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Diastolic dysfunction as a prognostic factor of atrial fibrillation relapses after sinus rhythm restoration with electrical cardio version

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ABSTRACT

Background: Atrial fibrillation has a high morbidity and mortality rate. It is the most common cardiac arrhythmia in humans. Restoring sinus rhythm by electrical cardio version is a first-line treatment of paroxysmal and persistent atrial fibrillation. Despite advances in the treatment strategies of patients with atrial fibrillation, the risk of recurrences one year after rhythm restoration is still over 50%.

Methods: This prospective study enrolled 150 patients with long-standing atrial fibrillation undergoing electrical cardioversion in Paul Stradins Clinical University Hospital. Anamnestic data was based on interviews and medical records. Standard transthoracic echocardiography was performed before electrical cardio version.

One year after sinus rhythm restoration with electrical cardio version using medical records and interview information about atrial fibrillation paroxysm during follow up period were obtained. At the end of follow up period was recorded electrocardiogram (ECG) for all patients.

Results: Normal diastolic function was found in 84(56%) patients, impaired relaxation, or dysfunction grade I in 45(30%), pseudo normalization or grade II in 21(14%), and there were any patients with dysfunction grade III. Statistically significant difference was found in atrial fibrillation relapses between patients with and without diastolic dysfunction (p 0.01).There were 47 patients with abnormal E/e′ (>8). 26 patients had atrial fibrillation relapse in one year after sinus rhythm restoration and it was not detected in 21 patients (p 0.04). In group with normal E/e′ (≤ 8) was 105 patients-18 with relapse and 85 without detected atrial fibrillation paroxysm (p>0.05).

Conclusion: Diastolic dysfunction and E/e′ are independent risk factors associated with atrial fibrillation recurrence after successful rhythm control attempt with electrical cardio version.

Keywords: Atrial fibrillation, Electrical cardio version, Diastolic dysfunction, Relapse

INTRODUCTION

Atrial fibrillation is the most common type of arrhythmia affecting up to 12% of the population over 60 years of age, increasing in prevalence with rising age. It is characterized by uncoordinated atrial activation that can lead to embolic complications and reduction in cardiac output resulting in significant morbidity, mortality, and impaired quality of life. It is associated with a 1.5 to 1.9 fold higher risk of death (Lakshminarayan et al., 2006). By the year of 2050 the incidence of atrial fibril-

lation is estimated to be 2.5 fold increased. By this time two percent of the whole population will suffer from this disease, a relative increase of 150% until 2060 (Lane et al., 2017).

The major complications of atrial fibrillation are thromboembolic events ranging from stroke to mesenteric ischemia and acute limb ischemia (Menke et al., 2010).

In order to avoid complications and reduce symptoms, atrial fibrillation can be converted, restoring normal heart rhythm, by using drugs or a controlled electrical shock. From current clinical experience, pharmacological cardioversion is the preferred strategy in patients presenting with recent onset atrial fibrillation (within 48 hours). Electrical cardioversion is the recommended strategy in case of prolonged atrial fibrillation (Knoka et al., 2018).

Direct current cardioversion is one of the most effective means of converting atrial fibrillation into sinus rhythm. However, not all attempts at cardioversion are successful, and at one year after cardioversion approximately 50% of patients again contract atrial fibrillation (Knoka et al., 2018).

Complete shock failure and immediate recurrence are estimated to occur in approximately 25% of patients undergoing electrical cardioversion, and sub-acute or early recurrences occur within 2 weeks in another 25% (Gelder et al., 1999).

Preservation of sinus rhythm after successful cardioversion remains a challenge for clinicians. Despite the use of antiarrhythmic drugs and serial cardioversions, the rate of AF recurrence remains high in the first year. Current evidence suggests that diastolic dysfunction, which is associated with atrial volume and pressure overload, may be a mechanism underlying the perpetuating cycle of AF recurrence following successful electrical cardioversion (Rowlens et al., 2012).

MATERIALS AND METHODS

Study Population

This prospective study enrolled 150 patients with long-standing atrial fibrillation undergoing electrical cardioversion in Paul Stradins Clinical University Hospital, Department of Arrhythmology. The study was started in March 2018 and completed in March 2019. The design of the study was reviewed and approved by the institutional review board committee at Riga Stradins University. All patients with long-standing atrial fibrillation receiving anticoagulation with warfarin (target INR 2 to INR 3) or direct oral anticoagulants for at least 3 weeks before elective cardioversion were screened and those with unsuccessful sinus rhythm restoration were excluded from the study.

Study Design

All demographic, electrocardiographic and echocardio-

graphic data and subsequent clinical outcomes were recorded in prepared questionnaires.

