Safety of transesophageal echocardiography-guided electrical cardioversion in patients with atrial fibrillation and inadequate anticoagulation

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KEY WORDS
anticoagulation, electrical cardioversion, spontaneous echo contrast, thrombus, transesophageal echocardiography

INTRODUCTION

Restoring sinus rhythm in patients with atrial fibrillation (AF)/atrial flutter (AFl) requires adequate oral anticoagulation prior to direct current cardioversion (DCC). Some patients eligible for DCC are not properly anticoagulated.

OBJECTIVES

The aim of the study was to assess risk factors for thrombus and spontaneous echo contrast (SEC) in the left atrium (LA) as well as the safety profile of transesophageal echocardiography (TEE)-guided DCC in patients with inadequate anticoagulation.

PATIENTS AND METHODS

From the cohort of 316 patients admitted for DCC, 139 patients (mean [SD] age, 63.4 [11.5] years) had inadequate anticoagulation; 91 patients were admitted urgently for acute coronary syndrome, heart failure (HF), or poor tolerance of arrhythmia. The mean (SD) CHA2DS2-VASc score was 3.0 (1.7).

RESULTS

TEE revealed a left atrial appendage (LAA) thrombus in 16 patients (11.5%), and SEC in the LA in 63 patients (45.3%). In a univariate analysis, LAA thrombus was more common in patients after myocardial infarction (odds ratio [OR], 3.92; 95% CI, 1.34–11.48; P = 0.009), while SEC in the LA was more common in patients with HF (OR, 2.23; 95% CI, 1.1-4.53; P = 0.02) and left ventricular ejection fraction of less than 40% (OR, 3.65; 95% CI, 1.66–8.06; P = 0.001). In a multivariate model, the most powerful SEC-predicting factor was the LA size exceeding 45 mm (OR, 3.08; 95% CI, 1.3–7.29). DCC was performed in 105 patients. No complications of TEE or DCC were observed.

CONCLUSIONS

AF/AFl inadequately treated with oral anticoagulation predisposes to thrombus formation and SEC in the LA. Once thrombus is excluded, DCC is a safe procedure. There were no predictors of LAA thrombus; therefore, TEE before DCC should be performed in all patients with AF/AFl in accordance with the guidelines.
Cardioversion of atrial fibrillation with inadequate anticoagulation

The inclusion criteria were the absence or inadequacy of anticoagulation before hospitalization or they do not take 1 or more doses of NOACs. The second group consists of patients admitted urgently due to hemodynamic deterioration: with heart failure (HF), acute coronary syndrome (ACS), or poor tolerance of arrhythmia. In these cases, it is often difficult to determine the exact duration of arrhythmia as these patients do not use anticoagulation or the efficacy of the treatment is uncertain. This group of patients also has the highest risk of thrombus in the left atrial appendage (LAA). In such situations, when it is necessary to treat the patient with DCC, it is recommended to perform transesophageal echocardiography (TEE). It has been documented that a reduction in the duration of OAC treatment by performing TEE and, in the absence of contraindications, DCC on the same day may improve the clinical status and well-being of the patients, as well as reduce the duration of hospital stay and the number of complications.

There have been few studies assessing the value of TEE in patients with inadequate or irregular anticoagulation. Moreover, there are scarce data on patients admitted urgently due to hemodynamic deterioration resulting from poorly tolerated AF. DCC performed to achieve hemodynamic stability without prior TEE may lead to thromboembolic complications.

The aim of this study was to evaluate the risk factors for spontaneous echo contrast (SEC) in the left atrium (LA) and the presence of thrombus in the LAA on TEE in patients with AF or AFI. We included patients who were admitted to the hospital to undergo DCC and who had an inadequate anticoagulation prior to hospitalization. In addition, the safety of DCC in elective and urgently admitted patients was evaluated.

