in the left ventricular ejection fraction (Table 4). In contrast, patients in whom arrhythmia persistent showed a trend for left atrial enlargement and reduction of ejection fraction (Table 4).

DISCUSSION

Our study shows that percutaneous ablation of complex left atrial arrhythmias occurring after mitral valve procedures, including valve replacement, is feasible, safe, and at least moderately effective. In our study group, ablation outcomes after PMC did not differ significantly from the outcomes in surgically treated patients. Ablation efficacy did not depend on whether the initially predominant arrhythmia was AF or left atrial AT.

Atrial arrhythmogenic substrate in patients with mitral valve disease may be particularly extensive. This is related to atrial remodelling secondary to the valvular disease, manifested by significant atrial dilatation, and histologically by severe fibrosis [13–15]. In addition, surgical treatment of the valvular disease results scarring and myocardial damage (Fig. 2) [16]. In patients with recurrent atrial arrhythmias, this is also accompanied by electrical remodelling which additionally promotes arrhythmia recurrences [17]. Thus, in most patients with mitral valve disease the arrhythmia becomes persistent or permanent, be it AF or AT. Antiarrhythmic drug therapy in these patients is usually ineffective. At the same time, these patients are relatively uncommonly offered ablation of the arrhythmia substrate due to fears of low effectiveness of such procedures coupled with a risk of major complications [11]. The periprocedural risk seems particularly high in patients with mechanical mitral valve prosthesis, with a possibility of prosthesis damage, catheter entrapment within the prosthesis, and thromboembolic complications [18].

Published data on ablation of atrial arrhythmogenic substrate, mostly of AF, in patients after PMC, are relatively sparse [19–21]. The largest study was published in 2010 and included 20 patients, of whom 10 were treated with ablation. In that population, AF was persistent, and lasted more than a year in 2 patients. In the subgroup treated with ablation, segmental isolation or extensive circumferential ablation of pulmonary vein ostia was performed immediately after PMC. This allowed SR maintenance during on average 4 years of follow-up in 80% of patients. Of note, however, all patients in the ablation subgroup received chronic antiarrhythmic drug therapy which was unsuccessful before ablation. Five patients received amiodarone, including 4 in combination with another drug (propafenone, flecainide or cibenzoline). In comparison, SR was maintained in only 20% of patients in the subgroup treated with only electrical cardioversion and antiarrhythmic drug (including 4 patients on amiodarone) following PMC [21]. This may suggest that the true effectiveness of ablation in such patients in combination with antiarrhythmic drugs is actually about 60%.

Outcomes of percutaneous ablation of atrial arrhythmogenic substrate after MVR were reported for overall about 150 patients. The first study was published in 2005, and 3 larger multicentre American studies were reported in 2012 [22–25]. The study populations varied, as were the

Table 3. Details of ablation procedures

Pts. no.	Arrhythmia	No. of ablations	No. of AT morphologies**	Procedure***	Sinus rhythm restoration at ablation	Duration of procedure [min]***	Duration of RF current applications [min]***	Duration of fluoroscopy [min]***
1	I. AFparox II. ATpers	2	4	4 PVI, linear: CTI*, LA roof*, MIsth*, CFAE (CS, LA)	I. RF II. RF‡	539	130	40
2	AFparox	1		4 PVI, linear CTI*	RF‡	150	28	20
3	I. AFparox II/III. ATpers	3	5	4 PVI, linear: CTI*, LA roof*, MIsth*, CFAE (CS, LA, RA)	I. CVE II. RF III. RF‡	720	179	54
4	I. AFpers 12 m II. AFpers	2		4 PVI, linear: CTI*, LA roof*, MIsth*, CFAE (CS, LA, RA)	I. CVE II. CVE	530	135	43
5	I. ATpers 1 m II. ATpers	2	2	4 PVI, linear: CTI*, LA roof*, MIsth*, CFAE (CS, LA, RA)	I. CVE II. CVE	320	111	49
6	I. ATpers 48 m II/III. ATpers	3	3	Linear LA roof, CFAE LA, CS	I. RF II. Prop III. CVE	440	126	41
7	ATpers	1	2	2 lines LA roof*, CFAE LA, CTI*	RF	240	48	28
8	I. ATpers 12 m II. ATpers	2	6	PVI, linear LA, 1 line CTI*, CFAE LA	I. RF II. RF	400	86	36,7
9	AF/ATpers	2	5	PVI, linear: LA roof*, MIsth* CTI*, CFAE LA	RF	220	70	33
10	I. AT/AFpers II. AT/AFpers	2		PVI, linear: CTI*, LA roof*, MIsth*; CFAE (LA, RA, CS)	I. RF‡ II. Prop	390	104	34
11	ATpers 6 m	1	3	PVI, lines and CFAE in LA, RA and CS	RF	240	75	19
12	ATpers 12 m	1	1	MIsth, CTI*	RF	100	24	8
13	ATpers 6 m	1	1	LA roof	RF	60	8	5
14	I. AF/ATpers II. ATpers	2	4	PVI, linear: CTI*, LA roof*, MIsth*; CFAE (LA)	I. Prop II. RF	210	62	21

