CAN ECHOCARDIOGRAPHIC PARAMETERS PREDICT RECURRENCES OF ATRIAL FIBRILLATION AFTER RADIOFREQUENCY CATHETER ABLATION OF TYPICAL ATRIAL FLUTTER?

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Summary

Objectives: The study aims at determining echocardiographic parameters influencing the probability of atrial fibrillation (AF) recurrences after radiofrequency catheter ablation (RFCA) of typical atrial flutter (AFl).

Design, Methods and Results: 63 patients with paroxysmal or persistent AF and AFl were followed up after successful RFCA of typical AFl. In 33 patients (52.4%) AF did not recur or the frequency of AF paroxysms with antiarrhythmic drugs decreased (Group I). In 30 patients (47.6%) the course of AF did not change or AF progressed into a chronic form (Group II). The short dimension of the left atrium (LA), the long dimension of the right atrium (RA), the short dimension of the RA have increased in the patients of Group II as well as the thickened interventricular septum and mitral regurgitation (MR) grade II were diagnosed.

The short dimension of the LA increased by 1 cm raises the probability of AF recurrences 2-fold, the long and short dimensions of the RA increased by 1 cm – 2.3-fold and 3-fold, respectively. The thickened interventricular septum >1.1 cm is related to the 3.5-fold increased probability of AF recurrence (OR = 3.5; p = 0.015). The probability of recurrence of AF after catheter RFA in patients with MR grade II is 4.5 times higher in comparison with those who have no MR (OR = 4.5; p = 0.001).

Conclusions: Recurrences of atrial fibrillation after radiofrequency catheter ablation of typical atrial flutter are more common in patients with the increased short dimension of the left atrium, long and/or short dimensions of the right atrium, the thickened interventricular septum and mitral regurgitation grade II.

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structural heart disease was found in 12 patients (19.1%). Echocardiographic parameters are shown in Table 1.

The present study evaluated the frequency of AF recurrences prior to and after RFCA of typical AFI depending on echocardiographic data – dimensions of the left atrium (LA) and the right atrium (RA), the diastolic diameter of the left ventricle (LV), ejection fraction (EF) of the LV, the thickness of the interventricular septum and the grade of mitral regurgitation.

Patients with AF or AFI paroxysms that occurred at least once a month were included into the study.

All the patients had been followed up for 1 year after RFCA of typical AFI before the results were evaluated. The frequency of AF episodes was evaluated in comparison with the frequency of AF episodes prior to RFCA of cavotricuspid isthmus. No episodes or two-fold reduction of AF episodes after the procedure, either receiving AAD or not, were chosen as the criteria of effectiveness. The patients received the treatment of class I or class III AAD (according to Vaughan-Williams classification) [14] prior to and at least one month after the procedure. Later, AAD were either transiently or permanently withdrawn for some patients depending on the absence or presence of documented arrhythmia.

The study was conducted according to the principles of the Declaration of Helsinki.

**Echocardiography**

Echocardiographical evaluation was performed 1–3 months prior to RFCA of typical AFI. Decreased LV function was stated when LV EF was less than 50% [15]. The LA was measured in two perpendicular planes in the apical four-chamber view at the end of systole. LA enlargement was diagnosed if any dimension exceeded 50 mm. The RA was measured in the apical four-chamber view at the end of systole in two perpendicular planes [16]. RA enlargement was diagnosed if any dimension exceeded 40 mm. The grade of mitral valve insufficiency was determined while evaluating the length of regurgitation flow from the mitral valve into the left atrium in four, two and three heart chambers’ sections, parasternal long and short axis sections. Grade I mitral valve regurgitation (MVR) – regurgitation flow registered from the MV to the third of the LA, grade III MVR – regurgitation flow registered from the MV annulus to a half of the LA, grade IV – regurgitation flow reached more than a half of the LA [17,18].

