Frequency and Significance of Right Atrial Appendage Thrombi in Patients with Persistent Atrial Fibrillation or Atrial Flutter

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Background: Atrial fibrillation (AF) and atrial flutter (AFL) are strong atrial thrombosis (THR) risk factors. In recent-onset tachyarrhythmias, the incidence of left atrial appendage (LAA) THR, detected by transesophageal echocardiography (TEE), has been widely studied, ranging from 6% to 18% (AF) and 4% to 11% (AFL). On the contrary, few studies have assessed right atrial appendage (RAA) THR, and there is no information on the relation between the RAA flow characteristics and the presence of RAA THR. The aims of this study were to evaluate the incidence of RAA THR in a population of patients undergoing TEE-guided cardioversion for recent-onset atrial tachyarrhythmias and to analyze RAA Doppler flow and its relation to thrombus formation.

Methods: From 1998 to 2012, patients admitted to the emergency department for persistent, non-self-terminating atrial tachyarrhythmia lasting >2 days who gave informed consent for TEE-guided cardioversion were prospectively enrolled in the study. Among 1,042 patients, complete anatomic and functional studies of the LAA and RAA were feasible in 983 (AF, n = 810 [23%]; AFL, n = 173 [5%]). The presence of RAA and LAA THR, appendage emptying velocities, and the presence of severe spontaneous echocardiographic contrast were studied.

Results: The overall incidence of atrial THR was 9.7% (96 of 983). The incidence of THR was 9.3% (91 of 983) in the LAA and 0.73% (seven of 983) in the RAA ($P < .01$). In the AF and AFL groups, the incidence of LAA THR was 10.3% (83 of 805), compared with 0.75% (six of 805) for RAA THR ($P < .01$). Among patients with AFL, the incidence of LAA THR was 6% (10 of 178), compared with 0.6% (one of 178) for RAA THR ($P < .01$). The mean LAA peak emptying velocity was 24 cm/sec (range, 10–32 cm/sec) in patients with LAA THR, compared with 38 cm/sec (range, 20–59 cm/sec) in those without THR; the mean RAA peak emptying velocity was 17 $\pm$ 7 cm/sec in patients with RAA THR, compared with 34 $\pm$ 13 cm/sec in those without THR ($P < .001$).

Conclusions: RAA thrombi are significantly less frequent than LAA thrombi but may reach large dimensions. Multiplane TEE allows RAA morphologic and functional assessment. Before TEE-guided cardioversion, both the LAA and the RAA must be routinely studied. (J Am Soc Echocardiogr 2014;27:1200-7.)

Keywords:: Atrial fibrillation, Atrial flutter, Atrial thrombosis, Left appendage, Right appendage, Transesophageal echocardiography, Cardioversion

Atrial fibrillation (AF) and atrial flutter (AFL) are the most common tachyarrhythmias. One percent to two percent of the world's population is affected by AF, and this prevalence is expected to double in the next 50 years.[1] Four percent of all hospitalizations are due to AF.[2] Apart from the hemodynamic impairment, the importance of these arrhythmias is the thromboembolic risk they confer. At least one in every five strokes may be caused by AF.[1-3] Transesophageal echocardiography (TEE) is a sensitive tool for thrombosis (THR) identification in the left atrium and left atrial appendage (LAA), and TEE-guided cardioversion (CV) has been shown to be as effective as conventional anticoagulation therapy in preventing embolism, with faster arrhythmia resolution.[4] On the other hand, low flow velocity within the LAA and the presence of spontaneous contrast in the LAA are predictors of thromboembolism and thrombus formation in the LAA.[5,6] Up to 98% of THRs are within the LAA.

The incidence of LAA THR has been widely studied, ranging from 6% to 18% (AF) and 1.6% to 27% (AFL), but few data are available on the incidence of right atrial appendage (RAA) THR, whose consequences may be underestimated as it is not always clinically evident. The RAA is not mentioned in the American and European AF guidelines.[7,8] Before CV, most laboratories focus examinations only on the left atrium and LAA, and it seems that, since the first studies,[4] the RAA has been "forgotten." Few investigators have assessed RAA THR, although pulmonary embolism may be a life-threatening

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Abbreviations

AF = Atrial fibrillation

AFL = Atrial flutter

CV = Cardioversion

LAA = Left atrial appendage

RAA = Right atrial appendage

SEC = Spontaneous echocardiographic contrast

TEE = Transesophageal echocardiography

THR = Thrombosis

complication of CV, and there is no information on the relation between RAA flow and the presence of THR. The aims of the study were to evaluate the incidence of RAA THR in a population of patients undergoing TEE-guided CV for recent-onset AF and AFL and to explore the characteristics of RAA Doppler flow and its correlation with thrombus formation. Our study was designed with the intention to restore sinus rhythm in patients with persistent atrial tachyarrhythmias, including AF and AFL, addressing the evaluation of the incidence of RAA THR and analysis of the correlation between RAA Doppler flow and thrombus formation.