*With bidirectional block in the given area; **total number of different morphologies observed during all ablation procedures; ***total of all ablation procedures; †on antiarrhythmic drugs; ‡no arrhythmia was induced after the procedure by rapid atrial pacing; AF — atrial fibrillation; AT — atrial tachycardia; CFAE — complex fractionated atrial electrograms; MIsth — mitral isthmus; CS — coronary sinus ablation; CTI — cavotricuspid isthmus; CVE — sinus rhythm restoration by electrical cardioversion; FU — follow-up; I — first ablation procedure; II — second ablation procedure; LA — left atrium; m — months; parox — paroxysmal; pers — persistent; RA — right atrium; RF — sinus rhythm restoration by radiofrequency current ablation; Prop — sinus rhythm restoration by intravenous propafenone administration; PVI — pulmonary vein isolation

reported ablation techniques, perhaps contributing to the differences in the duration of ablation procedures, fluoroscopy, and RF current application during ablation. Thus, it is difficult to directly compare these results to our findings. In these studies, the mean duration of ablation procedures, fluoroscopy, and RF current application was in the range of 135–199 min, 35–60 min and 50 min, respectively. These values are similar to those obtained in our patients but are larger than parameters reported for AF ablation in patients with less advanced structural heart disease. In the other studies, the proportion of patients with paroxysmal arrhythmia ranged from 40% to 50%, and thus was significantly larger than in our population of patients with mostly persistent or long-persistent arrhythmia. This may also explain a greater efficacy reported after a single procedure and overall, which was up to 49% and 83%, respectively, in the American studies. Literature data

Table 4. Clinical and echocardiographic data depending on ablation success

Pts. no.	NYHA		LA [mm]		LVEF [%]		Outcome	EHRA	Duration of follow-up [months]
	Before ablation	After ablation	Before ablation	After ablation	Before ablation	After ablation			
Patients with successful ablation									
1	3	1	57	55	70	69	SR†	1	37
2	1	1	40	40	66	67	SR	1	46
4	2	1	53	51	66	66	SR	1	33
7	3	1	53	50	62	64	SR	1	44
8	3	1	52	49	60	63	SR†	1	32
9	2	1	54	51	60	62	SR†	1	18
11	2	1	58	55	57	64	SR	1	22
12	2	1	61	57	56	64	SR†	1	15
13	3	1	47	45	60	62	SR	1	14
14	2	2	46	46	68	66	SR†	1	11
Mean			53.5	51.4	62.1	64.9			
SD			6.2	5.2	4.6	2.3			
	p = 0.023		p = 0.017		p = 0.035				
Patients with persistent arrhythmia									
3	2	3	52	54	58	54	AT	3	12
5	2	2	47	52	60	57	AF	2	11
6	3	2	51	54	35	32	AT	3	18
10	3	2	45	47	55	54	†AT	2	10
Mean			48.8	51.8	52	49.3			
SD			3.3	3.3	11.5	11.6			
	p = 0.13		p = 0.067		p = 0.067				

†On antiarrythmic drugs; EHRA — severity of symptoms of arrhythmia in the EHRA scale (score from 0: no symptoms to 4: severe symptoms); NYHA — New York Heart Association functional class; LA — left atrial dimension in the parasternal long-axis view; LVEF — left ventricular ejection fraction; SR — sinus rhythm; AF — atrial fibrillation; AT — atrial tachycardia

indicate that the effectiveness of percutaneous ablation of the arrhythmogenic substrate in patients after invasive treatment of mitral valve disease is lower compared to patients without valvular disease matched for numerous other characteristics [11, 22–25].

