Transesophageal Echocardiography-Guided Cardioversion After Cardiac Operations

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Background. Transesophageal echocardiography (TEE) is often performed during cardiac operations. The need to repeat TEE to exclude left atrial or left atrial appendage thrombus before direct current cardioversion (DCCV) in patients with a recent intraoperative TEE showing no thrombus is unclear. We sought to determine the incidence of and risk factors for new thrombus in patients undergoing TEE-guided DCCV after cardiac operations.

Methods. We reviewed 817 patients referred for TEE-guided DCCV within 30 days of a cardiac operation and an intraoperative TEE. Patients were excluded if the intraoperative TEE showed thrombus or a surgical left atrial appendage intervention was performed. Univariate logistic regression identified risk factors for thrombus.

Results. The study included 362 patients (71% male) with a mean age of 69 years. Median time from the operation to DCCV was 6 days. Thrombus was present in 13 patients (3.6%) on TEE before cardioversion; DCCV was cancelled in these patients. Heart failure was associated with a significantly higher risk of new thrombus formation (7% vs 2%; odds ratio, 3.26; 95% confidence interval, 1.07 to 9.95). Preoperative atrial arrhythmias, duration of perioperative arrhythmias, level of anticoagulation, and time from operation to DCCV were not significantly associated with thrombus. Thrombus was not associated with 30-day mortality.

Conclusions. Development of new thrombus in patients with atrial arrhythmias early after cardiac operations is not uncommon, especially in patients with heart failure. Patients at high risk for thromboembolic events should undergo TEE before DCCV, even if a recent intraoperative TEE showed no thrombus.

Patients and Methods

The Mayo Clinic Institutional Review Board approved this study and waived the need for patient consent.

Patient Selection

We conducted a retrospective cohort study of adults referred to the Mayo Clinic Cardioversion Unit between May 2000 and July 2009. Patients who provided prior authorization for use of their medical record for research purposes were included if they were referred for a DCCV for treatment of atrial arrhythmias within 30 days of a cardiac operation that included an intraoperative TEE. Patients were excluded if their intraoperative TEE demonstrated LA or LAA thrombus, if their procedure included surgical intervention on the LAA, such as ligation or suture closure, or if they underwent LAA closure before the current operation.

Anticoagulation Before DCCV

As specified in our institution’s Cardioversion Unit protocol, hospitalized patients with acute or postoperative atrial arrhythmias referred for DCCV required a TEE before DCCV if they were not anticoagulated with intravenous unfractionated heparin within 48 hours of arrhythmia onset. Patients who were not therapeutically

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Abbreviations and Acronyms

ASD  = atrial septal defect  
AV  = aortic valve  
AVR  = aortic valve replacement  
CABG  = coronary artery bypass grafting  
CHADS2  = congestive heart failure, hypertension, age ≥75 years, diabetes, and stroke  
CHA2DS2-VASc  = congestive heart failure, hypertension, age ≥75 years, diabetes, prior stroke, vascular disease, age 65 to 74 years, and sex category (female gender)  
DCCV  = direct current cardioversion  
EF  = ejection fraction  
INR  = international normalized ratio  
IQR  = interquartile range  
LA  = left atrial  
LAA  = left atrial appendage  
LVEF  = left ventricular ejection fraction  
MV  = mitral valve  
TEE  = transesophageal echocardiogram  
TIA  = transient ischemic attack  
TV  = tricuspid valve

anticoagulated, defined as an activated partial thromboplastin time of less than 50 seconds or an international normalized ratio (INR) of less than 2, received an additional weight-adjusted bolus of unfractionated heparin coupled with an increased rate of heparin infusion before TEE and DCCV. Patients with therapeutic levels of anticoagulation within 48 hours of arrhythmia onset could still undergo a TEE before DCCV at the discretion of the referring physician.

TEE Examination

Intraoperative and pre-DCCV TEEs were performed by level 3 trained echocardiographers [6] with the Philips Sonos 5500 (Philips Medical Systems, Andover, MA) or Acuson (Siemens, Mountain View, CA) echocardiography systems. The pre-DCCV TEE examination was performed as previously described and included a thorough examination of the LA and LAA [7, 8]. If thrombus was detected, the DCCV was canceled, and the patient received a course of anticoagulation in accordance with guideline recommendations [4].

