Effects of catheter ablation of idiopathic ventricular ectopic beats on left ventricular function and exercise capacity

Jacek Lelakowski, Adam Dreher, Jacek Majewski, Jacek Bednarek

Department of Electrocardiology, Institute of Cardiology, Jagiellonian University *Collegium Medicum*, The John Paul II Hospital, Krakow, Poland

Abstract

Background: Frequent ventricular ectopic beats (VEB) in patients without significant cardiac disease are usually classified as benign arrhythmia. However, they may alter cardiac performance. RF ablation can effectively eliminate VEB.

Aim: To evaluate the effects of RF ablation on selected haemodynamic parameters of left ventricular (LV) systolic and diastolic function and exercise capacity in patients with VEB.

Methods: The study population consisted of 22 patients (8 males, 14 females, mean age 37.8 ± 8.2 years) undergoing effective RF ablation for VEB. Those over 50 years of age, with concomitant cardiovascular disease, depressed global LV function (EF < 50%) and segmental wall motion abnormalities were excluded from the study. All patients underwent at baseline and at 6 months after the procedure: physical examination, standard ECG recording, 24-hour Holter monitoring, transthoracic echocardiography to evaluate LV systolic and diastolic function, and treadmill exercise test using the modified Bruce protocol to evaluate exercise duration, peak heart rate and workload achieved.

Results: NYHA functional class improved in the whole population after RF ablation. The LV end-systolic dimension (LVESD) and end-diastolic dimension (LVEDD) significantly decreased (33.1 ± 4.6 vs. 29.3 ± 3.4 mm and 49.0 ± 5.4 vs. 44.4 ± 2.8 mm, respectively; p < 0.001), whereas LVEF increased (58.0 ± 7.0 vs. 67.8 ± 4.8%; p < 0.001) along with fractional shortening (FS) improvement (34.2 ± 2.4 vs. 37.6 ± 1.4%; p < 0.001). Parameters of LV diastolic function significantly changed: the E/A ratio, diastolic pulmonary vein flow D and LV flow propagation velocity Vp significantly increased (p < 0.001), whereas systolic pulmonary venous flow S and pulmonary venous atrial reversal flow AR were significantly reduced (p < 0.001). Furthermore, E wave deceleration time (EDT) and isovolumetric relaxation time (IVRT) were significantly shortened (p < 0.001). The parameters of exercise capacity (exercise duration, peak heart rate and workload achieved) were increased after the procedure. The following correlation was found: the higher the number of VEB/24 h, the bigger the LVEDD and LVESD (r = –0.69 and r = –0.72, respectively), the longer EDT (r = –0.53), the larger AR (r = –0.51), the slower A and Vp waves (r = 0.56 and r = 0.62, respectively) and the lower EF and FS (r = 0.59 and r = 0.61, respectively). However, all these correlations did not reach statistical significance.

Conclusions: 1. Frequent VEB have a highly negative effect on LV systolic and diastolic function. In patients with VEB ablation improves LV systolic and diastolic function. 2. Exercise capacity improves significantly after RF ablation of VEB. 3. After the procedure NYHA functional class improves irrespective of arrhythmia type. 4. The higher the number of ventricular ectopic beats per day, the larger LV size and the more depressed its systolic and diastolic function.

Key words: ventricular ectopic beats, ablation, left ventricular systolic-diastolic function, exercise capacity

Kardiol Pol 2009; 67: 847-855

Introduction

Ventricular extrasystolic beats (VEB) in individuals without structural heart abnormalities are regarded as a benign ventricular arrhythmia, which in most cases does not require any treatment. However, many patients with numerous VEB complain of severe symptoms (fatigue, palpitations, impaired exercise capacity, chest pain, dizziness and syncope). The following pathologies should be excluded in a differential diagnosis of the causes of VEB: systemic disorders (hyperthyroidism, hypertension), genetic pathologies of ion channels (long QT syndrome, Brugada syndrome, catecholamine-induced tachycardia and others) and heart diseases (myocarditis, coronary artery disease, heart failure, cardiomyopathies, in particular arrhythmogenic right ventricular dysplasia), which can be the underlying cause of the numerous, usually polymorphic VEB. The

Address for correspondence:

Jacek Lelakowski MD, PhD, Klinika Elektrokardiologii, Instytut Kardiologii, Uniwersytet Jagielloński *Collegium Medicum*, Krakowski Szpital Specjalistyczny im. Jana Pawła II, ul. Prądnicka 80, 31-202 Kraków, tel.: +48 12 614 20 00, fax: +48 12 614 25 25, e-mail: jlelakow@szpitaljp2.krakow.pl

Received: 12 January 2009. **Accepted:** 01 April 2009.

presence of numerous, monomorphic VEB or ventricular tachycardia (VT) in ECG or in Holter monitoring with no ST-T segment changes in the baseline ECG after the termination of arrhythmia, and no signs of organic heart disease as assessed with imaging modalities confirm the diagnosis of idiopathic, focal ventricular arrhythmia.

Idiopathic, single VEB and idiopathic VT are regarded as benign ventricular arrhythmias, and the recommended first line pharmacotherapy includes beta-adrenolytics and verapamil. However, in many patients this therapy is ineffective, not tolerated by patients or causes side effects – for example bradycardia.

Guidelines of the Polish Cardiac Society from 2002 recommend ablation [1] in patients with numerous, single VEB with haemodynamic disturbances, which significantly influence the patient's quality of life [2, 3]. Numerous VEB were demonstrated to cause arrhythmic cardiomyopathy – one of the reversible causes of heart failure [4-9].