**Patients and Methods** This was a retrospective study involving patients with persistent AF/AFI who underwent TEE prior to DCC. The inclusion criteria were the absence or inadequacy of anticoagulation in the 3 weeks prior to cardioversion (omission of 1 or more doses of NOACs or a documented INR of less than 2 during the 3 to 4 weeks preceding the scheduled DCC). The study included patients admitted for elective DCC as well as for urgent reasons such as poorly tolerated symptoms of arrhythmia (palpitations, fainting, weakness), ACS, or HF exacerbation. ACS was diagnosed on the basis of clinical evaluation, electrocardiography, and cardiac troponin levels. The diagnosis of HF exacerbation was based on previous medical history, clinical presentation, laboratory results (N-terminal pro-B-type natriuretic peptide levels), and transthoracic echocardiography (TTE). In all patients, the risk of thromboembolic complications was estimated with the CHA2DS2-VASc score on admission to the hospital. TEE was performed in the fasting state on the same day as DCC. In the case of a suspected or evident thrombus, DCC was postponed for a minimum of 3 weeks. All patients gave their written informed consent to undergo both TEE and DCC under a short general anesthesia.

The study exclusion criteria were as follows: age <18 years, valvular heart disease, contraindications to undergo DCC (eg, LAA thrombus, stroke, pulmonary edema) or TEE (eg, esophageal disease), contraindications to anticoagulation, and the lack of the patient’s informed consent. Prior to DCC, every patient was administered unfractionated or low-molecular-weight heparin at therapeutic doses. Cardioversion was performed with biphasic defibrillator under a short general anesthesia (fentanyl/propranolol).

The effectiveness of DCC was determined on the basis of sinus rhythm restoration immediately after cardioversion and on the day of hospital discharge. The safety of DCC was assessed on the basis of the following endpoints: stroke, transient ischemic attack (TIA), symptomatic systemic embolic event, and death. The study was positively assessed by the Bioethics Committee of the Poznan University of Medical Sciences, Poznań, Poland.

**Echocardiographic examination** TTE and TEE were performed using a Vivid 9 device (General Electric Healthcare, General Electric Healthcare, Horten, Norway). In TTE, we evaluated the basic dimensions of the left ventricle (LV, in diastole) and LA (in systole), aortic dimensions, blood flow through the valves, and LV ejection fraction (LVEF). A TEE multiplane transducer was used. The study evaluated the presence of a thrombus in the LAA and SEC in both LA and LAA. Blood clots were identified as a circular or irregular mass inside or in the lumen of the LA, not being a part of the endocardium or pectinate muscles. SEC was defined as a smoke-like echo with a characteristic motion during the cardiac cycle. The presence of a thrombus in the LA/LAA was a contraindication to DCC, while in the case of the SEC, the decision was made after consultation with other cardiologists.

**Statistical analysis** A statistical analysis was performed using STATISTICA ver. 12 (StatSoft Inc., 1984–2014, Tulsa, Oklahoma, United States). Qualitative variables were presented as percentage, and quantitative ones—as the arithmetic mean and standard deviation (SD) for normal distribution and median for nonnormal distribution. The Mann–Whitney test was used to compare the 2 groups in a nominal scale and an interval scale in the absence of normality. More than 2 groups were compared using the Kruskal–Wallis test with the post-hoc Dunn test. The χ2 test of independence was used for the nominal scale. To evaluate the risk of LAA thrombus and SEC, the logistic regression model was used in a univariate analysis and a stepwise backward regression model in a multivariate analysis. To determine the relationship between the mode
TABLE 1  Clinical characteristics of the study group