All pre-DCCV or intraoperative TEE studies suggesting thrombus were retrospectively reviewed by the authors (M.W.C., V.T.N., N.M.A.). Thrombus was defined as an echogenic mass in the LA or LAA that was distinct from the endocardium and detected on more than one imaging plane [7]. The authors also reviewed the intraoperative TEEs of all patients with thrombus on their pre-DCCV TEE to confirm absence of thrombus on the intraoperative TEE.

DCCV Procedure

The DCCV procedure was performed in the same manner as previously described [8]. The DCCV procedure was considered successful if it restored sinus rhythm until the patient was dismissed from the Cardioversion Unit.

Data Collection and Variable Definitions

Clinical and echocardiographic data were prospectively entered into the Mayo Clinic Echocardiography Laboratory and Cardioversion Unit databases. Preoperative left ventricular ejection fraction (EF), LA volume index, and diastolic function grade were defined according to the most recent preoperative TTE up to 100 days before the operation. If a preoperative TTE was unavailable, the prebypass intraoperative TEE was used to define the preoperative left ventricular EF.

CHADS2 (congestive heart failure, hypertension, age ≥75 years, diabetes, and stroke) and CHA2DS2-VASc scores according to published scales [4].

Details regarding operative interventions and postoperative outcomes were obtained from a prospectively collected clinical database of cardiac surgical patients and electronic medical record review. Postoperative events included death, transient ischemic attack (TIA), or permanent stroke occurring within 30 days of the operation or at any time during the index hospitalization.

Statistical Analysis

Continuous variables are expressed as mean ± standard deviation if normally distributed or as median with interquartile range (IQR) if not normally distributed. Independent sample t tests or Wilcoxon rank sum tests were used to compare continuous variables and χ² or Fisher exact tests were used to compare categoric variables. Univariate logistic regression identified risk factors for new thrombus formation. An α of 0.05 served as the threshold for statistical significance. Analyses were performed using JMP and SAS statistical software (SAS Institute, Cary, NC).

Results

Study Cohort

From May 2000 to July 2009, 817 patients were referred for DCCV within 30 days of a cardiac operation and an intraoperative TEE. Two patients were excluded due to thrombus on their intraoperative TEE and 359 because they did not undergo TEE-guided DCCV. Of the remaining 456 patients, 93 were excluded because they underwent surgical intervention on the LAA, and 1 patient was excluded due to prior percutaneous LAA closure. The final study group included 362 patients.
Baseline Characteristics

Table 1 reports the baseline patient characteristics. Mean age was 69 years, and 71% were male. Hypertension was present in 60%, heart failure in 27%, and diabetes mellitus in 25%; a prior stroke or TIA had occurred in 12%, and 40% had a preoperative history of atrial arrhythmias. Median preoperative left ventricular EF was normal at 0.60 (IQR, 0.51 to 0.65) but was less than 0.50 in 19% of patients. The duration of postoperative atrial arrhythmias before TEE-guided DCCV was less than 2 days in 20% of patients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total (N = 362)</th>
<th>Thrombus (n = 13)</th>
<th>No Thrombus (n = 349)</th>
<th>p Valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>69 ± 13</td>
<td>68 ± 14</td>
<td>69 ± 13</td>
<td>0.75</td>
</tr>
<tr>
<td>Male gender</td>
<td>257 (71)</td>
<td>8 (62)</td>
<td>249 (71)</td>
<td>0.44</td>
</tr>
<tr>
<td>Hypertension</td>
<td>216 (60)</td>
<td>9 (62)</td>
<td>207 (59)</td>
<td>0.47</td>
</tr>
<tr>
<td>Heart failure</td>
<td>99 (27)</td>
<td>7 (54)</td>
<td>92 (26)</td>
<td>0.03</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>173 (48)</td>
<td>9 (62)</td>
<td>164 (47)</td>
<td>0.12</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>90 (25)</td>
<td>4 (31)</td>
<td>86 (25)</td>
<td>0.62</td>
</tr>
<tr>
<td>Prior stroke</td>
<td>21 (6)</td>
<td>2 (15)</td>
<td>19 (5)</td>
<td>0.13</td>
</tr>
<tr>
<td>Prior transient ischemic attack</td>
<td>23 (6)</td>
<td>1 (8)</td>
<td>22 (6)</td>
<td>0.84</td>
</tr>
<tr>
<td>Preoperative ejection fraction</td>
<td>144 (40)</td>
<td>8 (62)</td>
<td>136 (39)</td>
<td>0.10</td>
</tr>
<tr>
<td>CHADS2 score</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>2 (1–3)</td>
<td>0.11c</td>
</tr>
<tr>
<td>CHA2DS2-VASc score</td>
<td>3 (2–4)</td>
<td>4 (3–5)</td>
<td>3 (2–4)</td>
<td>0.17c</td>
</tr>
</tbody>
</table>

