Parametry echokardiograficzne przedsionków w przewidywaniu nawrotu migotania przedsionków badanego u pacjentów z dwujamowym stymulatorem serca

Atrial echocardiographic parameters as predictors of atrial fibrillation recurrence examined in patients with dual-chamber pacemaker

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Streszczenie

Wstęp. Migotanie przedsionków (AF) jest najczęstszą arytmią w naszej populacji, przy tym z dużą częstością nawrotów. Celem pracy była ocena przydatności parametrów echokardiograficznych lewego (LA) i prawego (RA) przedsionka w przewidywaniu nawrotu AF po kardiowersji elektrycznej (CV). *Materiał i metody.* Badaniem objęto 60 pacjentów z implantowanym dwujamowym stymulatorem serca i zachowaną funkcją skurczową lewej komory (LV), u których wykonano CV z powodu przetrwałego AF. Badanie echokardiograficzne wykonywano 7 dni po CV u pacjentów z rytmem zatokowym. Za nawrót AF uznawano epizod AF ≥ 30 min zarejestrowany w pamięci holterowskiej stymulatora. *Wyniki.* Analizowano wyniki uzyskane w grupie 52 chorych w średnim wieku 75 ± 8 lat, którzy utrzymali rytm zatokowy przez 7 dni po AF. W echokardiografii stwierdzono powiększenie obu przedsionków: średni wymiar LA wynosił 46 ± 4 mm, pole powierzchni LA 29±4 cm^2, a pole powierzchni RA 26 ± 4 cm^2. W czasie 12-miesiecznej obserwacji arytmia nawróciła u 47 (90%) osób: u 28 pacjentów nawrót AF stwierdzono w czasie 7-30 dni po CV, a u 19 chorych w okresie 31 dzień-1 rok po CV. U pacjentów, którzy utrzymali rytm zatokowy w czasie 12-miesięcznej obserwacji stwierdzono większą frakcję opróżniania LA (p<0,01) oraz większą zmianę pola powierzchni RA (p = 0,01). *Wnioski.* U pacjentów z powiększeniem przedsionków większa frakcja opróżniania LA i większa zmiana pola powierzchni RA mogą wskazywać na mniejsze ryzyko nawrotu AF po CV. *Geriatria 2015; 9: 73-78.*

Słowa kluczowe: migotanie przedsionków, prawy przedsionek, lewy przedsionek, echokardiografia

Abstract

Background. Atrial fibrillation (AF) is the most common arrhythmia with frequent relapses. The study aimed to assess the importance of left atrial (LA) and right atrial (RA) echocardiographic parameters in predicting AF recurrence after electrical cardioversion (CV). *Material and methods.* The study included 60 patients with dual-chamber pacemaker and preserved left ventricular function, who had underwent CV due to persistent AF. Echocardiographic examination was performed 7 days after CV in patients with sinus rhythm. During follow-up AF recurrence lasting ≥ 30 min detected by pacemaker logs was taken into consideration. *Results.* Analysis included 52 patients in the mean age of 75 ± 8 years who remained in sinus rhythm 7 days after CV. Echocardiography revealed enlarged both atria: the mean LA diameter was 46 ± 4 mm, LA area was 29 ± 4 cm^2, and RA area was 26 ± 4 cm^2. During 12-month observation AF recurred in 47 (90%) patients: in 28 patients AF relapsed within 7-30 days after CV, and in 19 patients between 31 days and one year after CV. Among echocardiographic parameters LA emptying fraction

(P < 0.01) and RA fractional area change (P = 0.01) were higher in patients who remained in sinus rhythm one year after CV. ***Conclusions.*** In patients with enlarged atria higher LA emptying fraction and higher RA fractional area change may indicate lower risk of AF recurrence after CV. *Geriatria 2015; 9: 73-78.*

Keywords: atrial fibrillation, left atrium, right atrium, echocardiography

Introduction

Atrial fibrillation (AF) is the most frequent arrhythmia observed in clinical practice, with higher occurrence particularly in elderly subjects. This arrhythmia leads to changes in electrophysiological parameters and structural remodeling of atria, which may promote AF recurrence or its progression to permanent AF. Knowledge of the factors that predict recurrence of the arrhythmia may be useful in making therapeutic decisions. In our study performed in patients with preserved left ventricular (LV) systolic function and dual-chamber pacemaker implanted who underwent electrical cardioversion (CV) due to persistent AF, we indicated that brain natriuretic peptide (BNP) level of 700 fmol/mL or higher 7 days after CV was predictive of AF recurrence during 12 months of follow-up [1]. We also found that baseline neopterin level was significantly higher in these patients compared to the control group of healthy subjects, however it was not predictive of AF recurrence [2].