Ablation of VEB can be performed with the classical method or using a system with electroanatomic mapping of the electrical activity of the heart, such as the CARTO system [10]. The limitation of the CARTO system is the fact that during the ablation procedure the presence of arrhythmia is necessary with the frequency of occurrence high enough to develop the activation map. In the case of localisation of the arrhythmic site in the direct neighbourhood of the His bundle the application of the radio-frequency (RF) current is associated with increased risk of iatrogenic AV or right bundle branch block [11]. Immediate efficacy of the procedure is confirmed by the termination of the spontaneous arrhythmia and non inducibility of arrhythmia during electrophysiological study (EPS) with or without pharmacological provocation with isoproterenol. The efficacy of ablation in idiopathic arrhythmias originating from the right or left ventricular outflow tract (RVOT/LVOT) is over 90% [4-10, 12, 13].

The influence of RF ablation in patients with VEB on physical activity and haemodynamic parameters of systolic and diastolic heart function was assessed only partially and was not clearly determined. Therefore, the aim of the study was to assess the influence of percutaneous RF ablation of ventricular ectopy on selected parameters of systolic and diastolic left ventricular (LV) function and exercise capacity.

Methods

The study population was recruited from 149 consecutive patients (80 males, 69 females), who were referred for RF ablation of symptomatic, persistent, monomorphic VEB between October 2004 and June 2007.

The inclusion criteria were as follows: 1) immediate efficacy of the procedure and no complications during RF ablation; 2) no aggravation of VEB (≥ 1000/24 h) during the 6-month follow-up period; 3) age ≥ 50 years, LV ejection fraction (LVEF) ≥ 50% and no regional wall motion abnormalities in the echocardiographic study prior to the ablation.

The exclusion criteria were: 1) the presence of polymorphic VEB in 24-hour ECG monitoring; 2) co-existence of structural heart diseases: coronary artery disease, myocarditis, congenital heart disease, heart valve disease, cardiomyopathy (including arrhythmogenic right ventricular dysplasia) and the presence of long QT syndrome or other genetic disorders of the heart ion channels determined on the basis of the current diagnostic standards; 3) prior cardiac surgery; 4) hypertension; 5) atrial fibrillation or flutter documented in the ECG, Holter monitoring or induced in the EPS study; 6) heart failure of severity at least class II according to NYHA; 7) the presence of other diseases or chronic symptoms which could influence haemodynamic parameters, exercise capacity, and QT interval, such as: diabetes, hyperthyroidism, other endocrinopathies and metabolic disorders, electrolyte disturbances, acid-base disturbances, neoplastic diseases, locomotor system diseases, chronic diseases of the pulmonary system, anaemia, neurological and psychiatric disorders; 8) the necessity of using antiarrhythmic drugs influencing the QT interval after ablation; 9) conduction abnormalities; 10) severe obesity (poor conditions for the echocardiographic study); 11) poor quality of the images; 12) lack of the control study after 6 months.

Finally, the population which fulfilled such rigorous inclusion and exclusion criteria consisted of 22 patients (8 males, 14 females, age range: 22-50 years, mean: 37.8 ± 8.2) who underwent RF ablation.

Patients' evaluation

All patients were evaluated before the procedure. The following parameters were analysed: a) patient's history (including the time since VEB occurred, the number of antiarrhythmic drugs used before ablation, the number of hospitalisations due to arrhythmia, functional class according to NYHA), b) physical examination, c) normal baseline ECG, d) 24-hour Holter ECG monitoring, e) transthoracic echocardiography (ECHO), f) exercise treadmill test.

Treatment with antiarrhythmic drugs was terminated before all studies at least a 5 times longer period than was the half-life of the drug, and in the case of amiodarone at least 2 months before. All studies were repeated 6 months after ablation. During this period the patient did not take any antiarrhythmic medications.

Ablation of ventricular ectopy using the CARTO system

The procedure was performed using the CARTO electroanatomic mapping system, a monitoring system of the BARD company, a UHS 20-Biotronic diagnostic stimulation unit, and a Stockert-Cordis RF generator. Each procedure was performed using a single mapping/ablation catheter (Navi-Star, 7F), which was introduced into the right ventricle through the right femoral vein, and into the left ventricle through the left femoral artery. An activation map was generated by registration of spontaneous ectopic beats (Figure 1).

The site of RF application was determined on the basis of the earliest activation time. The localisation of the ablation catheter was confirmed by generating QRS complexes with similar morphology in standard 12-lead ECG during RV or LV pacing.

RF application of the energy of 40W was routinely used for 90 s with the maximal temperature of 55°C. The application was terminated immediately when sudden increase of impedance occurred or when catheter dislocation was noticed. In order to confirm success of the ablation, programmed ventricular stimulation in basic condition as well as during isoprenaline infusion was performed. The evaluation was performed 30 min after the end of the procedure. The immediate efficacy of the ablation was confirmed by the regression of spontaneous arrhythmia and no presence of arrhythmias during EPS with or without isoprenaline infusion. Symptoms of irregular heart rhythm and the presence of VEB in standard ECG and in ECG Holter monitoring were analysed during 6-month follow-up. Full success of the procedure after 6 months was defined when the number of VEB was reduced to < 1000/24 h [10]. Precise localisation of VEB is presented in Table I.

