EVALUATION OF THE ECHOCARDIOGRAPHIC PARAMETERS IN PAROXYSMAL AND PERSISTENT ATRIAL FIBRILLATION

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Abstract: *Echocardiography is the imaging technique mostly used in clinical cardiology practice, occupying a particular place in detecting and confirming certain diagnoses in cardiology, bringing useful information on cardiac structure and function. Currently, it is the primary imaging technique in cardiology and due to its skills (anatomical and functional diagnosis, noninvasive, accessible, easily repeatable, cost-effective), the use of echocardiography has grown increasingly in investigating the cardiac patients. The purpose of this research, conducted in the Cardiology Clinic within the County Clinical Emergency Hospital of Sibiu, was to study the dynamics of the contractile function of atrial myocardium after cardioversion, in order to assess the influence of left atrial size and its reservoir function (correlation between the ejection fraction of the left atrium and its maximum systolic volume), in successfully restoring and maintaining sinus rhythm performed by two methods of treatment, electrical cardioversion and drug conversion, as well as the assessment of pulmonary vein size in paroxysmal and persistent atrial fibrillation and their evolution after the conversion. The association between EF and the systolic maximum volume of the left atrium (left atrial reservoir function) is a closer indicator in terms of relapse rate in the patients with atrial fibrillation. Recurrences of atrial fibrillation are more common in the patients with EF <50% and a maximum systolic volume of the LA > 40 ml, the lowest rate of recurrence being recorded in the patients who were diagnosed with atrial fibrillation presenting EF ≥ 50% and with a maximum systolic volume of the LA < 40ml. Relapse rate is higher in the patients who were diagnosed with atrial fibrillation and had dilated PV compared with the patients who have been diagnosed with atrial fibrillation and with normal diameter of the pulmonary veins.*

Cuvinte cheie: *fibrilația atriala, ritm sinusal, vene pulmonare, funcția de rezervor, atriul stâng, fracție de ejecție*

Rezumat: *Ecocardiografia este cea mai utilizată tehnică imagistică în practica clinică cardiologică, ocupă un loc particular în depistarea și confirmarea anumitor diagnostice în cardiologie, ea aducând informații utile referitoare la structura și funcția cardiacă. În momentul actual ea reprezintă principala tehnică imagistică în cardiologie iar datorită calităților sale (diagnostic anatomic și funcțional, neinvazivă, accesibilă, ușor repetabilă, cost – eficiență bun), utilizarea ecocardiografiei s-a extins din ce în ce mai mult în investigarea pacienților cardiaci. Scopul acestei cercetări, efectuată în Clinica de Cardiologie a Spitalului Clinic Județean de Urgență Sibiu, a fost studierea dinamicii funcției contractile a miocardului atrial după cardioversie, pentru evaluarea influenței dimensiunilor atriului stâng și a funcției de rezervor a acestuia (corelația între fracția de ejectie a atriului stâng și volumul maxim sistolic a acestuia), în reușita restabilirii și menținerii ritmului sinusal efectuată prin două metode de tratament, conversie electrică și conversie medicamentoasă, precum și aprecierea dimensiunilor venelor pulmonare în fibrilația atrială paroxistică și persistentă și evoluția acestora după realizarea conversiei. Asocierea între FE a atriului stâng și volumul maxim sistolic al atriului stâng (funcția de rezervor a atriului stâng) reprezintă un indicator mai fidel în ceea ce privește rata recidivelor la pacienții cu fibrilație atrială. Recurențele fibrilației atriale sunt mai frecvente la pacienții care prezintă FE<50% și un volum sistolic maxim al AS>40 ml, cea mai mică rată a recurențelor fiind la pacienții care au fost diagnosticați cu fibrilație atrială si care prezintă FE≥50% și un volum sistolic maxim al AS<40ml. Rata recidivelor este mai mare în cazul pacienților care au fost diagnosticați cu fibrilație atrială și prezentau VP dilatate în comparație cu pacienții care au fost diagnosticați cu fibrilație atrială și aveau diametrul VP în limite normale.*

INTRODUCTION

Echocardiography occupies a particular place in detecting and confirming certain diagnoses in cardiology. Currently, it is the primary imaging technique in cardiology and due to its skills (anatomical and functional diagnosis, noninvasive, accessible, easily repeatable, cost-effective), the use of echocardiography has grown increasingly in investigating the cardiac patients.