In the present study performed in the same group of patients we aimed to assess whether evaluation of echocardiographic parameters of left atrium (LA) and right atrium (RA) can be useful in predicting AF recurrence. Contemporary pacemakers have unique diagnostic functions, which are very useful to monitor cardiac rhythm and enable very precise evaluation of AF occurrence in the examined subjects.

Methods

The study included patients with persistent AF and no significant LV systolic dysfunction referred for planned CV [1,2]. All patients had a dual-chamber pacemaker implanted which had diagnostic functions allowing to register AF episodes (including intracardiac electrograms recordings). The exclusion criterion comprised: moderate or severe LV systolic dysfunction - left ventricular ejection fraction (LVEF) < 45% diagnosed in echocardiographic examination carried out before CV, clinically significant valve disease or prosthetic valve, NYHA class III or IV heart failure, myocardial infarction, unstable angina, PCI or CABG surgery within 3 months or acutely reversible causes of AF. The study protocol was approved by the local Bioethical Commission and all patients expressed written consent to participation in the study.

Electrical cardioversion was performed under conscious sedation with a use of direct-current biphasic shock (Medtronic Physio-Control Lifepak 20E). The initial shock energy was 100 J, and it was increased to 200 J, and 200 J was repeated in case of CV failure. Shocks were applied with paddles localized in anterolateral position at least 10-15 cm away from the pacemaker can. Cardioversion was regarded successful if sinus rhythm persisted within one hour after CV.

Patients were examined within 24 hours before CV, and then 24 hours and 7 days after CV. Apart from the medical history and physical examination, the pacemaker was controlled with detailed analysis of its data logs and stored electrograms. Chronic kidney disease was recognized if the glomerular filtration rate, estimated by the Cockroft-Gault formula, was below 60 mL/min in two consecutive examinations. Patients with an episode of AF within the first 7 days after CV were excluded from the analysis.

Follow-up examinations were carried out 1, 3, 6 and 12 months after CV, with interrogation of the pacemaker data logs and detailed analysis of intracardiac electrograms. An episode of AF ≥ 30 min recorded in the pacemaker memory was considered as recurrence of arrhythmia. Depending on the time of AF occurrence, the patients were divided into 3 groups: group 1 – AF occurrence within 30 days after CV, group 2 – AF recurrence between 31 days and one year after CV, and group 3 – no AF during one year observation after CV.

Echocardiographic examinations were carried out 7 days after CV in patients with sinus rhythm, using a commercially available instrument (Vivid 3, GE Healthcare, USA) with a 3.5 MHz phased array transducer. The measurements were performed in accordance with the recommendations of the Echocardiographic Section of the Polish Cardiological Association [3]. The LV end-systolic and end-diastolic volumes were calculated from the 2- and 4-chamber

apical views, and then the LVEF was calculated by the Simpson's biplane method [4]. Special attention was paid to atrial parameters: LA diameter (in parasternal long axis view), LA area and RA area (measured by planimetry in the 4-chamber view at end systole), left atrial (LAFAC) and right atrial fractional area change (RAFAC), LA and RA volume, left atrial (LAEF) and right atrial emptying fraction (RAEF). Maximum left atrial area (LAAmax) and volume (LAVmax) were measured in apical 4-chamber view in the final phase of ventricular systole, just before opening of the mitral valve. Minimum LA area (LAAmin) and volume (LAVmin) were measured in the same view in the final phase of ventricular diastole, after atrial systole. LAFAC was determined as the quotient of the difference between the maximum and minimum LA area and maximum LA area and expressed as percentage: [(LAAmax – LAAmin)/LAAmax] x 100%). LAEF was computed as the quotient of difference of maximum and minimum LA volume and maximum LA volume expressed as percentage: [(LAVmax – LAVmin)/LAVmax] x 100%). Measurement of the maximal and minimal RA volume, maximal and minimal RA area was performed in the same manner in the apical 4-chamber view, and subsequently RAFAC and RAEF were calculated. On the basis of mitral and tricuspid inflow analysis, the maximum velocity, velocity time integral (VTI) and duration of mitral and tricuspid A-wave were measured.