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of arrhythmia</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>103 (74.1)</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>36 (25.9)</td>
</tr>
<tr>
<td>Duration of arrhythmia</td>
<td></td>
</tr>
<tr>
<td>≤48 hours</td>
<td>9</td>
</tr>
<tr>
<td>&gt;48 hours</td>
<td>97</td>
</tr>
<tr>
<td>&gt;30 days</td>
<td>21</td>
</tr>
<tr>
<td>Indefinite</td>
<td>12</td>
</tr>
<tr>
<td>Concomitant disorders</td>
<td></td>
</tr>
<tr>
<td>HF</td>
<td>50 (35.9)</td>
</tr>
<tr>
<td>NYHA class on admission, n = 50, mean (SD)</td>
<td>2.6 (0.7)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>99 (71.2)</td>
</tr>
<tr>
<td>Type 2 diabetes</td>
<td>31 (22.3)</td>
</tr>
<tr>
<td>Previous stroke/TIA</td>
<td>19 (13.6)</td>
</tr>
<tr>
<td>Previous MI</td>
<td>33 (23.7)</td>
</tr>
<tr>
<td>Previous CABG/PCI</td>
<td>34 (24.4)</td>
</tr>
<tr>
<td>CKD</td>
<td>9 (6.4)</td>
</tr>
<tr>
<td>COPD</td>
<td>11 (7.9)</td>
</tr>
<tr>
<td>Echocardiographic data</td>
<td></td>
</tr>
<tr>
<td>LA, mm, mean (SD)</td>
<td>44.7 (6.0)</td>
</tr>
<tr>
<td>LVEDd, mm, mean (SD)</td>
<td>54.2 (8.7)</td>
</tr>
<tr>
<td>LVEF, %, mean (SD)</td>
<td>43.9 (14.6)</td>
</tr>
<tr>
<td>LVEF &lt;40%</td>
<td>40 (32.5)</td>
</tr>
</tbody>
</table>

Data are presented as number (percentage) of patients unless indicated otherwise.

Abbreviations: CABG, coronary artery bypass grafting; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; HF, heart failure; LA, left atrium; LVEDd, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NYHA, New York Heart Association; PCI, percutaneous coronary intervention; TIA, transient ischemic attack

TABLE 2  Reason for hospital admission and performing transesophageal echocardiography of the left atrium

<table>
<thead>
<tr>
<th>Reason for admission</th>
<th>n</th>
<th>LAA thrombus</th>
<th>SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective admission</td>
<td>48</td>
<td>3 (6)</td>
<td>20 (42)</td>
</tr>
<tr>
<td>Poor tolerance of arrhythmia</td>
<td>57</td>
<td>6 (11)</td>
<td>24 (42)</td>
</tr>
<tr>
<td>ACS</td>
<td>13</td>
<td>4 (31)</td>
<td>8 (62)</td>
</tr>
<tr>
<td>HF</td>
<td>21</td>
<td>3 (14)</td>
<td>11 (52)</td>
</tr>
</tbody>
</table>

Data are presented as number (percentage) of patients.

Abbreviations: ACS, acute coronary syndrome; LAA, left atrial appendage; SEC, spontaneous echo contrast; others, see TABLE 1

Between the years 2011 and 2013, 316 patients with AF or AFl scheduled to undergo DCC were admitted to the Department of Cardiology at the Poznan University of Medical Sciences. A total of 139 patients (46 women and 93 men) met the inclusion criteria; the mean (SD) age was 63.4 (11.5) years. Forty-eight patients were admitted electively, and 91 patients—urgently. The reasons for performing urgent cardioversion were poor tolerance of arrhythmia (57 patients), ACS (13 patients), and exacerbation of HF (21 patients). On admission, 83 patients (60%) were taking VKAs, 15 patients (11%) were administered NOACs, and 41 patients (29%) did not take any OACs. Aspirin (75 mg/d) was administered in 45 patients (32%), and 20 patients (14%) were on dual antiplatelet therapy (aspirin and clopidogrel, both at a dose of 75 mg/d). Four patients were on triple antithrombotic treatment (VKA, aspirin, and clopidogrel).

TEE revealed an LAA thrombus in 16 patients (11.5%) and LA SEC in 63 patients (45.3%). In 15 patients (94%), the thrombus was accompanied by SEC. Six patients with LAA thrombus were on treatment with dual antithrombotic therapy (OAC plus a single antiplatelet: aspirin or clopidogrel) before admission. Triple antithrombotic therapy (OAC, aspirin, and clopidogrel) was administered in 1 patient; single VKA, in 3 patients; single aspirin, in 1 patient; single clopidogrel, in 1 patient; and dual antiplatelet treatment (aspirin and clopidogrel), in 2 patients. Only 1 patient was on NOAC (rivaroxaban) and 1 patient was not treated with any OAC or antiplatelet agent.

The mean (SD) CHA2DS2-VASc score was 3.0 (1.7); 83 patients (60%) had a CHA2DS2-VASc score exceeding 2. The clinical characteristics of the study group are shown in TABLE 1.