Echocardiography is the imagining technique mostly used in clinical cardiology practice, bringing useful information on cardiac structure and function. This technique has a direct influence on the diagnosis and therapeutic management of the assessed patient, allowing dictating the therapeutic decisions, the assessment of the response to the initial therapy and last but not least, it can deliver appropriate predictive data on patients' outcomes.

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It has been well demonstrated that atrial remodelling is a time dependent process that develops such as an adaptive mechanism of cardiac myocytes to maintain cell homeostasis against stress factors. The type and extent of remodelling depends on the strength and duration of exposure to the "stressful factor". The most frequent stressors of atrial myocytes are: tachycardia and overload (especially in heart failure).(2)

PURPOSE

The purpose of this research, conducted in the Cardiology Clinic within the County Clinical Emergency Hospital of Sibiu, was to study the dynamics of the contractile function of atrial myocardium after cardioversion, in order to assess the influence of left atrial size and its reservoir function (correlation between the ejection fraction of the left atrium and its maximum systolic volume), in successfully restoring and maintaining sinus rhythm performed by two methods of treatment, electrical cardioversion and drug conversion, as well as the assessment of pulmonary vein size in paroxysmal and persistent atrial fibrillation and their evolution after the conversion.

METHODS

Onset transthoracic ultrasound allowed the detection of organic cardiac pathology, the evaluation of the contractile function of the atrial and ventricular myocardium, valvular insufficiency degree, the existence or not of the left atrial thrombus. Bidimensional ultrasound has been recorded in parasternal incidence long and short axis and in apical incidence with 2 to 4 chambers. For each patient, transthoracic ultrasound has been performed in the same standard sequence, respectively on the onset, on checkups carried out at 3 months, 6 months, 12 months or as needed. Atria size and implicitly the dimension of the left atrium have a questionable value in terms of conversion to sinus rhythm in atrial fibrillation, as well as in maintaining this pace. Left atrial diameter was determined in accordance with the existing guidelines and with the echocardiographic recommendations, measuring the maximum distance between the posterior wall of the aortic root and the left atrial posterior wall in end systole.

RESULTS

204 patients were evaluated, being divided into 2 groups; first group consisted of 149 cases, diagnosed with paroxysmal atrial fibrillation; the second group consisted of 55 cases diagnosed with persistent atrial fibrillation. The group I was subdivided into two groups, the first consisting of 79 patients with left atrial diameter less than 45 mm, and the second group consisted of 70 cases that had left atrial diameter less than 45 mm.

After sinus rhythm restoration, the duration of maintaining this rate in the patients of group I was as follows:

- 3 months later, 74 patients (93.67%) out of 79 patients maintained sinus rhythm;
- 6 months later, 68 of the 79 patients (86.07%) maintained sinus rhythm;
- 12 months later, 62 patients of the 79 patients (78.48%) maintained sinus rhythm.

The patients in group II, according to the duration of maintaining the sinus rhythm, recorded the following distribution:

- 3 months later, 65 cases (92.85) of the 70 cases maintained sinus rhythm;
- 6 months later, 60 patients (85.72) of the 70 patients have maintained sinus rhythm;
- 12 months later, of the 70 patients, 53 (75.71%) patients maintained sinus rhythm

Studying the results, it can be observed that at the check-ups made at 3, respectively 6 months, the relapse rate in the patients with paroxysmal atrial fibrillation is closer in the patients with LA<45 mm compared with those with LA ≥ 45 mm.

At12 month check up, the relapse rate is significantly higher in the patients with LA ≥ 45 mm.