Echocardiographic study

Transthoracic echocardiography was performed with the Aloka Prosound α 10 using a 2.5/3.5 MHZ transducer. M-mode (M), two-dimensional (2D) and Doppler images were acquired according to American Society of Echocardiography guidelines [14-19]. Heart chamber dimensions were recorded in M-mode view in the long parasternal projection using the 2D view as a correction. In addition, atrial dimensions were determined in the apical 4-chamber view in the late systole (telesystole).

In order to assess diastolic function, mitral inflow velocity spectrum was assessed using pulse wave Doppler in apical 4-chamber view. Thereafter flow in the right upper pulmonary vein was evaluated – the Doppler gate was placed in the vein 1 cm from the left atrium. Inflow into LV was acquired during held expiration. The final measurements according to the Doppler method were the mean of the results derived from 5 consecutive cardiac cycles. Ale measurements were performed during sinus rhythm with heart rate < 80 beats per min.

The obtained results were used to calculate the following parameters: 1) LV end-diastolic diameter (LVEDD); 2) LV end-systolic diameter (LVESD); 3) LVEF calculated according to Teichholz formula; 4) LV shortening fraction (FS); 5) anterior-posterior diameter of the left atrium (LA--AP) in the parasternal long axis view; 6) superior-inferior diameter (long axis) of LA in the apical 4-chamber view (LA-SI); 7) latero-medial diameter (short axis) of LA in the apical 4-chamber view (LA-LM); 8) superior-inferior diameter (long axis) of the right atrium (RA-SI) in the apical 4-chamber view; 9) latero-medial diameter (short axis) of RA (RA-LM) in the apical 4-chamber view; 10) maximal velocity of the early diastolic filling of LV (E); 11) maximal velocity of the atrial-dependent LV filling (A); 12) deceleration time (DT) calculated as the interval between peak velocity of the E wave and the crossing point of the descending curve of the E wave spectrum with the null line; 13) isovolumetric relaxation time (IVRT) – calculated on the basis of simultaneous registration of the closing of aortic and mitral valve. The Doppler gate was placed between the LV inflow and outflow tract; 14) systolic and diastolic velocity of the flow in the pulmonary veins (S and D); 15) velocity of the reverse flow in the pulmonary vein (AR); 16) mitral inflow propagation velocity (Vp) measured in the apical 4-chamber view in M-mode using colour Doppler.

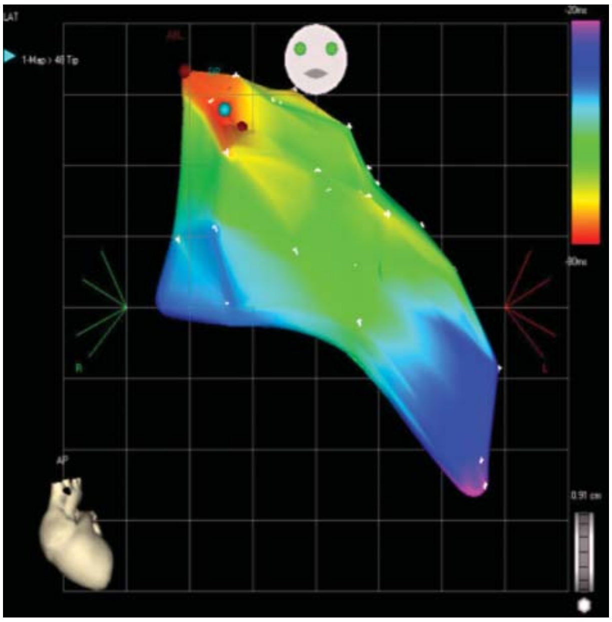

Figure 1. Activation map of the right ventricle performed using the CARTO system from ectopic beats originating from the outflow tract. Red dots represent sites of successful RF applications. Red colour represents the area with the earliest activation

Table I. Localisation of ventricular extrasystolic beat (VEB) sites

Localisation of VEB	Number of patients, n (%)
Right ventricular outflow tract (RVOT)	12 (54.5)
Left ventricular outflow tract (LVOT)	6 (27.3)
Right ventricular free wall (RVFW)	4 (18.2)

Exercise test

Symptom-limited maximal exercise test on a treadmill was performed according to the modified Bruce protocol [20]. Each patient performed a short run-in test at least 1 day before the proper one. The study was performed according to American Heart Association (AHA) guidelines [21]. The following parameters of the exercise test were analysed: 1) test duration; 2) maximal heart rate reached; 3) maximal workload calculated according to Wasserman formula [20]: Work [W] = B × (2.05 × V + 0.29 × V × G – 2.8)/10.5; where: B – body weight [kg], V – velocity of the march [km/h], G – treadmill grade [%].

Statistical analysis

Data are presented as means ± SD or as numbers and percentages. Continuous variables were compared using the T-test – for comparisons within one group the test for paired samples was used. Nonparametric data (categorical data) were compared using the χ^2 test.

A p-value < 0.05 was considered statistically significant for all tests. Associations between analysed parameters were evaluated using the correlation coefficient.