Annualized stroke risk based on
- CHADS2 score: 4.1 (2.1), 5.1 (2.9), 4.0 (2.1), p = 0.11
- CHA2DS2-VASc score: 3.7 (2.5), 4.8 (2.9), 3.7 (2.5), p = 0.19

Type of operation
- Isolated CABG: 52 (14), 3 (23), 49 (14)
- Isolated aortic valve: 70 (19), 1 (8), 69 (20)
- Isolated mitral valve: 48 (13), 1 (8), 47 (13)
- CABG + aortic valve: 63 (17), 3 (23), 60 (17)
- CABG + mitral valve: 22 (6), 1 (8), 21 (6)
- Mitral valve + tricuspid valve: 11 (3), 1 (8), 10 (3)
- Congenital heart disease: 21 (6), 1 (8), 20 (6)
- Other: 75 (20), 2 (15), 73 (21)

Presenting arrhythmia
- Atrial fibrillation: 253 (70), 11 (85), 242 (69), p = 0.24
- Atrial flutter: 99 (27)n, 2 (15), 97 (28)n, p = 0.32
- Atrial tachycardia: 11 (3), 0 (0), 11 (3), p = 0.52

Anticoagulation at time of DCCVf
- Warfarin use: 242 (67), 12 (92), 230 (66), p = 0.05
- Unfractionated or low-molecular-weight heparin: 275 (76), 11 (85), 264 (76), p = 0.46
- Any therapeutic anticoagulation at time of DCCV: 198 (55), 7 (54), 191 (55), p = 0.95

Atrial arrhythmia >48 hours in duration before DCCVg
- 286 (80), 12 (92), 274 (79), p = 0.26

Days from operation to DCCV
- 6 (5–9), 7 (6–14), 6 (5–9), p = 0.22c

Left atrial appendage emptying velocity, cm/s
- 35 (23–50), 14 (11–17), 35 (23–51), <0.001c

Hospital length of stay, days
- 9 (7–12), 8 (6–13), 9 (7–12), 0.35c

a Continuous variables are presented as mean ± standard deviation or as median (interquartile range). Categoric variables are presented as number (%), with the percentages based on the total patients in each column. b The p values are based on a χ² test for categoric variables and an independent t test for continuous variables, unless indicated. c The p value is based on the Wilcoxon rank sum test due to skewed distribution of variables.

Table 1. Baseline Clinical and Echocardiographic Characteristics of the Study Population

CABG = coronary artery bypass grafting; CHADS2 = congestive heart failure, hypertension, age ≥75 years, diabetes, and stroke; CHA2DS2-VASc = congestive heart failure, hypertension, age ≥75 years, diabetes, prior stroke, vascular disease, age 65 to 74 years, vascular disease, and sex category (female gender); DCCV = direct-current cardioversion.
patients. Median time from operation to DCCV for all patients was 6 days (IQR, 5 to 9 days).

**Thrombus Incidence and Predictors**

Thrombus was present in 13 of 362 patients (3.6%) on TEE before planned DCCV. All thrombi were detected in the LAA. Table 2 outlines characteristics of individual patients with postoperative LA/LAA thrombus. Of those 13 patients, 8 were in sinus rhythm before their cardiac operation, and 5 had atrial arrhythmias preceding their operation. In the 8 patients in sinus rhythm preoperatively, the median duration of new postoperative atrial arrhythmias before planned TEE-guided DCCV was 5 days.

Current or prior heart failure was associated with significant risk of new thrombus formation (odds ratio, 3.26; 95% confidence interval, 1.07 to 9.95). Thrombus developed in 7% of those with vs 2% of those without heart failure ($p = 0.03$). An EF of less than 0.50 was also associated with thrombus formation (odds ratio, 3.82; 95% confidence interval, 1.24 to 11.7). Median LAA emptying velocities were significantly lower in patients with thrombus (14 vs 35 cm/s; $p < 0.001$). Thrombus developed in 1 of the 72 patients (1.4%) with atrial arrhythmias of less than 48 hours vs in 12 of the 286 patients (4.2%) with atrial arrhythmias greater than 48 hours ($p = 0.26$). The type of operation, time from operation to referral for DCCV, presenting atrial arrhythmia, and a history of preoperative atrial arrhythmias were not significantly different between those in whom LA/LAA thrombus did or did not develop (Table 1).

