Transesophageal Echocardiography and Cardioversion Trends in Patients with Atrial Fibrillation: A 10-Year Survey

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Background: Transesophageal echocardiography (TEE) has long been used to assess for left atrial thrombus (LAT) in patients undergoing direct-current cardioversion (DCC) for atrial fibrillation or flutter. However, little is known about its recent trends and current applications.

Methods: In this retrospective study, 3,191 serial transesophageal echocardiographic studies in 2,705 unique patients (mean age, 66 ± 13 years; 68% men) with atrial fibrillation or atrial flutter who underwent TEE before DCC from 1999 to 2008 were identified using the Cleveland Clinic echocardiography database. Clinical data and information on the presence of spontaneous echocardiographic contrast, sludge, or LAT before DCC were obtained as well as the total number of transesophageal echocardiographic studies and DCC procedures performed in outpatient or inpatient settings.

Results: Increasing trends of TEE-guided DCC were observed over the past 10 years (25% in 1999, 34% in 2008). TEE-guided DCC was also performed more often in the outpatient setting (21% in 1999, 37% in 2008). There was no yearly difference for the prevalence of LAT or sludge (8% overall; $P = .12$).

Conclusions: Over the past 10 years, trends have suggested that the application of TEE-guided DCC compared with the conventional approach have consistently grown and that more DCC procedures are done in the outpatient setting. Given the high LAT or sludge detection rate of 8%, TEE-guided DCC has continued to be an important part of atrial fibrillation management. (J Am Soc Echocardiogr 2012;25:962-8.)

Keywords: Transesophageal echocardiography, Trends, Atrial fibrillation, Direct current cardioversion

Atrial fibrillation (AF) is the most common arrhythmia seen in general clinical practice[1] and is associated with increased morbidity and mortality.[2] It is estimated that almost 2 million people in the United States have forms of AF.[3,4] Because of the rising prevalence of chronic heart disease, the aging population, and better diagnostic tools, we have observed an increase in the prevalence and rate of hospitalization related to AF in the past 20 years. Projections are that there will be up to a threefold increase in the number of patients with AF by 2050.[5,6]

Direct-current cardioversion (DCC) has long been used to convert patients with AF back to normal sinus rhythm. However, this intervention is associated with risk for stroke after DCC.[7-9] Conventionally, to reduce this risk, anticoagulation therapy has been recommended for ≥3 weeks before elective DCC and 4 weeks after the procedure.[10] Another alternative and more recent strategy was using transesophageal echocardiography (TEE) to evaluate the left atrium for thrombus and pursuing DCC if no thrombus is detected.[9,11,12]

The Assessment of Cardioversion Using Transesophageal Echocardiography (ACUTE) trial was one of the landmark studies to evaluate the role of TEE as a screening tool in safely conducting DCC in patients with AF by excluding thrombus.[12] It examined the effectiveness of using short-term heparin anticoagulation therapy as an alternate to the conventional strategy of using therapeutic warfarin before DCC. It demonstrated that TEE-guided DCC was not inferior to conventional treatment when comparing the rate of primary end point events (stroke, transient ischemic attack [TIA], and systemic emboli).[13] Moreover, TEE-guided DCC was associated with a lower cumulative cost of up to 24% less than the conventional approach.[14]

Because of the prevalence of AF and because patients often require hospitalization, treatment costs for the health care system are often excessive. At our institution, we investigated trends in the past 10 years of DCC, either guided by TEE or not. The aim of this study was to assess the impact of the ACUTE trial on our group's clinical practice.

METHODS

Patients

From January 1999 through December 2008, 3,299 consecutive or serial AF studies in patients who underwent TEE before DCC

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Abbreviations

ACUTE = Assessment of Cardioversion Using Transesophageal Echocardiography

AF = Atrial fibrillation

AFL = Atrial flutter

CHF = Congestive heart failure

DCC = Direct-current cardioversion

LA = Left atrial

LAA = Left atrial appendage

LAT = Left atrial thrombus

SEC = Spontaneous echocardiographic contrast

TEE = Transesophageal echocardiography

TIA = Transient ischemic attack

were identified from Cleveland Clinic echocardiography and electrophysiology databases. In this retrospective study, we excluded 109 patients because of insufficient documentation of the transesophageal echocardiographic cardioversion. Among the total of 3,190 transesophageal echocardiographic studies included, 2,705 were performed on the unique patients who underwent TEE-guided DCC only once, and the remaining 485 patients underwent the procedure multiple times. This study was approved by the Cleveland Clinic institutional review board.