In comparison to the control group, patients after MVR significantly more frequently present with baseline or recurrent atypical AFL or AT. Hussein et al. [24] reported these arrhythmias before ablation in as many as 43% of their patients. Also recurrent AT was significantly more common in patients after MVR compared to controls (57% vs. 40%). In our study population, AT was noted before ablation in 50% of patients, exclusively those after surgical treatment (in 7 of 9 patients, 78%). This arrhythmia was also predominant during recurrences and was seen in 5 of 7 patients (71%) in whom more than one ablation procedure was performed. The main reason for this phenomenon is the presence of atrial scarring due to underlying disease, previous surgical valve replacement, or previous ablation of the arrhythmogenic substrate. In combination with such structures as valvular annuli and pulmonary vein ostia, this forms excellent barriers that may allow creation of a reentrant circuit.

Hussein et al. [24] reported that 36% patients in their study group underwent ablation of the arrhythmogenic substrate during MVR. In this group, a return of conduction between pulmonary veins and the atrium was noted in 96% of these patients during percutaneous ablation [24]. A similar phenomenon was observed in our study population. Incomplete isolation of pulmonary veins and/or return of conduction through ablation lines within the atria remain one mechanism of AF recurrence and/or occurrence of AT after surgical ablation. Obtaining good results, particularly in patients with persistent arrhythmia, often requires extensive procedures that include pulmonary vein isolation, linear lesions and ablation of fragmented potentials. Ablation procedures need to be repeated in more than half of patients. Achieving stable

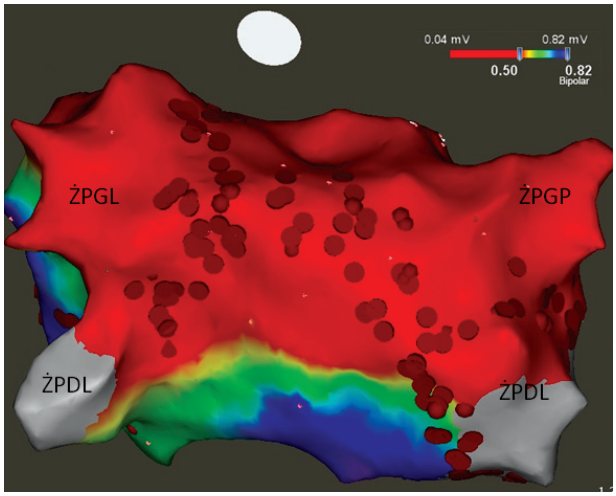

Figure 2. Color-coded voltage map of the left atrium in a patient after mitral valve replacement with simultaneos surgical pulmonary vein isolation. Posterior-anterior view with slight cranial angulation. Note low voltage of atrial potentials (below 0.82 mV, purple), with most areas below 0.5 mV (red), indicating severe atrial damage and corresponding to scar; ŻPDL — lower left pulmonary vein; ŻPGL — upper left pulmonary vein

SR significantly reduces complaints related to the arrhythmia as evaluated using the EHRA score, improves NYHA class, reduces left atrial dimension, and improves ejection fraction.

CONCLUSIONS

Percutaneous catheter ablation of complex left atrial arrhythmias in patients after percutaneous or surgical mitral valve procedures, including MVR, is an effective and safe therapeutic option. Due to the size and complexity of the arrhythmia substrate, extensive ablation procedures are often necessary. Recurrences after the first ablation are frequent and patients may require repeat ablations. Achieving stable SR significantly reduces complaints related to the arrhythmia and improves patient clinical status.

Conflict of interest: *none declared*

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Przezskórna ablacja podłoża złożonych lewoprzedsionkowych zaburzeń rytmu u pacjentów po zabiegach na zastawce mitralnej

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Streszczenie

Wstęp: U pacjentów z wadami zastawki mitralnej często występują złożone arytmie lewoprzedsionkowe, głównie migotanie przedsionków (AF) i częstoskurcze lewoprzedsionkowe (AT). Zarówno zabiegi naprawcze wykonywane na zastawce metodą przezskórną lub chirurgiczną, jak i jej wymiana nie przyczyniają się istotnie do przywrócenia lub utrzymania rytmu zatokowego.