**Radiofrequency catheter ablation of typical atrial flutter**

The ablation of typical AFI was performed according to established techniques [19,20]. The procedure started from the intracardiac electrophysiological study. Typical AFI was considered to be either “counterclockwise” or “clockwise” macro-reentrant tachycardia dependent on cavotricuspid isthmus and limited to the RA. The line of ablation spots was created between the tricuspid valve and the inferior vena cava. CARTO electroanatomic system (Biosense-Webster) was used for the isthmus ablation in six patients with recurrences of AFI after the first procedure. The termination of AFI and bidirectional conduction block in the cavotricuspid isthmus were considered as early success markers of the procedure [8].

For at least one month after the procedure, 325 mg of aspirin daily, or warfarin were administered to maintain international normalized ratio (INR) in a range of 2.0–3.0. These drugs were chosen depending on the risk of thromboembolic complications [14] and later – on the course of AF.

**Statistical analysis**

The tests were performed using the SAS and SPSS statistical packages. Results were expressed as mean ± SD, median, and range. Univariate analysis of factors associated with the occurrence of AF was performed using Student’s t-test for continuous variables. Variables of data were compared by the two-tailed Mann–Whitney–Wilcoxon rank sum test. Statistical significance was established at p < 0.05. Multivariate and univariate logistic regression model analysis was performed to determine independent predictors of the development of AF. Odds ratios (OR) with 95% CI were calculated.

**Results**

Results were evaluated one year after the successful procedure of RFCA of typical AFI. After successful RFCA of typical AFI, positive effect (AF

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**Table 1. Echocardiographic parameters**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number of patients (%)</th>
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<tbody>
<tr>
<td>Ejection fraction of the LV &lt; 50%</td>
<td>18 (28.6%)</td>
</tr>
<tr>
<td>The enlarged diastolic diameter of the LV</td>
<td>22 (34.9%)</td>
</tr>
<tr>
<td>The enlarged LA</td>
<td>47 (74.6%)</td>
</tr>
<tr>
<td>The enlarged RA</td>
<td>42/63 (66.7 %)</td>
</tr>
</tbody>
</table>

LA – left atrium; LV – left ventricle; RA – right atrium
ceased or the frequency of AF decreased twice) was achieved in 33 patients (52.4%) (Group I). In 30 patients (47.6%) AF paroxysms sustained or converted to chronic AF despite the treatment with class I or III AAD (Group II). One month after the procedure aspirin or warfarin were discontinued in 6 patients (9.5%); 19 patients (30.2%) continued aspirin and 38 patients (60.3%) – warfarin.

Statistically significant correlation between the increase of the short dimension of the LA \((p = 0.048)\), the long dimension of the RA \((p = 0.023)\), the short dimension of the RA \((p = 0.009)\) and the outcome was found (Figures 1–3).

Logistic regression analysis of these parameters has shown that:

1. The enlargement of the LA short dimension by 1 cm increased the probability of the recurrence of AF twice;
2. The enlargement of the RA long dimension by 1 cm increased the probability of AF recurrence 2.3-fold;
3. The enlargement of the RA short dimension by 1 cm increased the probability of AF recurrence 3-fold.

In patients in whom paroxysms of AF had either remained or progressed into chronic form, the short dimension of the LA was \(5.75 \pm 0.79\) cm, the long dimension of the RA – \(5.12 \pm 0.72\) cm, the short dimension of the RA – \(4.65 \pm 0.70\) cm in comparison with those in whom either positive or relative effect was achieved – \(5.37 \pm 0.68\) cm \((p = 0.048)\), \(4.34 \pm 0.75\) cm \((p = 0.023)\), \(4.22 \pm 0.57\) cm \((p = 0.009)\), respectively.

\(\chi^2\)-test showed statistically significant correlation between interventricular septum thickness more than 1.1 cm and the outcome of the treatment \((p = \ldots\).
Figure 3. Correlation between the enlarged short dimension of the right atrium and the results of the treatment of atrial fibrillation after radiofrequency catheter ablation of typical atrial flutter.

Table 2. Correlation between the thickness of the interventricular septum prior to radiofrequency catheter ablation of atrial flutter and the results of the treatment.

<table>
<thead>
<tr>
<th>Result</th>
<th>Normal thickness of interventricular septum</th>
<th>Thickened interventricular septum</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>No AF/AF frequency decreased</td>
<td>21</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>AF paroxysms sustained/converted to chronic AF</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

AF – atrial fibrillation

0.016). In 20 patients (66.7%) of Group II, the thickness of the interventricular septum was increased (Table 2).