Reasons for hospital admission and echocardiographic image of the left atrium  More than half of the patients admitted with ACS (62%) and HF (52%) had SEC, and 30% of the patients with ACS had LAA thrombus. The LAA thrombus was twice as common in patients admitted urgently (13 of 91 patients) as in patients admitted electively (3 of 48 patients) (TABLE 2). Among patients admitted within up to 48 hours since the onset of arrhythmia, LAA thrombus was observed in 2 patients (1%) and SEC—in 4 patients (3%).

Predictors of thrombus and spontaneous echo contrast on transesophageal echocardiography  A comparison of patients with LAA thrombus and SEC with those without any LA abnormalities on TEE is presented in TABLES 3 and 4. Only a history of myocardial infarction was significantly more frequent in patients with an LAA thrombus compared with those without thrombus. HF, a higher New York Heart Association class reduced LVEF, and enlarged LA were significantly more common in patients with LA SEC and enlarged LA were significantly more common in patients with LA SEC compared with those without any LA abnormalities.
Comparison of patients with left atrial appendage thrombus and without thrombus

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LAA thrombus (n = 16)</th>
<th>No thrombus (n = 123)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean (SD)</td>
<td>68.6 (10.6)</td>
<td>62.7 (11.4)</td>
<td>0.1</td>
</tr>
<tr>
<td>CHA2DS2-VASc score, mean (SD)</td>
<td>3.8 (2.0)</td>
<td>2.9 (1.7)</td>
<td>0.08</td>
</tr>
<tr>
<td>HF, n (%)</td>
<td>8 (50)</td>
<td>42 (34.2)</td>
<td>0.2</td>
</tr>
<tr>
<td>NYHA class, n = 50, mean (SD)</td>
<td>2.9 (0.6)</td>
<td>2.5 (0.7)</td>
<td>0.2</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>11 (68.8)</td>
<td>88 (71.5)</td>
<td>0.95</td>
</tr>
<tr>
<td>Type 2 diabetes, n (%)</td>
<td>5 (31.2)</td>
<td>26 (21.1)</td>
<td>0.6</td>
</tr>
<tr>
<td>Female sex, n (%)</td>
<td>4 (25.0)</td>
<td>41 (33.3)</td>
<td>0.5</td>
</tr>
<tr>
<td>Previous stroke/TIA, n (%)</td>
<td>3 (18.8)</td>
<td>16 (13.0)</td>
<td>0.8</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>8 (50.0)</td>
<td>25 (20.3)</td>
<td>0.02</td>
</tr>
<tr>
<td>Previous CABG/PCI, n (%)</td>
<td>7 (43.8)</td>
<td>27 (22.0)</td>
<td>0.1</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td>1 (6.3)</td>
<td>10 (8.1)</td>
<td>0.8</td>
</tr>
<tr>
<td>CKD, n (%)</td>
<td>1 (6.3)</td>
<td>8 (6.5)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Echocardiographic data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LAA thrombus</th>
<th>No thrombus</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA, mm, mean (SD)</td>
<td>46.1 (3.7)</td>
<td>44.5 (6.2)</td>
<td>0.3</td>
</tr>
<tr>
<td>LA &gt;45 mm, n (%)</td>
<td>8 (57.1)</td>
<td>43 (37.4)</td>
<td>0.2</td>
</tr>
<tr>
<td>LVEDd, mm, mean (SD)</td>
<td>52.7 (8.7)</td>
<td>54.9 (8.7)</td>
<td>0.2</td>
</tr>
<tr>
<td>LVEF, %, mean (SD)</td>
<td>41.2 (13.8)</td>
<td>44.3 (14.7)</td>
<td>0.5</td>
</tr>
<tr>
<td>LVEF &lt;40%, n (%)</td>
<td>6 (46.2)</td>
<td>34 (30.9)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 4: Comparison of patients with and without spontaneous echo contrast in the left atrium