Among the 362 patients, median preoperative CHADS$_2$ score was 2 and the median CHA$_2$DS$_2$-VASc score was 3. Median CHADS$_2$ score was 2 in those with and without thrombus ($p = 0.11$). Median CHA$_2$DS$_2$-VASc score was 4 in those with thrombus and 3 in those without thrombus ($p = 0.17$). The annualized stroke risk calculated by the CHADS$_2$ and CHA$_2$DS$_2$-VASc scores was not different between those with and without thrombus (Table 1). CHADS$_2$ and CHA$_2$DS$_2$-VASc scores were not significantly different between the 3 patients undergoing isolated CABG who developed thrombus and the 49 isolated CABG patients who did not develop thrombus (CHADS$_2$: $p = 0.64$; CHA$_2$DS$_2$-VASc: $p = 0.79$).

LA volume index and left ventricular diastolic function grade were not significantly associated with thrombus formation.

**Anticoagulation Before DCCV**

At the time of DCCV, 242 of 362 patients (67%) were receiving warfarin, and only 89 (37%) of those were therapeutically anticoagulated to an INR of 2 or higher. Of the 273 patients with an INR of less than 2, 109 (40%) were therapeutically anticoagulated with heparin to an activated partial thromboplastin time 50 or more seconds. Overall, 198 of 362 patients (55%) were therapeutically anticoagulated upon presentation for DCCV, and 144 (40%) were subtherapeutically anticoagulated on heparin but received a bolus of intravenous heparin and an increase in their heparin infusion rate before DCCV according to our Cardioversion Unit protocol. Among the remaining 20 patients (5.6%), 13 had an INR of 1.5 to 1.9 at the time of DCCV and 7 had an INR of less than 1.5 and did not receive additional heparin at the discretion of the referring physician. Seven of these 20 patients had less than 48 hours of atrial arrhythmias before DCCV, including 4 of the 7 with an INR of less than 1.5.

Rates of thrombus formation were 3.5% (7 of 198) among patients who presented to DCCV with therapeutic levels of anticoagulation and 3.7% (6 of 164) among the patients with subtherapeutic anticoagulation ($p = 0.95$).

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**Table 2. Clinical and Surgical Characteristics of Patients With Left Atrial or Left Atrial Appendage Thrombus After Cardiac Operation on Transesophageal Echocardiogram Before Direct-Current Cardioversion**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Gender</th>
<th>Type of Operation</th>
<th>LVEF</th>
<th>Days of Postoperative Atrial Arrhythmia Before TEE</th>
<th>Days From Operation to TEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Male</td>
<td>MV repair + CABG</td>
<td>0.35$^a$</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>44</td>
<td>Male</td>
<td>CABG</td>
<td>0.34</td>
<td>Preoperative</td>
<td>7</td>
</tr>
<tr>
<td>59</td>
<td>Male</td>
<td>Secundum ASD closure + TV annuloplasty</td>
<td>0.63</td>
<td>Preoperative</td>
<td>4</td>
</tr>
<tr>
<td>64</td>
<td>Male</td>
<td>AVR + ascending aorta repair</td>
<td>0.47</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>74</td>
<td>Male</td>
<td>CABG</td>
<td>0.35$^b$</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>88</td>
<td>Male</td>
<td>AV replacement + CABG</td>
<td>0.52</td>
<td>Preoperative</td>
<td>23</td>
</tr>
<tr>
<td>64</td>
<td>Male</td>
<td>MV replacement</td>
<td>0.41</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>65</td>
<td>Male</td>
<td>CABG</td>
<td>0.48</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>41</td>
<td>Female</td>
<td>TV + MV repair</td>
<td>0.63</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>79</td>
<td>Female</td>
<td>AV replacement + TV replacement</td>
<td>0.62</td>
<td>Preoperative</td>
<td>8</td>
</tr>
<tr>
<td>69</td>
<td>Female</td>
<td>Pericardectomy</td>
<td>0.60</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>85</td>
<td>Female</td>
<td>AV replacement + CABG</td>
<td>0.58</td>
<td>Preoperative</td>
<td>12</td>
</tr>
<tr>
<td>79</td>
<td>Female</td>
<td>AV replacement + CABG</td>
<td>0.70</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

$^a$ LVEF was obtained from the preoperative TEE, unless indicated otherwise.  
$^b$ The preoperative LVEF was obtained from the intraoperative prebypass TEE because no preoperative TEE was available.