Logistic regression analysis of this parameter showed that diastolic interventricular septum thickness more than 1.1 cm was related to the 3.5-fold increased probability of AF recurrence (OR = 3.5; *p* = 0.015).

χ²-test showed statistically significant correlation between MR grade II and the negative outcome of the treatment (*p* = 0.001).

Logistic regression analysis showed that the probability of AF recurrence after successfully performed catheter RFCA in patients with MR grade II is 4.5 times higher in comparison with those who have no MR (OR = 4.5; *p* = 0.001).

The Mann–Whitney–Wilcoxon test showed no statistically significant correlation between reduced EF of the LV, the enlarged LV diameter and the results of the treatment (*p* = 0.753).

Discussion

RFCA is an optimal method for the treatment of typical AFI because usually AAD are not effective [9]. On the other hand, AF is often treated with AAD, because the catheter treatment of AF is complicated and not always enough effective [21–23]. While treating AF with AAD of class IC and III, favourable conditions for the development of AFI may arise. This leads to the development of hybrid therapy for co-existing AF and AFI, i.e. the administration of AAD and the application of RFCA for the treatment of typical AFI [6,11–13,24–26].

The current study showed that the increase of the short dimension of the LA and the increase of either long or short dimensions of the RA had been determined as factors, having negative impact on the results of the treatment of AF after RFCA of typical AFI.

Epidemiological studies described atrial enlargement as an independent risk factor of AF [27,28]. The enlarged LA is an independent risk factor of AF even if overload is successfully controlled [29]. The enlarged RA is supposed to be a risk factor of the development of AFI rather than AF [30]. Studies evaluating the course of AF after RFCA of typical AFI showed that patients with LA or RA enlargement were at a greater risk of the development of AF [11–13,22,31,32]. Several studies, like the current one, found that this correlation was statistically significant [11,29,30] and may have negative impact on the results of the AF treatment.

In our study, all the patients with a thickened interventricular septum had arterial hypertension (AH). So, according to our study, the recurrence of AF was related to AH complicated by left ven-
tricular hypertrophy (LVH). Epidemiological studies described LVH as an independent risk factor of AF. The common reason of LVH is AH [26,33]. Effective arterial hypertension correction ceases or reduces the frequency of AF recurrences in 64.6% of patients [34].

Epidemiological studies exposed MR as an independent risk factor for AF [25]. MR is often diagnosed in elderly people. Due to this, the LA is increased and AF may occur [35–37]. Some studies like ours, having evaluated AF recurrences after AFI RFCA, determined statistically reliable correlation between MR grade II and the results of the treatment [13,38]. Other studies confirmed that recurrences of AF after AFI RFCA in patients with significant MR were more frequent, but statistically it was not reliable [22,36].

LV EF had no statistically proved impact on the results. The data of epidemiological studies showed that the risk of the development of AF was greater in patients with decreased LV EF [25]. Some studies evaluating the course of AF after RFCA of AF showed that decreased LV EF as a risk factor for the development of AF after AFI RFCA [11,13,30,32,39], in this case increased the risk of AF 3.8-fold [11]. Other studies, as well as the current one, showed no statistically significant correlation between this factor and the results of the treatment of AF after RFCA of typical AF [6,12,13]. In our study, the latter phenomenon may be explained by the fact that the number of patients with decreased LV EF was not large enough and this condition had been well controlled prior to the procedure and the treatment was continued after AFI RFCA.

Conclusions

The probability of recurrence of atrial fibrillation after catheter ablation of typical atrial flutter is higher:

- if the short dimension of the left atrium is increased (increase by 1 cm raises the probability of atrial fibrillation recurrences 2-fold);
- if any dimension of the right atrium is increased (the long dimension increased by 1 cm raises the probability of atrial fibrillation recurrences 2.3-fold, the short dimension – 3-fold).
- interventricular septum diastolic thickness more than 1.1 cm is related to the 3.5-fold increased probability of atrial fibrillation recurrence.
- mitral regurgitation of grade II increases the probability of atrial fibrillation recurrence 4.5 times.

References