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SEC (n = 63)</th>
<th>No SEC (n = 76)</th>
<th>P value</th>
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<tbody>
<tr>
<td>Age, y, mean (SD)</td>
<td>63.3 (11.0)</td>
<td>63.5 (11.9)</td>
<td>0.7</td>
</tr>
<tr>
<td>CHA2DS2-VASc score, mean (SD)</td>
<td>3.1 (1.8)</td>
<td>2.8 (1.7)</td>
<td>0.5</td>
</tr>
<tr>
<td>HF, n (%)</td>
<td>29 (46.0)</td>
<td>21 (27.6)</td>
<td>0.02</td>
</tr>
<tr>
<td>NYHA class, n = 50, mean (SD)</td>
<td>2.8 (0.6)</td>
<td>2.3 (0.7)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>46 (73.0)</td>
<td>53 (69.7)</td>
<td>0.8</td>
</tr>
<tr>
<td>Type 2 diabetes, n (%)</td>
<td>17 (26.9)</td>
<td>14 (18.4)</td>
<td>0.3</td>
</tr>
<tr>
<td>Female sex, n (%)</td>
<td>16 (25.4)</td>
<td>29 (38.2)</td>
<td>0.1</td>
</tr>
<tr>
<td>Previous stroke/TIA, n (%)</td>
<td>10 (15.9)</td>
<td>9 (11.8)</td>
<td>0.7</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>19 (30.2)</td>
<td>14 (18.4)</td>
<td>0.2</td>
</tr>
<tr>
<td>Previous CABG/PCI, n (%)</td>
<td>17 (27.0)</td>
<td>17 (22.4)</td>
<td>0.7</td>
</tr>
<tr>
<td>COPD, n (%)</td>
<td>6 (9.5)</td>
<td>5 (6.6)</td>
<td>0.8</td>
</tr>
<tr>
<td>CKD, n (%)</td>
<td>3 (4.8)</td>
<td>6 (7.9)</td>
<td>0.7</td>
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</table>

Echocardiographic data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SEC</th>
<th>No SEC</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA, mm, mean (SD)</td>
<td>47.3 (5.3)</td>
<td>42.8 (5.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>LA &gt;45 mm, n (%)</td>
<td>32 (58.2)</td>
<td>25.7 (37.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LVEDd, mm, mean (SD)</td>
<td>56.1 (9.0)</td>
<td>53.6 (8.3)</td>
<td>0.07</td>
</tr>
<tr>
<td>LVEF, %, mean (SD)</td>
<td>38.8 (13.9)</td>
<td>48.1 (13.9)</td>
<td>0.003</td>
</tr>
<tr>
<td>LVEF &lt;40%, n (%)</td>
<td>25 (49.0)</td>
<td>15 (20.8)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

In the univariate analysis, thrombus was 4-fold more common in patients with a history of myocardial infarction (OR, 3.92; 95% CI, 1.34–11.48; P = 0.009). SEC in the LA was diagnosed twice more often in patients with a history of HF (OR, 2.23; 95% CI, 1.1–4.53, P = 0.02) and over 3-fold more often in the case of LVEF lower than 40% (OR, 3.65; 95% CI, 1.6–8.06; P = 0.001). Furthermore, the LA diameter exceeding 45 mm was diagnosed 4-fold more often in patients with SEC (OR, 4.03; 95% CI, 1.91–8.51; P <0.001). In the multivariate analysis, the best predictor of SEC in the LA was the LA diameter exceeding 45 mm (OR, 3.08; 95% CI, 1.3–7.29). Both the ejection fraction of less than 40% and a history of HF appeared to be nonsignificant predictors (OR, 1.86; 95% CI, 0.63–5.4 for LVEF <40% and OR, 0.54; 95% CI, 0.51–3.59 for HF).

The presence of the LA thrombus was not associated with the mode of hospital admission (elective vs urgent; P = 0.16), duration of arrhythmia (<48 hours, >48 hours, >30 days; n = 127; P = 0.56), or the type of anticoagulation (VKA, NOAC, no OAC; P = 0.82). There were no correlations between LA SEC and the mode of admission (P = 0.65), duration of arrhythmia (P = 0.99), or type of anticoagulation (P = 0.57).