Table II. Changes in NYHA class

Change in NYHA class	Patients with VEB n (%)
II – 0	1 (25.0)
II – I	3 (75.0)
II – II (no change)	0 (0)
I – 0	12 (92.3)
I – I (no change)	1 (8.5)
0 – 0 (no change)	5 (100.0)
Change of 2 classes	1 (4.5)
Change of 1 class	15 (68.2)
No change	6 (27.2)

Percentages were calculated in relation to the number of patients in each NYHA class

Table III. Number of VEB/24 h and the number of RF applications

	VEB before ablation	VEB after ablation	No. of RF applications
Min	2000	0	2
Max	30 000	756	25
Mean ± SD	13 333 ± 7755	175 ± 228	9.81 ± 6.93

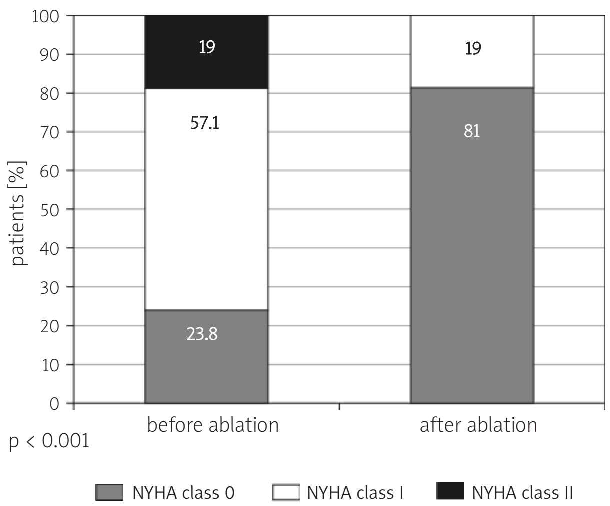

Figure 2. Distribution of NYHA classes before and after ablation

Results

According to patients' history arrhythmias were present in the study group for a mean of 8.7 ± 4.1 years (range: 1 to 17 years). Patients were treated with 1 to 4 (mean 2.7 ± 1.2) antiarrhythmic drugs and the mean number of hospitalisations due to arrhythmia ranged from 0 to 3 (mean 1.0 ± 1.0). Changes in patients' functional class according to NYHA after ablation are presented in Table II and Figure 2.

Differences in the distribution of the classes according to NYHA were highly significant (p < 0.001). Out of 17 patients with heart failure symptoms prior to the procedure, an improvement in functional class according to NYHA was observed in 16. In no patient was aggravation of heart failure symptoms observed.

Number of VEB and RF applications

The number of VEB and applications performed during RF ablation are presented in Table III.

No retrograde activation of the atria after extrasystolic beats was observed. Nor was a significant difference observed between coupling interval of the ectopic beat with the leading rhythm. The mean number of monomorphic ectopic beats decreased from 13 333 before the procedure to 175 per 24 h. No ventricular tachycardia or polymorphic ectopic beats were observed.

Echocardiographic study

Changes in the echocardiographic parameters are presented in Table IV. Significant decrease of LVEDD and LVESD was observed (in 77% and 77% respectively). Also significant improvement of LV systolic and diastolic function was observed: [EF (86%), FS (86%), E (77%), A (68%), EDT (64%), IVRT (73%), S (77%), D (68%), AR (73%), Vp (86%)] (the percentages presented in parentheses represent patients with improvement). The dimensions of RA and LA did not change significantly.

The qualitative assessment after ablation revealed that 63.9% of patients had improvement of all studied parameters, aggravation of symptoms was observed in 16.3%, and in 19.8% the follow-up analysis revealed no changes (p < 0.05).

Table IV. Changes in echocardiographic parameters after ablation

	Before ablation	After ablation	Before ablation	After ablation	Before ablation	After ablation	Before ablation	After ablation	Before ablation	After ablation
	AS [1/min]		LVEDD [mm]		LVESD [mm]		EF [%]		FS [%]	
Min	65	65	39	38	25	24	50	59	30	35
Max	78	75	55	50	38	37	70	75	39	40
Mean ± SD	70.5 ± 4.0	70.3 ± 3.4	49.0 ± 5.4	44.4 ± 2.8	33.1 ± 4.6	29.3 ± 3.4	58.0 ± 7.0	67.8 ± 4.8	34.2 ± 2.4	37.6 ± 1.4
p	NS		< 0.001		< 0.001		< 0.001		< 0.001	
	E [m/s]		A [m/s]		E/A		EDT [ms]		IVRT [ms]	
Min	0.55	0.6	0.49	0.55	1.00	1.00	150	160	70	70
Max	1.00	1.00	0.85	0.84	1.20	1.19	295	240	110	100
Mean ± SD	0.70 ± 0.13	0.75 ± 0.12	0.63 ± 0.12	0.70 ± 0.09	1.10 ± 0.08	1.04 ± 0.07	232 ± 45	207 ± 20	91 ± 13	81 ± 7
p	< 0.001		< 0.001		NS		< 0.001		< 0.001	
	S [m/s]		D [m/s]		S/D		AR [m/s]		LA-AP [mm]	
Min	0.35	0.34	0.35	0.35	0.90	0.80	0.12	0.13	30	30
Max	0.66	0.61	0.60	0.63	1.30	1.20	0.28	0.22	43	42
Mean ± SD	0.54 ± 0.09	0.49 ± 0.07	0.48 ± 0.07	0.51 ± 0.07	1.11 ± 0.13	0.96 ± 0.09	0.21 ± 0.05	0.17 ± 0.02	36.2 ± 3.0	35.5 ± 2.8
p	< 0.001		< 0.001		< 0.001		< 0.001		NS	
	LA-SI [mm]		LA-LM [mm]		RA-SI [mm]		RA-LM [mm]		Vp [m/s]	
Min	28	28	35	34	30	30	33	32	0.2	0.31
Max	39	39	50	50	38	38	49	49	0.47	0.48
Mean ± SD	34.9 ± 3.3	34.7±3.4	44.4 ± 5.0	44.1 ± 4.8	34.0 ± 2.2	33.8 ± 2.3	42.9 ± 4.9	42.8 ± 4.6	0.35 ± 0.09	0.42 ± 0.05
p	NS		NS		NS		NS		p < 0.001	

Abbreviations: see Methods section

Exercise test

In all patients the reason for test termination was fatigue with dyspnoea. No VT was observed. Changes in exercise test parameters are presented in Table V. After ablation significant improvement in all studied parameters was observed. The qualitative assessment after ablation showed improvement in all studied parameters in 97.2% and no changes in 2.8% (p < 0.001).