Anamnestic data was based on interviews and medical records. Data obtained by the questionnaire included atrial fibrillation paroxysm duration, co-morbidities such as arterial hypertension, diabetes mellitus, heart failure, stroke and chronic kidney disease, previously used medications including antiarrhythmic drugs and anticoagulants.

Electrocardiographic data was collected from electrocardiograms 24 hours, 6 and 12 months after electrical cardioversion for each patient. Standard transthoracic echocardiography was obtained for all patients before rhythm restoration.

Electrical cardioversion was performed by a cardiologist under general anesthesia. An ECG, blood pressure and oxygen saturation were controlled during procedure. Position of paddles was anterio-posterior. Biphasic defibrillators were used to perform electrical cardioversion. The energy ranged from 150 J to 360 J.

One year after sinus rhythm restoration with electrical cardioversion using medical records and interview information about atrial fibrillation paroxysm during follow up period was obtained. At the end of follow up period were recorded ECG for all patients.

Echocardiographic Assessment

Echocardiographic evaluation of diastolic function is important factor in the risk stratification of arrhythmia recurrence after electrical cardioversion. Assessment of diastolic function involves integration of multiple echocardiographic parameters (Rosenberg et al., 2012).

The latest recommendations for assessment of left ventricular diastolic function are practical and simple to implement in daily practice, and these recommendations are mainly based on six parameters: E wave, E/A ratio, septal or lateral e′, average E/e′, left atrial volume indexed, and peak tricuspid regurgitation velocity. In patients with atrial fibrillation one parameter in diastolic function assessment is missing. Since there are no p waves, not possible to acquire E/A ratio (Kossaify et al., 2019).

In our study each participant underwent pulsed-wave Doppler examination of mitral inflow and Doppler tissue imaging of the mitral annulus. Additionally, we measured left atrium volume index, peak tricuspid regurgitation velocity and ejection fraction.

Grading of diastolic dysfunction was classified as follows: grade I, impaired relaxation and decreased suction of the LV; grade II, pseudo normalization, increased stiffness of the LV, and possible elevated filling pressure; and grade III, restrictive filling with elevated filling pressure and noncompliant LV (Nagueh et al., 2009).

Statistical Analysis

Statistical analysis Statistical software SPSS (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 23.0. Chicago, United States) was used for data analysis.

Continuous variables were presented as mean ± standard deviation or median (25%-75% interquartile), and categorical variables were reported as frequencies and percentages. Fisher's exact test or Chi-square analysis was done as appropriate to compare the frequencies of categorical variables.

Our null hypothesis was analyzed, that there is no significant difference between relapse of atrial fibrillation and deceleration time and E. For figuring out, whether any association between atrial fibrillation relapse and diastolic function parameters exists, the Man-Whitney U-test was performed. We chose this nonparametric test for our null hypothesis, as it can be used for non-normally distributed variables (Nachar et al., 2008). Furthermore, it was statistically analyzed, if an association exists between the relapse of atrial fibrillation after electrical cardioversion and the P deceleration time and E and we hypothesized that there is no statistical significance. For proving the null hypothesis in that case, the Mann-Whitney U-test was performed as well. A two tailed p-value of 0,05 was regarded to be statistically significant.

RESULTS

Patient baseline characteristics are shown in Table 1. All enrolled patients before electrical cardioversion received anticoagulants. The usage duration was at least three weeks for all anticoagulants.

Table 1: Baseline characteristic.

Characteristic	Total (N=150)
Age, mean ± SD (max; min)	65.3 ± 9.2 (33; 84)
Age group, n (%)	
<45	4(3)
45-65	68(45)
>65	78(52)
Male sex, n (%)	104(69)
Height, cm ± SD (max; min)	174 ± 9,6 (155;197)
Weight, kg ± SD (max; min)	92 ± 17,9 (55;140)
BMI ± SD (max; min)	30,2 ± 5,0 (21;48)
Risk factors and comorbidities, n (%)	
Arterial hypertension	
Grade I	44(29)
Grade II	100(67)
Grade III	4(3)
Total	148(98)
Congestive heart failure	119(79)
Diabetes	25(17)
Prior myocardial infarction	23(15)
Percutaneous coronary intervention	39(26)
Stroke	21(14)
COPD, bronchial asthma	17(11)
Current smoking	71(47)
Echocardiographic characteristic	
Ejection fraction	
Preserved ≥ 50%	128(85)
Mid range 40%-49%	17(11)
Reduced <40%	5(4)
LAVI, n(%)	
≤ 34 ml/m^2	53(35)
>34 ml/m^2	97(65)
Left ventricular hypertrophy, n (%)	
Mild	63(42)
Moderate	14(9)
Severe	3(2)
Duration of paroxysm, n (%)	
<30 days	14(9)
30-90 days	68(45)
90-180 days	17(11)
>180 days	40(27)
Unknown	11(7)

The most common anticoagulants were NOAC-rivaroxaban was used in 61 cases (41%) and dabigatran used 42 patients (28%). Warfarin usage was found in 46 cases (31%).