**CHA2DS2-VASc score and the presence of spontaneous echo contrast and left atrial appendage thrombus.** There were no correlations between the CHA2DS2-VASc score and the presence of thrombus in the LA (P = 0.08) or the CHA2DS2-VASc score and SEC in the LA (P = 0.53). LAA thrombus was diagnosed in patients with at least 1 thromboembolic risk factor (CHA2DS2-VASc ≥1), and LA SEC was found in 1 man with a CHA2DS2-VASc of 0 (FIGURE 1). Patients with a CHA2DS2-VASc of 1 and LAA thrombus were men admitted urgently due to poor tolerance of arrhythmia, with hypertension (the first patient) and congestive HF (the second patient). None of them was taking OACs according to the guidelines.

There was no correlation between the mode of admission (elective vs urgent; P = 0.47), the type of anticoagulants taken (VKA, NOAC, no OAC; P = 0.56), the duration of arrhythmia (<48 h, >48 h, >30 days; P = 0.351), and the CHA2DS2-VASc score. The CHA2DS2-VASc score proved to be a poor predictor of thrombus or SEC (FIGURE 2A and 2B). The ROC analysis showed an area under the ROC curve (AUC) of 0.63 (95% CI, 0.55–0.71; P = 0.09) for thrombus and an AUC of 0.53 (95% CI, 0.45–0.62; P = 0.52) for SEC.

DCC was performed in 105 patients (76%). It was not performed in 16 patients with LAA thrombus, 8 patients with SEC, 6 patients with sinus restoration directly before DCC, and 3 patients due to an ablation procedure. DCC was effective in 93 patients (89% of the performed cardioversions), but in 2 patients, the sinus rhythm was restored after the second DCC (performed <24 hours after the first one). Twelve patients were discharged home with AF/AFl. The mean
of these risk factors can reduce the 
time of anti­
oculation prior to cardioversion.

In our study 
group, thrombus was reported in 11.5% of the 
patients, and simultaneous SEC was reported in 
45.3% of the 
patients (in 15 of 16 patients with 
thrombus). Based on a 
meta­analysis of more than 
20 000 patients who had underwent TEE prior to 
DCC, thrombus was found in approximately 10% 
of the patients with paroxysmal AF and approx ­
imately 15% of those with persistent or chronic 
arrhythmia. 

The 
prevalence of LAA thrombus, 
however, may vary considerably among popu­
lations. 

In the available literature, there are 
scarce data on TEE assessment of the 
LA in pa­
tients admitted urgently due to AF/AFl. In a 
study 
by Grewal et al, 
approximately 53% of the 
patients were hemodynamically unstable or present­
ed symptoms of arrhythmia, and thrombus was 
diagnosed in 8.2% of 
the 
patients. Most studies 
cluded stable patients in whom no anticoagu­
ation was used prior to TEE or the 
anticoagula­
tion was inadequate. 

In our study, 65% of the 
patients were urgently admitted to the 
hospital. The rate of LAA thrombus was 2-fold higher 
in these patients than in those admitted elec­
tively who underwent a TEE exam due to ina­
dquate anticoagulation (13% and 6%, respectively).

FIGURE 1 Patients with left atrial appendage (LAA) thrombus and spontaneous echo contrast (SEC) in the left atrium (LA) according to the CHA2DS2­-VASc score

(14x25)FIGurE 1 Patients with left atrial appendage (LAA) thrombus and spontaneous echo contrast (SEC) in the left atrium (LA) according to the CHA2DS2-VASc score

Prevalence of left atrial appendage thrombus and spontaneous echo contrast in the left atrium Echocar­
diographic indicators of thromboembolic risk fac­
tors (thrombus, impaired blood flow in the LA, LA 
SEC) are helpful in deciding about DCC. The lack 
of these risk factors can reduce the time of anti­
oculation prior to cardioversion. In our study 
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tients, and simultaneous SEC was reported in 
45.3% of the patients (in 15 of 16 patients with 
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however, may vary considerably among popu­
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patients were hemodynamically unstable or present­
ed symptoms of arrhythmia, and thrombus was 
diagnosed in 8.2% of the patients. Most studies 
cluded stable patients in whom no anticoagu­
ation was used prior to TEE or the anticoagula­
tion was inadequate. 