Cel: Celem pracy była ocena skuteczności i bezpieczeństwa ablacji przezskórnej podłoża zaburzeń rytmu prądem o wysokiej częstotliwości w tej grupie pacjentów.

Metody: Badaniem objęto 14 pacjentów (9 kobiet) w średnim wieku 55 ± 11 lat, którzy w przeszłości zostali poddani przezskórnej lub chirurgicznej interwencji na zastawce mitralnej z powodu jej zwężenia lub niedomykalności (przezskórna komisurotomia mitralna: 5 osób; chirurgiczna plastyka zastawki mitralnej: 3; wymiana zastawki mitralnej: 6). Wśród pacjentów leczonych chirurgicznie u 6 wykonano jednocześnie izolację żył płucnych, a u 4 plastykę zastawki trójdzielnej. AF jako jedyna arytmia występowało u 7 pacjentów, w tym u wszystkich 5 po przezskórnej komisurotomii mitralnej (AF napadowe: 2 pacjentów; AF przetrwałe: 4; AF długotrwale przetrwałe: 1). AT dominowały u 7 z 9 osób po zabiegach chirurgicznych (z medianą 2 morfologii na pacjenta), trwając nieprzerwanie od 1 miesiąca do 4 lat przed ablacją. Zabieg ablacji był dostosowany do sytuacji klinicznej i elektrofizjologicznej; obejmował izolację żył płucnych, linie ablacyjne oraz ablację rozfragmentowanych potencjałów. Ablacji AT dokonywano na podstawie analizy aktywacji i odpowiedzi na stymulację.

Wyniki: Skuteczność po jednej ablacji wynosiła 36%. Ostatecznie w całej grupie wykonano łącznie 25 zabiegów, co pozwoliło na utrzymanie stabilnego rytmu zatokowego w okresie 23 ± 13 miesięcy u 10 (71,4%) pacjentów, przy czym u 4 z nich stosowano leczenie antyarytmiczne. U wszystkich 6 osób, u których dokonano uprzedniej chirurgicznej izolacji żył płucnych w trakcie zabiegu na zastawce, zaobserwowano nawrót przewodzenia między przedsionkiem i co najmniej jedną z izolowanych żył. Nie zanotowano różnic dotyczących skuteczności ablacji, niezależnie od tego, czy wyjściowo dominowało zwężenie czy niedomykalność mitralna (skuteczny zabieg odpowiednio u 5 z 8 oraz u 5 z 6 pacjentów; p = 0,57). Podobnie nie stwierdzono różnic w tym zakresie między pacjentami leczonymi uprzednio przezskórnie i chirurgicznie (skuteczna ablacja odpowiednio u 3 z 5 i 7 z 9 pacjentów; p = 0,58), nie miał również znaczenia rodzaj arytmii wyjściowej (skuteczna ablacja u 5 z 7 pacjentów z AF i z AT; p = 1,00). U chorych, u których udało się uzyskać stabilny rytm zatokowy, zaobserwowano istotne zmniejszenie dolegliwości zależnych od arytmii ocenianych w skali EHRA, poprawę wydolności fizycznej ocenianej na podstawie skali NYHA, redukcję wymiaru lewego przedsionka oraz poprawę frakcji wyrzutowej. Z kolei u pacjentów, u których nie udało się usunąć arytmii, zanotowano tendencję do powiększania się lewego przedsionka i obniżania się frakcji wyrzutowej.

Wnioski: Przezskórna ablacja złożonych lewoprzedsionkowych zaburzeń rytmu u pacjentów po zabiegach przezskórnych i chirurgicznych na zastawce mitralnej, w tym po jej wymianie na zastawkę mechaniczną, jest zabiegiem skutecznym i bezpiecznym. Nawroty arytmii po jednej ablacji są częste, co może wymagać przeprowadzenia kolejnych zabiegów. Uzyskanie stabilnego rytmu zatokowego istotnie zmniejsza dolegliwości zależne od arytmii i przyczynia się do poprawy stanu czynnościowego pacjentów.

Słowa kluczowe: migotanie przedsionków, częstoskurcz przedsionkowy, ablacja, wymiana zastawki, przezskórna komisurotomia mitralna

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