Use of intracardiac echocardiography to guide implantation of a left atrial appendage occlusion device (PLAATO)

Ivan C. K. Ho, MD,* Petr Neuzil, MD, PhD,† Tomas Mraz, MD,† Zuzana Beldova,† Dan Gross,† Pavel Formanek, MD,† Milos Taborsky, MD, PhD,† Petr Niederle, MD,† Jeremy N. Ruskin, MD,* Vivek Y. Reddy, MD*

*From the *Cardiac Arrhythmia Service, Massachusetts General Hospital, Boston, Massachusetts, and the †Na Homolce Hospital, Prague, Czech Republic.*

BACKGROUND Over 90% of thrombi in atrial fibrillation (AF) originate from the left atrial appendage (LAA). Patients with contraindications to anticoagulation are potential candidates for LAA occlusion using the Percutaneous Left Atrial Appendage Transcatheter Occlusion system (PLAATO, ev3 Inc., Plymouth, MN). Transesophageal echocardiography (TEE) is typically used to guide implantation.

OBJECTIVE This study sought to examine the utility of intracardiac echocardiography (ICE) in providing adequate imaging guidance as an alternative to TEE during PLAATO implantation.

METHODS The study group consisted of 10 patients who underwent PLAATO implantation with simultaneous TEE and ICE imaging guidance. ICE was used to perform the following tasks typically fulfilled by TEE: (1) verification of the absence of LAA thrombus, (2) identification of the LAA ostial dimension for device sizing, (3) guidance of transseptal puncture, (4) verification of the delivery sheath position, and (5) confirmation of location and stability of device before its irrecoverable release. The ability of ICE to perform these tasks was assessed from three separate positions: the standard right atrial (RA) position, within the coronary sinus (CS), and the right ventricular outflow tract.

RESULTS ICE imaging of the LAA was optimal from within the CS, although imaging from the proximal pulmonary artery provided better visualization of the distal LAA in cross-section. The LAA dimensions, confirmation of the absence of LAA thrombus, proper positioning of the delivery sheath, verification of location and stability of the device obtained by ICE were consistent with findings from TEE.

CONCLUSION Using nonconventional imaging planes, ICE imaging was able to perform the intraprocedural functions provided by TEE during implantation of the PLAATO left atrial appendage occlusion device.

KEYWORDS Atrial fibrillation; Intracardiac echocardiography; Left atrial appendage occlusion; Transesophageal echocardiography

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Atrial fibrillation (AF) is an important cause of stroke and systemic thromboembolic events. Despite the proven benefit of oral anticoagulation in preventing strokes in high-risk AF patients, the numerous lifestyle restrictions for patients, narrow therapeutic window, and potential risk of bleeding complications have led to a significant underuse of anticoagulation therapy.[1] Because more than 90% of all thrombi in patients with nonrheumatic AF originate from the left atrial appendage (LAA), AF patients with contraindications to anticoagulation are potential candidates for an LAA occlusion device.[2–5] Recent studies have shown the feasibility and safety of implanting the percutaneous LAA transcatheter occlusion device (PLAATO system, ev3 Inc., Plymouth, MN) in AF patients with contraindication to anticoagulation, with good short-term results and low rates of late complications.[6–8] Transesophageal echocardiography (TEE) typically is used to guide implantation of the PLAATO device. One alternative to TEE-guided implantation was the use of intracardiac echocardiography (ICE), which has proven to be useful in a variety of percutaneous interventional procedures.[9–10] This study examines the utility of ICE in providing adequate imaging guidance as an alternative to TEE during PLAATO implantation.

Methods

The study group consisted of 15 patients with AF who required alternatives to anticoagulation either because of contraindications or ineffectiveness of current therapy (Table 1). Six of the patients had TIA or stroke despite being on anticoagulation, whereas 5 of these 6 patients were unable to maintain their international normalized ratio in the range of 2 to 3 (several of these patients had presented to the hospital with an international normalized ratio over 8), and 1 of these patients had hemorrhagic complications leading to discontinuation of anticoagulation therapy. The other 4 patients had either bleeding complications while on