The specialized literature mentioned studies that supported that in the patients with paroxysmal atrial fibrillation, recurrences are more frequent when the left atrial diameter is increased considerably. Dethy and collaborators have argued that LA diameter> 45 mm has an important value in predicting the frequency of atrial fibrillation recurrences, this one having a sensitivity of 66% and a specificity of 61%, being mentioned a SR duration <6 months regarding the LA size ≥ 45 mm. [1]. Although the prognostic value of this parameter is questionable, however its influence on the duration of sinus rhythm can not be denied.(3)

The patients in group II were also divided according to left atrial size in 2 groups. Group I consisted of 31 patients with LA diameter <45 mm, and group II was made up of 24 patients diagnosed with persistent AF and LA ≥ 45 mm in diameter. The duration of sinus rhythm in the patients in group I was as follows:

- 3 months later, 28 patients (90,32%) maintained sinus rhythm.
- 6 months later, of the 31 patients, 26 (83,87%) maintained sinus rhythm.
- 12 months later, 20 cases (64,52%) maintained sinus rhythm.

The distribution of cases in group II, according to the duration of sinus rhythm at check-ups had the following results:

- 3 months later, of the 24 patients, 20 patients (83,33%) succeeded in maintaining sinus rhythm.
- 6 months later, 19 patients (79,16%) maintained sinus rhythm.
- 12 months later, 14 cases (58,33%) maintained sinus rhythm.

The results obtained showed that for persistent AF, left atrial size has an influence on maintaining sinus rhythm. Notice that upon all check-ups, the relapse rate was significantly higher in the patients who had the diameter of the LA ≥ 45 mm.

Research on echocardiographic indices (left atrial volume, left atrial ejection fraction), aimed at highlighting certain associations between these factors responsible for the successful conversion of atrial fibrillation to sinus rhythm and preventing the recurrence of cardiac arrhythmias. Most studies on atrial fibrillation took into account either the diameter of the left atrium or the ejection fraction thereof. Left atrial reservoir function is a correlation between left atrial volume and left atrial ejection fraction. With the help of this, one can determine more accurately the involvement the ultrasound data have on maintaining sinus rhythm in the patients with atrial fibrillation.

In our study, in order to assess the involvement of the left atrial reservoir function in maintaining sinus rhythm in the patients with paroxysmal or persistent atrial fibrillation a total number of 134 patients were followed. Bidimensional ultrasound was recorded in long and short axis parasternal incidence and in apical incidence with 2 to 4 chambers. By ultrasound, left atrial size was determined, while the left atrial ejection fraction was calculated by Simpson method.

Left atrial ejection fraction was calculated by the well-known formula:

$$\textbf{EF} = \frac{\text{End-diastolic volume} - \text{End-systolic volume}}{\text{End-diastolic volume}}$$

The patients were divided into 2 groups: group I comprised 75 patients with EF < 50%, and group II consisted of 59 patients with EF ≥ 50%. Each group was divided into 2 groups:

- group I includes patients with EF <50% and end-systolic maximum volume of LA ≤ 40ml: 41 cases;
- group II comprises patients with EF < 50% and end-systolic maximum volume of LA > 40ml: 34 cases;
- group III comprises patients with EF ≥ 50% and end-systolic maximum volume of LA ≤ 40ml: 33 cases;
- group IV comprises patients with EF ≥ 50% and end-systolic maximum volume of LA >4 0ml: 26 cases.

At the checkups carried out at 12 months, the results regarding the maintenance of sinus rhythm related to left atrial reservoir function has the following representation:

- 27 patients (65,85%) of group I maintained sinus rhythm;
- regarding the group II, 16 patients (47,06%) maintained sinus rhythm;
- in group III, 28 patients (84,84%) maintained sinus rhythm.
- 19 patients (73,08%) in group IV maintained sinus rhythm.

The results obtained showed that the patients in group III had the highest rate of maintaining sinus rhythm 12 months after conversion, the worst result being recorded in the patients belonging to group II. Thus, we can say that in the patients who have EF ≥ 50% and a maximum volume of LA ≤40ml, fewer recurrences have been registered. The patients with EF <50% and a maximum volume of LA > 40ml present a higher risk of recurrence of atrial fibrillation which is why these patients should be monitored more closely, especially in terms of ultrasound in order to assess the evolution of cardiac remodelling after sinus rhythm restoration.