Statistical analysis

The data are presented as mean values ± standard deviation, as the number and percentage of patients, or median values with the 1st and 3rd quartile [Q_I; Q_{III}] (interquartile range). Variables with normal distribution were compared using the t-Student test, and otherwise, the U Mann-Whitney test was used to compare independent variables. The Kruskall-Wallis test or the one-way ANOVA was used to compare the variables between the group 1, 2, and 3 of patients with different time of the first AF recurrence after CV. STATA software (version 12.1, STATACorp) was used to calculate statistics. $P < 0.05$ was considered statistically significant.

Results

The study involved 60 patients with persistent AF in whom successful CV was performed. There were no complications related to CV or anesthesia,

nor pacemaker malfunction after CV. Cardioversion was successful in all patients, however in 8 patients AF recurred within the first week after CV, and those subjects were excluded from further analysis.

Clinical characteristic of the investigated 52-person group is shown in Table I. The patients' mean age was 75 ± 8 years, and there were 47 patients (90%) aged ≥ 65 years. Twenty eight patients had dual-chamber pacemaker implanted due to sinus node disease, and 24 due to second or third degree atrio-ventricular block. In the vast majority of patients (88%) arterial hypertension was diagnosed. Echocardiographic examination revealed mean LVEF of 55 ± 5% (46-65%), and atrial enlargement: mean LA diameter 46 ± 4 mm (40-53 mm), LA area 29 ± 4 cm² (21-41 cm²), and RA area 26 ± 4 cm² (18-36 cm²).

Table I.   Clinical characteristics of patients from the study group (N = 52)

Age (years)	75 ± 8 (54-90)
Gender: males	30 (58)
BMI (kg/m²)	28 ± 4 (20-42)
AF history (years)	3.5 [QI 0.9; QIII 9.5]
Arterial hypertension	46 (88)
Coronary artery disease	18 (35)
Heart failure	22 (42)
Diabetes	19 (36)
Chronic obstructive pulmonary disease	8 (15)
Chronic kidney disease	23 (44)

Antiarrhythmic drugs
    Class 1
    Class 3
    Beta-blockers
ACEI or ARBs
Statins
	7(14)
	22(42)
	41(79)
	34(65)
	44(85)

Data presented as: number (%) where appropriate. ACEI – angiotensin converting enzyme inhibitors; ARBs –angiotensin II receptor blockers

In the studied population 47 patients had AF recurrence after CV. In 28 patients arrhythmia occurred in the first month after CV (group 1), and in 19 patients between 31 days and one year (group 2). Only in 5 patients (group 3) AF did not relapse within the one--year observation after CV. Table II shows comparison of echocardiographic parameters in the three patient groups with different time of AF occurrence after CV. Significantly higher LAEF and RAFAC was observed

Table II. Echocardiographic characteristics of patients depending on time of the first atrial fibrillation (AF) recurrence after electrical cardioversion (CV)

Variable	Group 1: AF ≤ 30 days after CV (N = 28)	Group 2: AF between 31 days and 1 year after CV (N = 19)	Group 3: no AF within 1 year after CV (N = 5)	p
Left ventricular end-diastolic diameter [mm]	51 ± 4	51 ± 5	52 ± 3	0.5
Left ventricular ejection fraction [%]	54 ± 6	55 ± 5	58 ± 6	0.4
LA diameter [mm]	47 ± 3	46 ± 3	48 ± 5	0.2
LA maximal area [cm^2]	29 ± 4	28 ± 4	31 ± 5	0.4
LA fractional area change [%]	28 ± 6	29 ± 6	33 ± 7	0.3
LA maximal volume [ml]	78 ± 13	73 ± 12	84 ± 11	0.2
LA emptying fraction [%]	34 ± 4*	38 ± 5	39 ± 6*	< 0.01
Interventricular septum diameter [mm]	10.5 ± 0.7	10.7 ± 1.2	11.5 ± 1.2	0.2
Posterior wall diameter [mm]	10 ± 0.7	11 ± 1.1	11 ± 1.2	0.8
Mitral A-wave maximal velocity [m/s]	0.6 ± 0.3	0.5 ± 0.2	0.5 ± 0.1	0.6
Mitral A-wave velocity time integral [cm^2]	7 ± 3	6 ± 2	6 ± 2	0.5
Mitral A-wave duration [ms]	188 ± 40	176 ± 32	189 ± 42	0.6
Posterior wall diameter [mm]	10 ± 0.7	11 ± 1.1	11 ± 1.2	0.8
Right ventricular diameter [mm]	27 ± 3	26 ± 3	28 ± 2	0.6
RA maximal area [cm^2]	25 ± 4	26 ± 4	27 ± 5	0.4
RA fractional area change [%]	30 ± 5	26 ± 5#	33 ± 6#	0.01
RA maximal volume [ml]	69 ± 15	70 ± 12	75 ± 16	0.5
Tricuspid A-wave maximal velocity [m/s]	0.3 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.3
RA emptying fraction [%]	35 ± 5	36 ± 5	37 ± 2	0.8
Tricuspid A-wave velocity time integral [cm^2]	5 ± 2	5 ± 2	6 ± 1	0.3
Tricuspid A-wave duration [ms]	189 ± 37	187 ± 27	204 ± 23	0.5