Clinical variables were obtained from patient records in the week before the date of TEE. $CHADS_2$ scores were calculated at the time of TEE as congestive heart failure (CHF; 1 point), hypertension (1 point), age >75 years (1 point), diabetes mellitus (1 point), and history of stroke or TIA (2 points).[15]

History of DCC, pulmonary vein isolation, coronary artery disease, valvular disease, AF, or atrial flutter (AFL); body mass index; antiarrhythmic drug therapy; and New York Heart Association class were extracted from patients' medical records as well. In addition, the total number of DCC procedures performed each year, the number of patients admitted into the inpatient versus outpatient setting for DCC, and the number of patients who underwent TEE-guided DCC were identified.

Persistent AF was defined as AF that was sustained beyond 7 days or, when it lasted <7 days, there was a need to be cardioverted either pharmacologically or electrically.[16]

TEE

At our institution, TEE was performed using standard multiplane phased-array transducer machines. TEE was performed <24 hours before DCC. Standard protocols were followed in all cases, including written informed consent, lidocaine local anesthesia of the hypopharynx, and conscious sedation with midazolam and/or fentanyl before esophageal intubation and performance of TEE. Using a transducer frequency of 5 MHz, examination of the left atrial (LA) appendage (LAA) anatomy included a continuous scan from 0° to 180° for the examination of trabeculae and multiple lobes as well as the identification of spontaneous echocardiographic contrast (SEC), sludge, and thrombus. Often, the LAA was evaluated at set angles of 45°, 90°, and 120°. Careful attention was made to differentiate thrombus from artifacts, pectinate muscles, and "Coumadin ridge," particularly in multilobed appendages.

Echocardiographic Readings

Transesophageal echocardiographic data reports were reviewed for SEC, sludge, and thrombus. SEC was defined as dynamic "smokelike" echoes with the characteristic swirling motion using optimal gain setting during the cardiac cycle.[17,18] Sludge was defined as a dynamic gelatinous, precipitous echo density (similar to a layering or a meniscus level), without a discrete mass, present throughout the cardiac cycle.[17] Sludge appears more dense and layered than severe SEC. Thrombus was defined as a circumscribed or uniformly echo-dense intracavitary mass distinct from the underlying left atrium or LAA endocardium and the pectinate muscles and present in more than one image plane, less heterogeneous and dynamic than sludge[17,19] (Figure 1, Video 1 [severe SEC] and Video 2 [sludge]). If a thrombus was present, it was often verified in more than one view using multiplane imaging.

Anticoagulation Profile

Patients underwent TEE before DCC to rule out LA thrombus (LAT) due to a lack of therapeutic international normalized ratio of 3 weeks' duration or due to a previous LAT. Patients were either therapeutic on warfarin with international normalized ratios of 2 to 3, dosed with heparin, or bridged with low–molecular weight heparin. All patients were adequately anticoagulated before DCC if no thrombus was found on TEE. Patients with thrombi were bridged to warfarin and anticoagulated for 3 to 4 weeks before future DCC.

Interobserver Variability

To assess interobserver and intraobserver variability, a nested case group of 20 patients from the TEE database, including normal SEC, sludge, and thrombus (five each), were randomly selected and analyzed by two same observers at two points 4 weeks apart. Intraobserver and interobserver concordance was very high in the identification of both sludge and thrombus ($\kappa \sim 1.00$) and was previously reported.[20]

Statistical Analysis

The frequency of TEE characteristics such as SEC, sludge, and thrombus in the total population was compared across each individual year using χ^2 tests. Cochran-Armitage tests for trend were used to compare $CHADS_2$ score variables over the 10-year period. Finally, the rates of TEE-guided DCC, conventional approach, and outpatient and inpatient hospitalizations were compared across the years of study to explore their possible differences. Statistical significance was defined as a P value $< .05$. All the statistical analysis was done using Stata version 11 (StataCorp LP, College Station, TX).

RESULTS

There were 2,705 unique individual patients (mean age, 66 ± 13 years; 68% men) who underwent 3,191 screening transesophageal echocardiographic studies before DCC (some underwent repeat TEE) for persistent AF or AFL. Patient demographics and characteristics are shown in Table 1. The overall $CHADS_2$ score averaged 1.99, with the majority of patients (52%) having scores of 2 or 3, observed in 30% and 22% of patients, respectively. There was a significant drop in the prevalence of patients who underwent TEE-guided cardioversion for AFL compared with the total number of patients undergoing TEE cardioversion ($P = .005$). The highest rate was observed in 2000, with 22%, and the lowest in 2007, with 8% of all cases.

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