Recently, clinical electrophysiology studies have suggested that ectopic potentials arising mainly from the pulmonary veins play an important part in the initiation and perpetuation of atrial fibrillation. However, the mechanisms underlying the focal arrhythmogenic activity of pulmonary veins is not fully understood. To visualize the pulmonary veins, we performed echocardiography using the apical window with 4 and 5 chambers and short axis parasternal left window. In case of our study we considered a dilated pulmonary vein only if it presents an ostial diameter exceeding 14 mm.

In our study, we analyzed the pulmonary vein size in 204 patients, as well as the influence that they have in maintaining sinus rhythm after conversion in the patients with paroxysmal and persistent atrial fibrillation. Depending on the patients' left atrial diameter, we recorded the following values: 110 patients with LA < 45 mm, 94 patients with LA ≥ 45 mm. The relation between left atrial diameter and pulmonary vein diameter showed that the 110 patients who had LA < 45 mm, had pulmonary veins with a normal diameter, while in those 94 patients with LA ≥ 45 mm, 55 of them had normal diameter of the pulmonary vein and in 39 cases, pulmonary veins were dilated.

The 204 cases investigated are divided according to the type of atrial fibrillation as follows: 149 cases were diagnosed with paroxysmal atrial fibrillation, 55 cases had persistent atrial fibrillation. The correlation of pulmonary vein size indicated the following distribution: of the 149 patients with paroxysmal atrial fibrillation, 129 patients (86.58%) had a PV diameter <14 mm, 20 patients (13.42%) had PV ≥ 14 mm. Of the 55 patients with persistent atrial fibrillation, 36 patients (65.45%) had pulmonary veins in the normal diameter, the patients with dilated pulmonary veins registered a number of 19 cases (34.54%).

Statistical analysis of the data obtained reveals the fact that the pulmonary veins extend subsequently to left atrium dilatation, all patients with LA size <45 mm having a normal diameter of the pulmonary veins, almost 42% of patients with LA ≥ 45 mm had dilated pulmonary veins. As in the case of left atrial dilatation, pulmonary veins dilate in a greater proportion in the patients with persistent atrial fibrillation.

After checkups made at 3 months, 6 months, 12 months, it was possible to study the correlation between pulmonary vein diameter and maintaining sinus rhythm in these patients. Of the 165 patients with PV diameter <14 mm, 154 patients (93.33%) maintained sinus rhythm for 3 months, 147 patients (89.09%) maintained sinus rhythm 6 months and a number of 137 patients (83.03%) maintained the sinus rhythm at12 months.

Regarding the patients with PV diameter ≥ 14 mm, they registered a number of 39 cases. 3 months later, 33 of them (84.62%) maintained sinus rhythm, 26 cases (66.66%) have managed to maintain sinus rhythm 6 months and for 12 months only 12 patients (30.76%) have maintained the pace sinus.

Analyzing the data obtained in our study, we can say that in patients with dilated pulmonary veins, the maintenance of sinus rhythm is achieved in a lower proportion, the recurrence rate being almost three times higher 12 months after atrial fibrillation conversion as against the patients with normal diameter of the pulmonary veins. Thus, the data obtained enables us to say that these patients should be monitored more closely, and due to many existing recurrences in these patients, anticoagulant treatment should be maintained for longer periods in order to prevent stroke occurrence and thus, to decrease mortality and morbidity in the patients with paroxysmal and persistent atrial fibrillation.

DISCUSSIONS

Different echocardiographic indices were investigated over time in many studies on the incidence and recurrence of atrial fibrillation that occur within this disease. One of the indices commonly investigated is the left atrial size, the value of this index being quite controversial even today. In our study, the recurrence rate at 12 month- follow-up was higher in the patients with LA diameter> 45mm. Also, one can see a difference in the relapse rate by type of atrial fibrillation, the recurrence rate being higher in the patients with persistent atrial fibrillation within the same group of left atrial size.