Analysis of correlation between number of VEB with changes of haemodynamic parameters and exercise capacity after ablation

No significant correlation between changes of the studied parameters of systolic and diastolic LV function and exercise capacity was observed. Only a trend toward a correlation between some changes in echocardiographic parameters after ablation and the number of VEB/24 h was found (Figure 3). However, this association did not reach statistical significance.

Discussion

RF ablation is an established method of treatment of VEB, especially in cases resistant to pharmacotherapy. Ablation leads to relief of arrhythmia and decrease of the number of hospitalisations, enables discontinuation of antiarrhythmic medications, and improves patients' quality of life [1, 22]. Common parameters used for the evaluation of the efficacy of treatment of cardiovascular diseases are haemodynamic parameters of systolic and diastolic LV function and parameters assessing exercise capacity. So far, only a few studies have evaluated the influence of RF ablation on these parameters in patients with VEB [4-9, 23]. Moreover, there are no studies with such rigorous inclusion and exclusion criteria in a population of young patients (aged < 50 years) with VEB who have undergone ablation. Therefore, it motivated us to perform the current study.

Percutaneous ablation of the site of arrhythmia in patients with VEB or with idiopathic VT originating from RVOT have been performed for many years. The classic

Table V. Changes of exercise capacity parameters after ablation

	ET-t [min]		Max. HR [min^{-1}]		Workload [W]	
	before ablation	after ablation	before ablation	after ablation	before ablation	after ablation
Min	8	11.9	110	125	50.6	160
Max	15	16.5	180	180	180	290.8
Mean ± SD	11.1 ± 2.3	14.3 ± 1.5	134.1 ± 18.6	155.3 ± 14.9	126.7 ± 44.3	215.7 ± 46.5
p	< 0.001		< 0.001		< 0.001	