LA – left atrium, RA – right atrium; Post-hoc Tukey test: * – P < 0.05, # – P < 0.05

in the group of patients with no AF recurrence after CV. In these patients LAEF was 39 ± 6%, just like in the group without AF for 30 days after CV: 38 ± 5%, while in the subjects with AF recurrence within a month - only 34 ± 4% (P < 0.01; Table II). RAFAC was 33 ± 6% in patients with no AF relapse, 26 ± 5% in patients with no AF for 30 days after CV, and 30 ± 5% in those with AF relapse within one month after CV (P < 0.01; Table II). No differences were found in the other echocardiographic parameters between the groups of patients with different time of AF recurrence after CV.

Discussion

In the present study carried out among elderly patients with preserved LV systolic function referred for CV due to persistent AF we found that additional assessment of RAFAC, and especially LAEF during echocardiographic examination may be helpful in predicting AF recurrence. Higher LAEF may indicate lower risk of AF relapse, despite the enlargement of the atria found on the basis of the assessment of standard atrial echocardiographic parameters.

It is worth emphasizing that our study involved patients with implanted dual-chamber pacemaker, which – thanks to unique diagnostic functions of contemporary pacemakers – made it possible to determine precisely the time of AF occurrence. However, the strict criterion of arrhythmia relapse we adopted (AF ≥ 30 min detected by pacemaker data logs) may explain the high AF recurrence rate in our study.

There are many studies which point out the prognostic importance of LA size in predicting the risk of AF, cardiovascular incidents, myocardial infarction, heart failure and total mortality [5]. The Framingham study

stressed frequent occurrence of AF and stroke in patients with enlarged LA [6-7]. Greater LA volume also indicates the risk of AF occurrence in elderly persons [8-9]. It is emphasized that the anterior-posterior dimension of LA evaluated in parasternal long axis view is not sufficient to precisely determine the size of LA [10-11]. It is so because LA enlargement may be asymmetric, i.e. lateral-medial or superior-inferior, and then the measurement in the anterior-posterior axis does not fully reflect the size of LA, especially if it is enlarged [10]. In our work, apart from the routine LA measurement in the parasternal view and LA area and volume in the apical view, we also measured LAEF. The LAEF evaluation applied in our study allows to determine the volume of blood passively propelled to the LV in the initial phase of mitral inflow, and blood actively transported as a result of LA systole [11]. LAEF depends not only on ventricular compliance but also on atrial systole. In our previous work [3] performed in 51 patients from the same group we found that LA emptying fraction < 38% was an independent predictor of AF recurrence after CV. In a study by Okcun et al. [12], LA emptying fraction >30% was related to maintaining sinus rhythm in 6 months' observation, however it was assessed by means of transoesophageal echocardiography.

In our patients considerable LA and RA enlargement was found, and it may explain why none of the standard atrial echocardiographic parameters could predict AF recurrence. Perhaps the use of other techniques, like tissue Doppler imaging would be helpful, but it was not performed in our patients.

Limitations of the study

One limitation of the study is definitely the low number of patients who maintained sinus rhythm over 12 months of observation after CV. In our study we did not analyze the LV diastolic function, and tissue Doppler examination was not performed.

Conclusions

In patients with enlarged atria none of standard atrial echocardiographic parameters allowed to predict the recurrence of AF over one year after CV. In these patients higher RA fractional area change, and especially higher LA emptying fraction may indicate lower risk of AF recurrence

Conflict of interest
None

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