It has been demonstrated in numerous studies that a large left atrial size is associated with atrial fibrillation occurrence. However, controversial is the idea that dilated left atrium can predict the recurrence of atrial fibrillation after ablation, a starting point for the study entitled *"Association between left atrial size and atrial fibrillation recurrence after circumferential pulmonary vein isolation single: to systematically review and meta - analysis of observational studies "* that performed a systematic review and meta analysis regarding the association between left atrial diameter and atrial fibrillation recurrence after pulmonary vein ablation.

By analyzing the results, it was observed that the difference in diameter between the patients with and without recurrence persisted regardless of the follow-up period of these patients. The researchers concluded that dilated left atrium increases the risk of recurrence of atrial fibrillation after one single pulmonary vein ablation. This applies especially to patients who were followed up for a long period of time.(4)

A significantly higher value in predicting the occurrence of atrial fibrillation occurrence and recurrences of this disease has been supported by numerous studies as being the left atrial volume. Other studies have investigated the value of left atrial ejection fraction in predicting the occurrence of cardiac arrhythmias and the recurrence of the disease. It seems

that a correlation between these two parameters, left atrial ejection fraction and left atrial volume is much more accurate in terms of incidence of atrial fibrillation recurrence of the disease.

The study *"Predictive value of left atrial volumes measured by non - invasive cardiac imaging in paroxysmal atrial fibrillation"*, the role of the left atrial volume has been investigated as a predictor of the results of pulmonary vein isolation by catheter ablation in the patients with atrial paroxysmal fibrillation. The researchers concluded that left atrial volume assessment should not be included as a major factor in the success of ablation in the patients with paroxysmal atrial fibrillation, but ablation should be performed in the patients with a diastolic volume of LA $\leq$ 95 ml in order to further prevent the dilatation of the left atrium, because the patients with a volume of LA > 95 ml had an increased likelihood of developing persistent atrial fibrillation in case of ablation failure.(5)

In our study, a correlation between the diameter of the pulmonary veins and cardiac arrhythmia recurrence rate has been made. It was found that the recurrence rate is higher in the patients who have dilated pulmonary veins, 30.46% of these maintaining sinus rhythm 12 months later, compared with the patients without pulmonary veins, these ones maintaining sinus rhythm at a rate of 83 03%.

Considering that catheter ablation has become a treatment strategy increasingly used in the patients with atrial fibrillation, the purpose of a study published in 2005 entitled *„Atrial volume reduction following catheter ablation of atrial fibrillation and relation to reduction in pulmonary vein size: an evaluation using magnetic resonance angiography"*, was to assess the impact of catheter ablation on the left atrial volume and its relation to decrease in size of the pulmonary veins.

The results of this study showed that the average volume of the left atrium decreased by 15.7% after ablation and the diameter of pulmonary veins at ostial level decreased by 11%. Thus, the researchers concluded that there was a significant correlation between changes in the levels of pulmonary vein and the left atrial size.(6)

CONCLUSIONS

1. The maintenance of sinus rhythm in the patients with atrial fibrillation is influenced by left atrial diameter, a diameter of the LA $\geq$ 45 mm showing a higher recurrence rate in both patients diagnosed with paroxysmal atrial fibrillation and in the patients diagnosed with persistent atrial fibrillation.
2. In the case of the patients included in the same group, either with LA diameter < 45 mm or with LA diameter $\geq$ 45 mm, the recurrence rate is higher in the patients with persistent atrial fibrillation compared with the patients with paroxysmal atrial fibrillation.
3. The association between EF of the left atrium and the left atrial systolic maximum volume (left atrial reservoir function) is a closer indicator in terms of relapse in the patients with atrial fibrillation.
4. Recurrences of atrial fibrillation are more common in the patients with EF <50% and a maximum LA systolic volume > 40 ml, the lowest rate of recurrence being recorded in the patients who were diagnosed with atrial fibrillation and who present an EF $\geq$ 50% and a LA maximum systolic volume < 40ml.
5. There is a relation between left atrial size and pulmonary vein diameter. All patients who had a diameter of LA < 45 mm presented a normal diameter of the pulmonary veins.
6. The relapse rate is higher in the patients who were diagnosed with atrial fibrillation and had dilated PV, compared with the patients who have been diagnosed with atrial fibrillation and had a normal diameter of the PV.

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