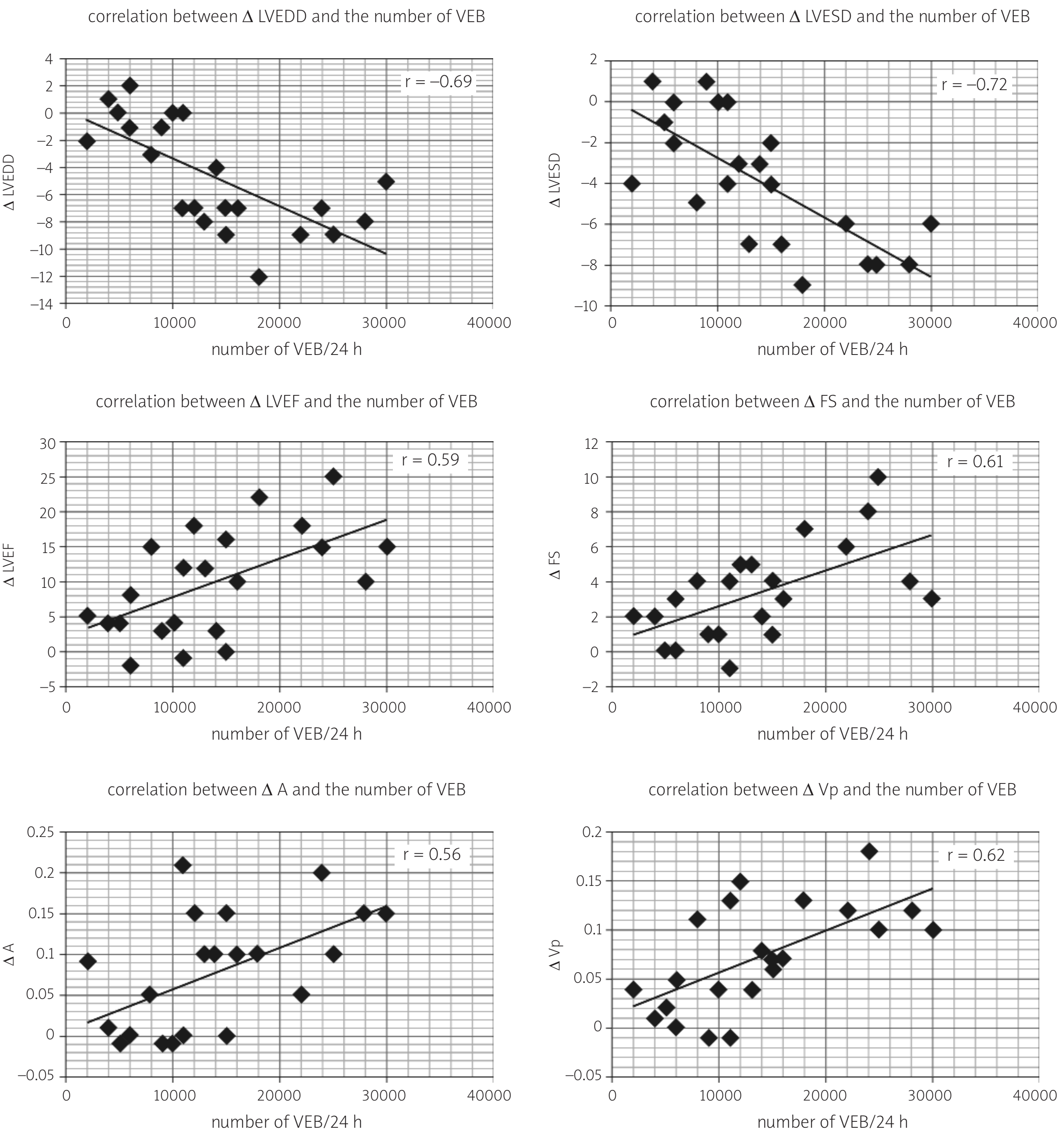

Figure 3. Correlations between number of VEB/24 h and changes in echocardiographic parameters

method is based on the identification of the site of the earliest activation with subsequent performance of pacemapping. Three-dimensional electroanatomic mapping generated using the CARTO system enables much more precise localisation of the arrhythmia origin site, which should lead to increased success rate and safety of the procedure [4, 13].

The current study had a prospective character. Its aim was to assess the influence of the termination of VEB with RF ablation on the haemodynamic parameters and exercise capacity during a 6-month follow-up period. On the basis of the available data from literature, it was assumed that this period is sufficient for reaching a stable benefit after treatment of cardiovascular diseases. Moreover, the decision to choose such a period was supported by the long history of arrhythmia in the studied population. It was taken as a rule that long lasting disease requires longer time for full recovery. This was demonstrated in the assessment of atrial remodelling in patients with atrial fibrillation. The longer is the history of arrhythmia before cardioversion, the longer does it take to recover LA mechanical function [24].

In the case of ventricular arrhythmias the severity of symptoms usually depends on the severity and the incidence of haemodynamic abnormalities caused by arrhythmia. During ventricular bigeminy sudden and alternating changes of stroke volume are observed, as well as increased stroke volume by sinus beat following VEB, blocked sinus beats or atrial contraction with closed atrioventricular valves. Mitral inflow into LV during diastole prior to the VEB is decreased. During VEB the aortic valve opens, but stroke volume is significantly diminished. Szumowski et al. [8] observed during VEB and VT increase of LV volume and decreased LVEF as well as stroke volume. The impairment of LV filling is caused both by shortened time of ventricular filling and, more importantly, by abnormal atrial function – their retrograde activation.

In our study the mean duration of arrhythmia prior to ablation was 8.7 years. Patients in the studied population were treated without success using a mean of 3 antiarrhythmic medications before they were referred for invasive treatment. In the whole group of patients after the procedure significant improvement of cardiovascular system function according to NYHA class was observed. Six months after ablation a significant decrease in the number of VEB per 24 h was observed. After ablation improvement of the analysed parameters of systolic and diastolic LV function was observed (in 63.9% of patients an improvement was observed for all studied parameters). The dimensions of RA and LA remained unchanged and were in the normal reference range. It should be underlined that in the studied population we did not observe retrograde atrial activation after VEB. According to the analysis of the results evaluating the influence of ablation on the haemodynamic parameters a beneficial effect of discontinuation of antiarrhythmic medications after the performed procedure cannot be excluded. We observed no correlation between the analysed parameters of haemodynamic function and exercise capacity. Therefore, we are unable to conclude whether the observed improvement was caused by demonstrated improvement of systolic or diastolic LV function. This is in concordance with the current concept, according to which LV function assessed by EF and stroke volume does not correlate with exercise capacity [22, 25, 26]. Observed improvement of exercise capacity in the published studies after ablation could be a result of the increased physical activity after the procedure. The anxiety caused by the possibility of aggravation of the irregular heart rate or the triggering of VT could be a possible psychological factor leading to limitation of everyday activity [22]. It should be underlined that the tendency for aggravation of VEB was observed at rest and in some patients a decrease of VEB during physical activity was noticed. Similar results were provided by Stec et al. [6].

Limitations of the study

Limitations of the study include the relatively small number of studied patients and incomplete assessment of LV systolic function. We did not use tissue Doppler imaging and we did not perform assessment of the E/E' ratio. Currently tissue Doppler imaging should be used for the evaluation of diastolic function [17, 27], but it was not performed in the present study.

Conclusion

Successful RF ablation of idiopathic VEB leads to the improvement of exercise capacity, NYHA class and echocardiographic parameters of LV function.