ASD = atrial septal defect;  
AV = aortic valve;  
AVR = aortic valve replacement;  
CABG = coronary artery bypass grafting;  
LVEF = left ventricular ejection fraction;  
MV = mitral valve;  
TEE = transesophageal echocardiogram;  
TV = tricuspid valve.
Postoperative Outcomes

DCCV was cancelled in the 13 patients with confirmed LA/LAA thrombus. Cardioversion was cancelled in another 10 patients, including 3 patients with dense echo contrast but no thrombus, 3 patients who spontaneously cardioverted to sinus rhythm, and other reasons in 4 patients. DCCV was successful in 296 of the 339 patients (87%) in whom it was attempted.

Postoperative events included death in 6 patients (1.7%), permanent stroke in 5 (1.4%), TIA in 3 (1.0%), and any event in 12 (3.3%). Postoperative stroke and death occurred in 2 patients. Stroke occurred in 1 of 13 patients (7.7%) with thrombus vs in 4 of 349 patients (1.1%) without thrombus (p = 0.047). Of the 8 patients who experienced TIA or stroke, 6 events occurred between the operation and DCCV. Only 2 neurologic events occurred after DCCV, and neither of these 2 patients demonstrated thrombus on their pre-DCCV TEE. The presence of thrombus was not significantly associated with an increased 30-day likelihood of postoperative death (p = 0.20) or a composite outcome of stroke, TIA, or death (p = 0.36).

Patients Undergoing DCCV Without TEE Guidance

As previously noted, 359 patients did not undergo TEE at the time of DCCV. Compared with patients in our primary analysis who underwent a TEE before DCCV, mean age (69 years; p = 0.49) and the prevalence of prior atrial arrhythmias (39%; p = 0.77) were no different in these patients without TEE at the time of DCCV. However, patients who did not undergo a TEE trended toward a lower prevalence of heart failure (22% vs 27%; p = 0.10), were less often male (62% vs 71%; p < 0.01), had a shorter median time from the operation to cardioversion (6 [IQR, 4 to 7] days vs 6 [IQR, 5 to 9 days]; p < 0.001), a higher prevalence of atrial arrhythmias in less than 48 hours before DCCV (55% vs 20%; p < 0.001), a higher prevalence of therapeutic anticoagulation at the time of cardioversion (64% vs 55%; p = 0.01), and a shorter median length of hospitalization (8 [IQR, 7 to 10 days] vs 9 [IQR, 7 to 12] days; p < 0.001).

Postoperative strokes occurred in 2 patients who did not undergo TEE at the time of DCCV. The TEE in 1 of these patients showed no source of embolism 3 days after his stroke and 2 days before his DCCV. The intraoperative TEE in the other patient documented a patent foramen ovale, and postoperative ultrasound documented a deep venous thrombosis. He was anticoagulated and underwent DCCV without TEE 6 days after his stroke and 9 days after his operation. No patients who did not undergo TEE before DCCV died in the first 30 postoperative days or index hospitalization.

Comment

This study demonstrates that new intracardiac thrombus developed in 3.6% of patients with postoperative atrial arrhythmias undergoing TEE-guided DCCV a median of 6 days after the cardiac operation with an intraoperative TEE that showed no intracardiac thrombus. Previous studies have reported a prevalence of intracardiac thrombus of 2% to 28% in patients with atrial arrhythmias of variable duration undergoing TEE. However, these studies were not performed specifically in patients after cardiac operations [11–13]. Given the prevalence of postoperative atrial arrhythmias after cardiac operations, our study provides evidence to support the use of TEE to guide DCCV in the early postoperative period, particularly in patients with risk factors for thrombus, even if they had no thrombus on a recent intraoperative TEE.

