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.**

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Atrial arrhythmias occur in up to 60% of patients after cardiac operations and are associated with adverse outcomes, including prolonged hospitalizations, stroke, and death [1–3]. The management of postoperative atrial arrhythmias may include direct-current cardioversion (DCCV) [4]. Patients frequently undergo transesophageal echocardiography (TEE) to exclude left atrial (LA) or left atrial appendage (LAA) thrombi before DCCV [5]. The need to repeat a TEE to guide DCCV in patients with atrial arrhythmias after recent cardiac operations that included an intraoperative TEE demonstrating no intracardiac thrombus remains unclear.

This study sought to assess the incidence of and risk factors for new LA or LAA thrombus in patients with atrial arrhythmias after cardiac operations referred for TEE-guided DCCV. We also compared early postoperative outcomes between those with and without thrombus at the time of TEE-guided DCCV.

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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
$CHADS_2$	= congestive heart failure, hypertension, age ≥75 years, diabetes, and stroke
CHA_2DS_2-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.

$CHADS_2$ (congestive heart failure, hypertension, age ≥75 years, diabetes, and stroke) and CHA_2DS_2-VASc (congestive heart failure, hypertension, age ≥75 years, diabetes, prior stroke, vascular disease, age 65 to 74 years, sex category [female gender]) scores were calculated in all patients as a marker of overall vascular disease [9, 10]. We also calculated $CHADS_2$ and CHA_2DS_2-VASc scores in patients who underwent isolated coronary artery bypass grafting, because these scoring systems have not been validated in patients with valvular or other structural heart disease. We assigned an average annual stroke risk to all patients by their $CHADS_2$ and CHA_2DS_2-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 χ^2 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.