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Table 1 Study group

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10
Age	61	73	71	56	62	56	68	74	82	68
Sex	F	F	M	M	M	M	M	M	M	M
Type of AF	Paroxysmal	Paroxysmal	Paroxysmal	Permanent	Permanent	Paroxysmal	Permanent	Permanent	Paroxysmal	Permanent
Indication*	1	1,2	4	1	1	3	1,2	2,3	1,3	4
Stroke	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
TIA	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No
HTN	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes
DM	No	No	No	No	Yes	No	Yes	Yes	No	No
HF	No	No	Yes	No	Yes	No	No	Yes	No	Yes
EF (%)	—	>60%	>60%	—	—	>60%	—	<40%	<40%	55%
LAA size by TEE (mm)	21	18	19	21	19	21	20	17	18	21
LAA size by ICE (mm)	23.3	21	21.8	26.7	25	27	20.7	16.8	18.8	25
Expanded LAA by TEE (mm)	26	20.3	24	26	29.8	22.9	23.2	19.3	22	26.4
Device size (mm)	32	29	29	32	32	32	29	23	26	32
Procedure length	40	50	42	36	68	20	38	45	28	49
Repositioning	No	No	Yes	No	No	No	No	No	No	Yes

AF = atrial fibrillation; DM = diabetes mellitus; EF = ejection fraction; F = female; HF = heart failure; HTN = hypertension; ICE = intracardiac echocardiography; LA = left atrium; LAA = left atrial appendage; M = male; TEE = transesophageal echocardiography; TIA = transient ischemic attack. *1 = embolism despite warfarin therapy, 2 = unstable international normalized ratio, 3 = bleeding complications, 4 = other contraindications.

anticoagulation, or were not considered anticoagulation candidates because of their fall risk, history of significant gastrointestinal bleeding, or history of intracerebral pathologies. These patients were selected in an unblinded fashion for the PLAATO device implantation. The details of the implantation procedure have been described elsewhere.[6] The first 5 patients represented the feasibility stage of the study. In the next 10 patients, the use of ICE in PLAATO implantation was systematically evaluated. Simultaneous TEE and ICE imaging was performed in all patients. Using a 10F ICE catheter (AcuNav, Siemens AG, Malvern, PA), intracardiac imaging was performed in all patients from 3 locations: standard right atrial position, within the coronary sinus, and in the right ventricular outflow tract. In addition to ICE imaging, all patients underwent standard simultaneous TEE for reference imaging. After excluding a left atrial or LAA thrombus, transseptal puncture was performed with ICE guidance.

During the PLAATO implantation procedure, the TEE is typically used to: (1) verify the absence of left atrial or LAA thrombus, (2) examine peak LAA emptying velocity and measure the LAA ostial dimension to determine proper device sizing, (3) guide mid-to-low puncture of the interatrial septum, (4) assess left superior pulmonary vein, (5) verify position of the delivery sheath before device expansion, (6) confirm implant location and proximal sealing of the LAA ostium, and (7) test stability of PLAATO by checking movement of the implant relative to the LAA before its irrecoverable release. The ability to perform these various tasks was assessed by ICE.

Results

Table 1 summarizes the clinical characteristics of patients in this study who underwent a PLAATO device implantation. Half of the patients had permanent AF, and all patients required alternatives to anticoagulation therapy because of either thromboembolic events despite adequate therapy, contraindications to warfarin from significant bleeding, or inability to maintain anticoagulation status in a safe therapeutic window. Optimal visualization of the LAA by ICE with comparable TEE imaging (Figure 1) was obtained by positioning the ICE probe in the coronary sinus (Figure 2). In some cases, visualization of the distal LAA was superior from the proximal pulmonary artery. Consistent with results of simultaneous TEE, no LAA or left atrial thrombus was observed in any patients by ICE imaging.

The average LAA orifice diameter of 22.6 ± 3.4 mm was consistent with TEE LAA measurements (average 19.5 ± 1.5 mm). PLAATO devices ranging from 23 to 32 mm were used (average 30 ± 3 mm, most common size 32 mm). ICE and TEE were comparable in guiding transseptal puncture (Figure 2B) in the mid-to-inferior region of the interatrial septum. ICE also was able to provide adequate imaging guidance to verify proper positioning of the delivery sheath and the device (Figure 2C, Movie 1), stability of the implant before full deployment (Figure 2D, Movie 2) and postrelease proximal sealing of the LAA ostium in all patients. The location of the device within the LAA was similar but not identical to the usual TEE plane used to visualize the LAA in long axis. In 2 of the patients, postprocedural ICE imaging of the left superior pulmonary vein was not ade-

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