Predictors of LA/LAA Thrombus

We found that TEE before DCCV documented LA/LAA thrombus in 7% of patients with current or prior heart failure vs only 2% of patient without heart failure. Thrombus development was more prevalent in patients with a preoperative left ventricular EF of less than 0.50, consistent with prior work demonstrating an association between heart failure and LA/LAA thrombus [14]. Other studies have shown that patients with heart failure carry a higher risk of thromboembolism after DCCV in cases of atrial fibrillation in less than 48 hours [15]. Our results extend these findings to the postoperative setting, suggesting that patients with heart failure undergoing DCCV for postoperative atrial arrhythmias require a TEE to thoroughly assess for LA/LAA thrombus.

In patients without a clinical history of heart failure, the rate of new thrombus detection on TEE before DCCV was significantly lower (2%). Thrombus occurred in only 3 of 218 individuals (1.4%) among those without clinical heart failure and an EF of 0.50 or higher. Two of those 3 patients had congenital heart disease and the other had a history of rheumatic heart disease plus subtherapeutic anticoagulation at the time of DCCV. Therefore, among patients with postoperative atrial arrhythmias referred for DCCV shortly after a cardiac operation with an intraoperative TEE showing no intracardiac thrombus, those with no clinical history of heart failure, normal left ventricular function, therapeutic anticoagulation at the time of cardioversion, and no rheumatic or congenital heart disease may represent a group in which the threshold for obtaining a TEE before DCCV is higher than in patients with a greater risk profile.

We found no association between CHADS2 scores, CHA2DS2-VASc scores, or annualized stroke risk and thrombus development. Our findings are consistent with prior data demonstrating that CHADS2 is not a strong predictor of LA/LAA thrombus [16]. The CHADS2 and CHA2DS2-VASc schemes should be used to predict stroke risk and guide decisions regarding long-term anticoagulation. However, they should not be used to predict LA/LAA thrombus risk or guide decisions regarding the need for TEE before DCCV, particularly in patients shortly after cardiac operations.

Clinical Outcomes

DCCV for treatment of atrial arrhythmias has a highly variable acute success rate, ranging from 70% to 95% [17, 18]. However, studies of DCCV success rates have...
typically not focused on patients shortly after cardiac operations. In our study, DCCV successfully restored sinus rhythm in 87% of patients in whom it was attempted.

Our study found a marginally significant association between LA/LAA thrombus and permanent stroke and no association between LA/LAA thrombus and postoperative death or composite events. The event rates were small regardless of thrombus status. Other studies have also demonstrated that LA/LAA thrombus on pre-DCCV TEE is not significantly associated with subsequent embolic events [5, 13]. The use of anticoagulation if thrombus is detected likely explains these limited associations between thrombus and subsequent event rates.

The primary analysis excluded 359 patients who did not undergo a TEE before DCCV. These patients had less heart failure, a shorter duration of atrial arrhythmias before DCCV, less time between the operation and DCCV, and higher rates of therapeutic anticoagulation before DCCV. No post-DCCV events occurred in this group. These patients are more likely to represent those in whom a TEE could be safely deferred. However, as our primary analysis demonstrates, patients with more risk factors for thrombus, particularly clinical heart failure or low EF, should undergo a TEE-guided DCCV in the early postoperative setting.

This is a single-institution retrospective review of patients presenting for TEE before DCCV for postoperative arrhythmias after cardiac operations. Our study is limited by the low number of outcome events and only 30 days of postoperative surveillance. Data on LAA morphology, an emerging risk factor for stroke in atrial fibrillation, were not available [19]. However, the intraoperative TEE assessment included a detailed examination of all lobes of multilobed appendages to exclude thrombus. Perioperative bleeding complications from anticoagulation were not analyzed as part of this study. TEE-related complications, such as esophageal perforations, are exceedingly rare in our practice, and we did not investigate the incidence of this complication. Given that only 13 cases of thrombus were detected, we were unable to perform a multivariable analysis to adjust for potential confounders of the association between heart failure and new thrombus development. Finally, this study occurred before widespread clinical use of new anticoagulants. The results are therefore not generalizable to patients who receive these agents.

In conclusion, the development of new atrial thrombus in patients undergoing TEE before DCCV for treatment of atrial arrhythmias after cardiac operations is not uncommon. A present or past history of heart failure and an EF of less than 0.50 were associated with an increased risk of LA/LAA thrombus. On the basis of these findings, patients with thrombotic risk factors, particularly clinical heart failure or low EF, undergoing DCCV for atrial arrhythmias after cardiac operations require careful evaluation with TEE, even if they recently underwent an intraoperative TEE that showed no LA/LAA thrombus.

References