References

1. Świątecka G (ed.). Standardy postępowania w elektroterapii serca. Sekcja Stymulacji Serca i Elektrofizjologii Klinicznej Polskiego Towarzystwa Kardiologicznego. *Folia Cardiol* 1999; I (Suppl. 1): 59-71.
2. Standardy PTK. Komorowe zaburzenia rytmu. http://www.ptkardio.pl/standardy.
3. Świątecka G (ed.). Miejsce przezskórnej ablacji prądem o częstotliwości radiowej w leczeniu zaburzeń rytmu serca. Standardy postępowania w elektroterapii serca. *Kardiol Pol* 1999; 50 (Suppl. 1): 58-69.
4. Pruszkowska-Skrzep P, Kalarus Z, Średniawa B, et al. Effectiveness of radiofrequency catheter ablation of right ventricular outflow tract tachycardia using the CARTO system. *Kardiol Pol* 2005; 62: 138-44.
5. Pytkowski M, Maciąg A, Sterliński M, et al. Lokalizacja ogniska arytmii u chorych z zaburzeniami rytmu serca pochodzącymi z drogi odpływu prawej komory. *Folia Cardiologica Excerpta* 2006; 13: 494-502.
6. Stec S, Walczak F, Kułakowski P, et al. Spoczynkowa bigeminia z drogi odpływu prawej komory – leczenie ablacją RF. *Kardiol Pol* 2003; 58: 505-10.
7. Sterliński M, Pytkowski M, Maciąg A, et al. Radiofrequency catheter ablation in patients with focal ventricular arrhythmias. *Kardiol Pol* 2002; 57: 1-14.
8. Szumowski Ł, Walczak F, Bodalski R, et al. Ustawiczny częstoskurcz komorowy z lewej zatoki Valsalvy. *Kardiol Pol* 2003; 59: 363-9.
9. Walczak F, Szumowski Ł. Częstoskurcz z drogi odpływu prawej komory wyzwalany wysiłkiem u chorej ze sprawnym przewodzeniem wstecznym – problem diagnostyczny i terapeutyczny. *Kardiol Pol* 2002; 56: 668-72.
10. Wnuk-Wojnar AM, Trusz-Gluza M, Czerwiński C, et al. Catheter ablation of ventricular tachycardia with the use of CARTO system in patients with ischaemic cardiomyopathy. Preliminary results. *Kardiol Pol* 2002; 56: 415-22.
11. Kaźmierczak J. Powikłania badania elektrofizjologicznego serca i ablacji. Zapobieganie i leczenie. In: Lubiński A, Trusz-Gluza M, Walczak F (eds.). Podręcznik elektrofizjologii klinicznej. *Via Medica*, Gdańsk 2007; 69-76.
12. Lubiński A, Trusz-Gluza M, Walczak F (eds.). Podręcznik elektrofizjologii klinicznej. *Via Medica*, Gdańsk 2007.
13. Trusz-Gluza M, Wnuk-Wojnar AM, Czerwiński C. Czy elektroanatomiczne mapowanie serca systemem CARTO poprawia skuteczność ablacji w zaburzeniach rytmu serca. *Kardiol Pol* 2002; 56: 649-54.

14. Cohen GI, Pietrolungo JF, Thomas JD, et al. A practical guide to assessment of ventricular diastolic function using Doppler echocardiography. *J Am Coll Cardiol* 1996; 27: 1753-60.
15. Kasprzak JD, Drożdż J, Krzemińska-Pakuła M. Nieinwazyjna ocena zaburzeń funkcji rozkurczowej. Co nowego? *Kardiol Pol* 1995; 43: 439-43.
16. Kasprzak JD, Krzemińska-Pakuła M. Echokardiografia dopplerowska w ocenie funkcji rozkurczowej komór serca. *Kardiol Pol* 1994; 40: 46-51.
17. Rydlewska-Sadowska W (ed.). Echokardiografia kliniczna. *PZWL*, Warszawa 1991.
18. Rossvoll O, Hatle LK. Pulmonary venous flow velocities recorded by transthoracic Doppler ultrasound: relation to left ventricular diastolic pressures. *J Am Coll Cardiol* 1993; 21: 1687-96.
19. Quiñones MA, Otto CM, Stoddard M, Waggoner A, et al. Recommendations for quantification of Doppler echocardiography: a report from the doppler quantification task force of the nomenclature and standards committee of the American Society of Echocardiography. *J Am Soc Echocardiogr* 2002; 15: 167-84.
20. Wasserman K, Hansen JE, Sue DY, et al. Principles of exercise testing and interpretation. 2nd ed. *Lea & Febiger*, Philadelphia 1994.
21. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training. A statement for healthcare professionals from the American Heart Association. *Circulation* 2001; 104: 1694-740.
22. Zipes DP, Camm AJ, Borggrefe M, et al. ACC/AHA/ESC 2006 guidelines for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death – executive summary. *Eur Heart J* 2006; 27: 2099-140.
23. Kowalska A, Łoboz-Grudzień K, Sokalski L, et al. Dopplerowska ocena czynności rozkurczowej lewej komory w chorobie niedokrwiennej serca. *Kardiol Pol* 1999; 50: 525-9.
24. Mattioli AV, Castelli A, Andria A, et al. Clinical and echocardiographic features influencing recovery of atrial function after cardioversion of atrial fibrillation. *Am J Cardiol* 1998; 82: 1368-71.
25. Franciosa JA, Park M, Levine TB. Lack of correlation between exercise capacity and indexes of resting left ventricular performance in heart failure. *Am J Cardiol* 1981; 47: 33-9.
26. Ponikowski P, Szełemej R, Banasiak W, et al. Znaczenie mechanizmów obwodowych w niewydolności krążenia. *Kardiol Pol* 1997; 47: 332-8.
27. Podolec P, Tracz W, Hoffman P (eds.). Echokardiografia praktyczna. *Medycyna Praktyczna*, Kraków 2005.