METHODS

Study Population

Patients admitted to the emergency department for persistent, nonself-terminating atrial tachyarrhythmia who were candidates for CV were eligible for this study. Inclusion criteria were age ≥ 18 years and arrhythmia duration > 2 days. Patients were informed of the risks and benefits of the two treatment strategies (i.e., ≥3 weeks of oral anticoagulation followed by CV or expedited CV using transesophageal echocardiographic guidance). Patients who gave written consent for TEE-guided CV were prospectively enrolled in the study. Exclusion criteria were onset time > 1 year, underlying acute coronary syndrome, pulmonary embolism or thyrotoxicosis, and the presence of contraindications to TEE. Hemodynamic instability was not a contraindication to enrollment. All patients received anticoagulation with intravenous sodium heparin, low–molecular weight heparin, or an oral anticoagulant (warfarin) at therapeutic doses. Patients free of thrombi on TEE were candidates for CV. Population characteristics are summarized in Table 1. Heart failure was defined as the presence of a clinical scenario of decompensated heart failure at admission with the need for diuretic therapy. Excluding mild degrees of valvular dysfunction, 124 patients were affected by significant valvular heart disease: in 28 cases, prosthetic valves were present, and among patients with native valvulopathy, there were 39 with mitral insufficiency, 13 with mitral stenoses, 34 with aortic stenoses, and 10 with aortic insufficiency. Mitral stenosis, defined as valve area < 2 cm, included rheumatic (nine cases) and degenerative (four cases) forms. The average duration of arrhythmias was 18 days (range, 1–360 days). Informed consent was obtained from all patients.

TEE

All patients underwent transthoracic echocardiography and multiplane TEE <24 hours before the scheduled CV using an Acuson Sequoia 512 ultrasound system (Siemens Healthcare, Erlangen, Germany) from 1998 to 2001 and a Vivid 7 ultrasound system (GE Healthcare, Milan, Italy) from 2002 to 2013. Echocardiographic examinations were performed by experienced operators certified by the Italian Society of Cardiovascular Echography, with competence level III according to the American Society of Echocardiography, performing about 100 transesophageal echocardiographic examinations per year. Studies were digitally recorded in cine loops and reviewed by two independent operators. Interobserver discrepancies occurred in six cases, and accord was reached after review of the images with another well-trained observer not involved in the study. Artifacts were considered when location and echogenicity suggestive of pectinate muscles or of reverberations (in particular the interatrial septum or the terminal crest for the RAA and the left upper pulmonary vein for the LAA) were obtained at different transesophageal rotational angles.

TEE was performed using a 5-MHz multiplane probe. The probe was inserted into the esophagus after topical anesthesia with lidocaine spray. Viscous lidocaine solution was used on the probe to facilitate introduction. Intravenous midazolam hydrochloride 2.5 to 5 mg was used as needed. No significant adverse effects occurred during TEE. Images of the LAA were acquired at 0°, 60°, 90°, and 130° to explore all of its lobes entirely. The RAA was examined in a midesophageal section at 90° and 130°, and additional views were used as needed: upper esophagus transverse 0° with a clockwise rotation of the probe and transgastric right bicameral view at 130° (Figure 1). Generally, the RAA was fully displayed until its bottom at 130 ± 10° and the LAA at 60 ± 10°. However, to achieve a complete exploration and differentiate thrombus from stacked pectinate muscles and reverberations, at least two different views were visualized. To obtain a good pulsed Doppler velocity spectrum, the best view was chosen. The presence of spontaneous echocardiographic contrast (SEC) was classified according to Fatkin *et al.*[9] Dense persistent and very low mobile SEC (Fatkin class 4) was differentiated from true thrombus, defined as a separate mass with a clear, well-defined, "nonsmoking" edge.[9] LAA flow velocities were measured by placing the pulsed Doppler sample volume in the middle part of the LAA orifice, 1 cm inside the cavity. RAA flow velocities were measured in the same modality (Figure 2). In all cases, the highest positive velocities within each of five consecutive cycles were measured and then averaged. When measurements using different views were discordant, the highest value was retained. A cutoff of 25 cm/sec was used to define low emptying velocity.

Table 1 Population characteristics (n = 983)

Characteristic	Value
Men	594 (60%)
Women	389 (40%)
Age (yrs)	69 ± 10 (30–96)
AF	805 (82%)
AFL	178 (18%)
Hypertension	610 (62%)
Coronary artery disease	177 (18%)
Valve disease/prosthesis	124 (13%)
Cardiomyopathy	59 (6%)
"Lone fibrillation"	68 (7%)
History of embolism	2%
Average duration of arrhythmia (d)	18 (1–364)

Main patients' features are reported. Note the high prevalence of hypertensive heart disease.

Statistical Analysis

All data are expressed as mean ± SD. For anatomic and functional comparisons between groups, continuous variables of mean LAA and RAA data were compared by using independent-samples