All enrolled patients underwent electrical cardioversion. The success rate after a single discharge was 87.3%. Two electrical shocks were required for 9.3% of patients and 3.3% of patients benefited from a third shock. Initial discharge was 150 J in 10% of all patients. In 76.7% of patients 200 J were used, 300 J were used for 6% of patients and 360 J for 3.3% of patients.

Normal diastolic function was found in 84(56%) patients, impaired relaxation, or dysfunction grade I in 45(30%), pseudo normalization or grade II in 21(14%), and there were any patients with dysfunction grade III. Recurrence of atrial fibrillation in dependence of diastolic function one year after sinus rhythm restoration with electrical cardioversion is shown in Table 2.

Statistically significant difference was found in atrial fibrillation relapses between patients with and without diastolic dysfunction (p 0.01).

There were 47 patients with abnormal E/e′ (>8). 26 patients had atrial fibrillation relapse in one year after sinus rhythm restoration and it was not detected in 21 patients (p 0.04). E/e′ and atrial fibrillation relapse distribution are shown in Table 3.

In group with normal E/e′ (≤ 8) were 105 patients-18 with relapse and 85 without detected atrial fibrillation paroxysm (p>0.05).

DISCUSSION

Atrial fibrillation relapse after sinus rhythm restoration is still common problem. There are some prognostic factors which are used to predict sustainability of sinus rhythm. To improve prognosis of atrial fibrillation relapse more sensitive parameters are required.

Diastolic function might be an important tool in risk stratification for arrhythmia. It is associated with increased myocardial fibrosis and ventricular stiffness. Moreover, diastolic function evaluation belongs to standard echocardiography examination protocol.

In this this study we focused on diastolic dysfunction to predict risk of atrial fibrillation relapse more sufficient.

Till now risk stratification of atrial fibrillation relapse mostly are based only on one echocardiographic parameter left atrial volume index. Enlargement of left atrium is an indicator of irreversible changes of myocardium.

Diastolic dysfunction can be detected in the early stage of these changes so that this parameter is more sensitive and can be found before severe changes in left atrium myocardium.

We hypothesized that E/e′ and diastolic functions are independent risk factors of atrial fibrillation relapse after sinus rhythm restoration with electrical cardioversion.

Analyzing recurrence of atrial fibrillation in patients with and without diastolic dysfunction we found that relapse risk increases with diastolic dysfunction grade. Patients with grade I and grade II had more common relapses in comparison with normal diastolic function.

Moreover, isolated E/e′ represents a reliable noninvasive surrogate for LV diastolic pressures.

The study demonstrates acceptable difference in atrial fibrillation relapse in patients with or without abnormal E/e′. Moreover, relapse is more common in patients with higher E/e′.

Transthoracic Doppler echocardiographic examination is commonly performed to define the diastolic ventricular function since it is widely available, noninvasive, and inexpensive with respect to other diagnostic imaging modalities. Diastolic function parameters might improve risk stratification for atrial fibrillation relapse after sinus rhythm restoration. This parameter should be included in everyday practice in combination with another risk stratification factors.

Table 2: Diastolic function and atrial fibrillation relapse.

Diastolic function	With relapse N, (%)	Without relapse N, (%)	Total
Normal	15(18)	69(82)	84
Impaired relaxation	15(33)	30(67)	45
Pseudo normalization	14(67)	7(33)	21

Table 3: E/e′ and atrial fibrillation relapse.

E/e′	With relapse	Without relapse	Total
9	3	9	12
10	6	7	13
11	1	0	1
12	9	3	12
13	7	2	9

CONCLUSION

Diastolic function parameters might improve risk stratification for atrial fibrillation relapse after sinus rhythm restoration. The study demonstrates acceptable difference in atrial fibrillation relapse in patients with or without abnormal E/e′. Furthermore, patients with higher E/e′ are more likely to relapse.

CONFLICT OF INTEREST

None

FUNDING

None

ETHICAL STATEMENT

I declare, on behalf of all authors, that the research was conducted according to Declaration of Helsinki.

INFORMED CONSENT

I declare, on behalf of all authors, that informed consent was obtained from all patients participating in this study.

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