Wpływ leczenia ektopii komorowej metodą ablacji RF na funkcję skurczową i rozkurczową mięśnia lewej komory serca i wydolność wysiłkową chorych

Jacek Lelakowski, Adam Dreher, Jacek Majewski, Jacek Bednarek

Klinika Elektrokardiologii, Instytut Kardiologii, Uniwersytet Jagielloński *Collegium Medicum*, Krakowski Szpital Specjalistyczny im. Jana Pawła II

Streszczenie

Wstęp: Ablacja RF jest uznaną metodą niefarmakologicznego leczenia niemiarowości w postaci ektopii komorowej (VEB).

Cel: Ocena wpływu leczenia VEB metodą ablacji RF na wybrane parametry hemodynamiczne funkcji skurczowej i rozkurczowej mięśnia lewej komory (LV) i wydolność wysiłkową chorych.

Metody: Badana populacja obejmowała 22 chorych (8 mężczyzn, średni wiek 37,8 ± 8,2 roku), u których wykonano skuteczną ablację RF VEB. U wszystkich chorych wykonano ablację ogniska VEB. Do badań nie kwalifikowano osób powyżej 50. roku życia, ze współistniejącymi chorobami układu sercowo-naczyniowego lub innymi schorzeniami przewlekłymi, istotnie upośledzoną globalną kurczliwością LV (frakcja wyrzutowa – EF < 50%) i odcinkowymi zaburzeniami kurczliwości. Wszystkich chorych poddano badaniom przed zabiegiem oraz 6 miesięcy po jego wykonaniu. Zastosowano następujące metody: 1) badanie podmiotowe i przedmiotowe, 2) standardowy zapis powierzchniowy EKG, 3) 24-godzinne badanie EKG metodą Holtera, 4) przezklatkowe badanie echokardiograficzne z oceną parametrów funkcji skurczowej i rozkurczowej LV oraz wymiarów jam serca, 5) test wysiłkowy na bieżni wg zmodyfikowanego protokołu Bruce'a z oceną parametrów: czas trwania testu, częstotliwość rytmu serca na szczycie wysiłku i pokonane obciążenie. Analizę statystyczną przeprowadzono, posługując się testem t-Studenta dla danych liczbowych oraz testem χ^2 dla danych nieparametrycznych. Za poziom istotności przyjęto $p < 0,05$.

Wyniki: Po ablacji obserwowano istotną poprawę wg klasyfikacji NYHA w całej populacji. W badanej grupie stwierdzono istotne zmniejszenie wymiaru końcowoskurczowego (LVESD) i końcoworozkurczowego LV (LVEDD) (33,1 ± 4,6 *vs* 29,3 ± 3,4 mm i 49,0 ± 5,4 *vs* 44,4 ± 2,8 mm; p < 0,001), przyrost EF (58,0 ± 7,0 *vs* 67,8 ± 4,8%; p < 0,001) oraz frakcji skracania wymiaru poprzecznego LV (FS) (34,2 ± 2,4 *vs* 37,6 ± 1,4%; p < 0,001). W zakresie parametrów funkcji rozkurczowej LV stwierdzono istotny wzrost maksymalnej prędkości fali E, A, rozkurczowej napływu płucnego D, propagacji napływu LV Vp (odpowiednio: p < 0,001) oraz istotne zmniejszenie prędkości fali skurczowej napływu płucnego S, wstecznego napływu płucnego AR (p < 0,001). Ponadto rejestrowano istotne skrócenie czasu deceleracji fali E (EDT) oraz rozkurczu izowolumetrycznego (IVRT) (p < 0,001). Stwierdzono istotną poprawę (p < 0,001) wszystkich badanych parametrów wydolności wysiłkowej, tj. czasu trwania wysiłku, maksymalnej częstotliwości rytmu serca na szczycie wysiłku oraz obciążenia. Stwierdzono zależność (korelację r) polegającą na tym, że im większa była ilość VEB w ciągu doby, tym większe wymiary LVEDD i LVESD (odpowiednio: r = –0,69 i r = –0,72), dłuższy czas EDT (r = –0,53), większa fala zwrotna napływu płucnego AR (r = –0,51), mniejsze prędkości fal A i Vp (odpowiednio: r = 0,56 i r = 0,62) oraz niższa EF i FS (odpowiednio: r = 0,59 i r = 0,61).

Wnioski: 1. Ekstrasystolia komorowa upośledza funkcję skurczową i rozkurczową LV, a po skutecznej ablacji RF następuje jej poprawa. 2. Po ablacji wykazano istotną poprawę wydolności wysiłkowej. 3. Obserwowano poprawę wydolności układu krążenia ocenianej na podstawie klasyfikacji NYHA. 4. Im większa była ilość ekstrasystolii komorowej w ciągu doby, tym większe wymiary LV i bardziej upośledzona jej funkcja skurczowo-rozkurczowa.

Słowa kluczowe: ektopia komorowa, ablacja, funkcja skurczowo-rozkurczowa lewej komory, wydolność wysiłkowa

Kardiol Pol 2009; 67: 847-855

Adres do korespondencji:

dr hab. n. med. Jacek Lelakowski, Klinika Elektrokardiologii, Instytut Kardiologii, Uniwersytet Jagielloński *Collegium Medicum*, Krakowski Szpital Specjalistyczny im. Jana Pawła II, ul. Prądnicka 80, 31-202 Kraków, tel.: +48 12 614 20 00, faks: +48 12 614 25 25, e-mail: jlelakow@szpitaljp2.krakow.pl

Praca wpłynęła: 12.01.2009. **Zaakceptowana do druku:** 01.04.2009.