DISCUSSION AF is associated with a 3.5- to 5-fold higher risk of stroke, 3-fold higher risk of congestive HF, and higher mortality. DCC is a recognized method for sinus rhythm resto­
ration; however, it is associated with a risk for stroke. Thus, treatment with OACs is recom­
ended prior to DCC. In clinical practice, it is 
difficult to achieve this goal within 3 weeks in 
a large group of patients treated with VKAs. 
According to the ORBIT­AF study, only 59% 
of the INR results were within the therapeutic 
range. In the case of NOACs, the difficulty lies in 
the fact that there are no tests to assess the reg­
ularity of use; therefore, it requires good coop­
eration with the patient and the patient’s com­
pliance with the physicians recommendations. 
Based on the results of the RE­LY study, about 
one­fifth of the patients stopped taking dabig­
atran after 2 years, even though they had indica­
tions for follow­up treatment due to risk fac­
tors for stroke.

Causes of admission and the presence of thrombus in the left atrial appendage and spontaneous echo con­
trast in the left atrium In our study, 65% of the 
patients were urgently admitted to the hospi­
tal. The rate of LAA thrombus was 2-fold higher 
in these patients than in those admitted elec­
tively who underwent a TEE exam due to inade­
quate anticoagulation (13% and 6%, respectively).
FIGURE 2  Receiver operating characteristic curves in the evaluation of the risk of left atrial appendage thrombus (A) and spontaneous echo contrast in the left atrium (B) depending on the CHA$_2$DS$_2$-VASc score.
Grewal et al. reported that thrombus was more common in patients with poor tolerance of arrhythmia (14%) or with symptoms of HF or ACS (10.5%) compared with scheduled patients (7%). The presence of thrombus was also reported in 12% of hemodynamically stable patients in the ACUTE study.

Patients with arrhythmia lasting up to 48 hours Our results suggest that the duration of arrhythmia was not associated with an increased risk of LAA thrombus or SEC in the LA. However, TEE was performed in 9 patients with arrhythmia terminating within 48 hours. Two of these patients had thrombus in the LAA. In a study of Kleeman et al., thrombus was found in 1.4% of the patients and SEC in 35% of hemodynamically stable patients with arrhythmia lasting no more than 48 hours. However, thrombus was found in only 4% of patients who had never been treated with OACs prior to admission (37% of the study group). These results suggest that each patient should be treated individually, and despite a relatively short duration of arrhythmia (≤48 hours), the implemented procedures should depend on the clinical situation and the patient’s condition.

Factors affecting the occurrence of thrombus in the left atrial appendage and spontaneous echo contrast in the left atrium In our study, patients with thrombus in the LAA more frequently suffered from diabetes, stroke, or TIA. These patients were older, had symptoms of HF, were in a higher NYHA class, and presented a higher CHA2DS2-VASc score. Interestingly, 7 of 16 patients with an LAA thrombus were on at least dual antithrombotic therapy (VKA plus aspirin or clopidogrel). It is probably due to the fact that 62% of the patients with LAA thrombus had myocardial infarction in the past. Moreover, they had lower LVEF and an enlarged LA on TTE. However, the only predictor of LAA thrombus was a history of myocardial infarction. The predictors of SEC included a previously diagnosed HF, LVEF of less than 40%, and an enlarged LA.

A reduced LVEF of less than 35% or less than 40% and an LA diameter enlarged to 45 mm or more were more frequently reported in patients with LAA thrombus and SEC. Moderate or severe LV dysfunction is known to be an independent predictor of stroke; however, HF and low LVEF are negative predictors of LAA thrombus resolution in patients with nonvalvular AF. Providencia et al. reported that the independent predictors of LAA thrombus in 180 patients were positive troponin levels and enlarged LA (indexed left atrial volume >60.0 ml/m²).

In other studies, thrombus predictors included older age, female sex, hypertension, diabetes, chronic HF, and higher CHA2DS2 and CHA2DS2-VASc scores associated with these factors.

The CHADS2 and CHA2DS2-VASc scores are used to assess thromboembolic risk. An increased score is associated with more frequent detection of LAA thrombus and SEC in the LA as well as thromboembolic events. In our study, there was no relationship between the CHA2DS2-VASc score and the risk of thrombus or SEC. However, LAA thrombus and SEC in the LA were found in 2 patients with a CHA2DS2-VASc score of 7.

On the other hand, in patients with no thrombotic risk factors (CHA2DS2-VASc = 0; 9 patients) 1 patient was diagnosed with SEC. LAA thrombus was also found in 2 male patients (12.5% of all thrombi) with a CHA2DS2-VASc score of 1. Puwanat et al. analyzed mainly patients at low risk of stroke (80% of patients presented a CHA2DS2 score of 1 or lower) admitted for AF ablation. SEC and thrombus in the LA were reported in 0.6% and 1.6% of the patients, respectively (of a total of 1058 patients). No thrombi in the LA were found in patients with a CHA2DS2 score of 0.

In a study by Rader et al. analyzing a group of patients admitted for DCC, thrombi in the LAA were found in 3% and SEC in 24% of the patients with a CHA2DS2 score of 0. In this study, in patients with a CHA2DS2 score of 2 or higher, thrombi were observed in 13% and SEC in at least 44% of the patients.

In a multivariate analysis, Wysokinski et al. found that the CHADS2 score was a predictor of thrombus in the LAA. However, when analyzing individual components, only some parameters of this scale (HF, history of stroke/TIA, diabetes), as well as chronic AF, duration of arrhythmia, and the presence of SEC were found to be independent risk factors for thrombus. This model was characterized by high diagnostic power (AUC, 0.90). The above results confirm the validity of recommendations for DCC and a mandatory 3-week preparation period or the need to perform TEE before cardioversion. The current European Society of Cardiology guidelines clarify how to proceed with patients at a low risk of thromboembolic complications. Only the CHA2DS2-VASc score (not CHA2DS2) is recommended for assessing the risk of stroke in patients with nonvalvular AF. OAC is recommended for all men with a CHA2DS2-VASc score of 2 or higher and for all women with a score of 3 or higher. In the case of men with a CHA2DS2-VASc score of 1 or women with a CHA2DS2-VASc score of 2, OAC should be considered depending on the individual characteristics of the patient and his or her preferences.

Limitations Our study has a number of limitations. First, we did not use any specific tests to verify patient’s compliance, test cognitive function, or monitor drug administration. It was a retrospective study and we did not have detailed data on the long-term history of the first and recurrent episodes of AF. We decided not to include these factors into analysis. Secondly, in our patients, the TEE exams were performed by 2 experienced specialists.
In doubtful cases, the third expert in the field was consulted. In fact, misinterpretation was possible. Due to the retrospective design of the study, we were not able to conduct inter- and intraobserver variability analysis as well as a 4-week follow-up of the patients. Moreover, patients who were not properly anticoagulated with NOACs (irrespective of the amount of missed medications) were classified as requiring TEE. We have no data on the number of missed drug doses.

Conclusions Persistent AF and AFI untreated or treated ineffectively with OACs predispose to thrombus formation in the LAA and SEC in the LA. In patients inadequately anticoagulated who require urgent DCC, the CHA2DS2-VASc score may be insufficient to determine the risk of thrombus. Thrombus occurs much more frequently in patients admitted urgently because of ACS or decompensated HF than in elective patients with inadequate anticoagulation before planned DCC. In patients admitted urgently, thrombus was observed despite the short duration of arrhythmia (≤48 hours). History of myocardial infarction is a predictor of thrombus in the LAA, and HF, decreased LVEF (<40%), and enlarged LA (>45 mm) are predictors of SEC in the LA. TEE performed in this group of patients ensures the safety of cardioversion.

Contribution statement AB designed the study, collected the data, discussed the results, and coordinated funding for the study. JZ collected the data, performed statistical analysis, and wrote the manuscript. MM performed statistical analysis. KK, RSZ, and JK collected the data. RD and MM collected the data and discussed the results. AN, PK, and ASZ discussed the results. All authors contributed to the interpretation of the data, reviewed the manuscript, and approved the final version of the manuscript before submission.

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