Risk of Intraatrial Thrombi After Thoracoscopic Ablation in Absence of Heparin and Appendage Closure

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Background. Catheter and surgical ablation of atrial fibrillation (AF) can be associated with a risk of thromboembolic events. The goal of this study was to assess optimal anticoagulation management during thoracoscopic ablation of AF.

Methods. Fifty-two patients with persistent or longstanding persistent AF underwent hybrid ablation consisting of thoracoscopic ablation followed by electrophysiologic (EP) evaluation and consecutive ablation if indicated. The thoracoscopic ablation was performed using three different anticoagulation protocols: (1) without periprocedural heparin and without occlusion of the left atrial appendage; (2) with periprocedural heparin but without left atrial appendage occlusion; and (3) with periprocedural heparin and left atrial appendage occlusion. Transesophageal echocardiography (TEE) was obligatorily used to screen for intraatrial thrombi before the surgical and EP procedure and before hospital discharge for patients in protocols 2 and 3.

Results. In group 1 (n = 20), 1 patient (5%) had a postoperative stroke with persistent neurologic deficit, and 6 other patients (30%) had a new thrombus in the left atrial appendage seen on the pre-EP TEE. In group 2 (n = 6), 3 left atrial appendage thrombi occurred (50%; 2 on predischarge TEE and 1 on pre-EP TEE). In group 3 (n = 26), no intracardiac thrombi were found on predischarge and pre-EP TEE, and there were no strokes in this group of patients, namely, the rates of thrombus or stroke were significantly reduced when compared with groups 1 and 2 ($p = 0.001$).

Conclusions. Thoracoscopic ablation of AF can be associated with a risk of left atrial appendage thrombus formation and possibly also stroke. With administration of heparin during the ablation, followed by occlusion of the left atrial appendage as a part of the procedure, this risk can be effectively reduced.

(Ann Thorac Surg 2017;104:790–6)

Atrial fibrillation (AF) is the most common sustained arrhythmia and has been associated with an increased risk of thromboembolic events, death, and hospitalization. Pulmonary veins isolation by means of catheter ablation has been proven to be an effective treatment strategy for patients with paroxysmal AF [1]. However, the results of catheter ablation in patients with nonparoxysmal AF are limited, even when more extensive procedures are used. Minimally invasive surgical ablation procedures for stand-alone AF have been developed, with inconsistent results [2]. The hybrid approach (ie, thoracoscopic ablation followed by catheter ablation) represents a rapidly evolving technique for nonparoxysmal AF patients [3].

Both catheter and surgical ablations have limitations with regard to periprocedural complications, with stroke being one of the most worrisome. The rate of periprocedural thromboembolic events during catheter ablation varies between 0.3% and 2.8% [1, 4]. To reduce this occurrence rate, routine heparin administration during catheter ablation has been used since its development and, recently, also ablation on uninterrupted warfarin or novel oral anticoagulant (NOAC) administration [5].

Despite expanded use of minimally invasive or hybrid ablations and a variety of ablation systems, anticoagulation management during those procedures has never been validated in detail, or even standardized. Although some researchers have reported using no anticoagulation management during their procedures, others have reported heparin use or the occlusion of the left atrial appendage (LAA) to be routine, or an eventual part of the procedure, for suitable patients [3].

The goal of this study was to report the frequency of intraatrial thrombi and thromboembolic events during and after thoracoscopic AF ablation (monopolar/bipolar radiofrequency [RF] device) when performed under different anticoagulation and LAA management protocols.

Patients and Methods

Patients who underwent a two-stage, hybrid ablation for AF in our institution were evaluated. The study was

Accepted for publication Jan 30, 2017.

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0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2017.01.113

Abbreviations and Acronyms

ACT	=	activated clotting time
AF	=	atrial fibrillation
CHA2DS2-VASc	=	score for prediction of estimated risk of stroke in patients with non-valvular atrial fibrillation
EP	=	electrophysiologic
HAS-BLED	=	score that estimates risk of major bleeding for patients with atrial fibrillation on anticoagulation
INR	=	international normalized ratio
LAA	=	left atrial appendage
LMWH	=	low molecular weight heparin
NOAC	=	novel oral anticoagulants
RF	=	radiofrequency
SEC	=	spontaneous echo-contrast
SR	=	sinus rhythm
TEE	=	transesophageal echocardiography

designed in accordance with actual recommendations [6]. The study was approved by the Institutional Ethics Committee, and all patients provided written informed consent. The data of all patients were collected prospectively; however, this analysis is presented in a retrospective manner owing to unexpected occurrences of intraatrial thrombi. A surgical, thoracoscopic, off-pump procedure was followed by an electrophysiologic (EP) evaluation and catheter ablation after 2 to 3 months. The anticoagulation protocol was modified over the duration of the project and will be described in detail. Patients with symptomatic, drug-resistant, nonparoxysmal, stand-alone AF were considered candidates for the procedure. The inclusion and exclusion criteria and surgical and EP procedures have been published in detail elsewhere [7]. During the surgery, a COBRA Fusion 150 (Estech, an AtriCure Company, San Ramon, CA) catheter was used to create a box-lesion around the pulmonary veins. Two to three cycles of ablation were performed in both bipolar and unipolar mode at a temperature-controlled energy application setting of 70°C and 60 seconds per cycle. If patient remained in AF, a direct current cardioversion was performed.

Anticoagulation and Intracardial Thrombosis Rule-Out Management

The perioperative anticoagulation management was changed during the course of our study and is described in detail. This first part of the anticoagulation protocol was applied in all patients over the entire period of the study and was not changed. Warfarin (or NOAC) was stopped 5 days (or 1 to 2) before surgery and low molecular weight heparin (LMWH [nadroparin]) started at a reduced dose (0.75 mg/kg twice daily) and stopped 12 hours before surgery. A TEE was performed just before the surgical incision to rule out intraatrial thrombus. After surgery, warfarin (target international normalized ratio [INR] of 2 to 3) or NOACs were given and continued until the EP procedure; a TEE was also performed before the EP procedure to rule out an intraatrial thrombus.

Because of the significant number of intracardial thrombi found during this examination, the original perioperative anticoagulation protocol was modified twice during the study, as follows:

(1) ORIGINAL PROTOCOL. Originally, no heparin was given to patients during surgery. This protocol was based on our previous experiences with thoracoscopic ablations and other reports, in which no heparin was used and no perioperative thromboembolic events occurred [8, 9]. The LMWH was started the morning after surgery at a reduced dose (0.75 mg/kg twice daily) and warfarin restarted 48 hours after surgery (or NOAC on the morning of the discharge day). No additional TEEs were performed.

(2) HEPARIN PROTOCOL. Heparin (80 IU/kg), was given to patients during surgery, after dissections, but before the ablation. The ablation was performed after verification of activated clotting time (ACT) of 300 to 350 seconds. The ACT value was measured every 20 minutes; additional heparin was given to the patient if the value fell below 300 seconds. No heparin antagonist was given after the ablation. In the intensive care unit, a continuous infusion of heparin was given with a target ACT of 200 seconds until the next morning, when the first dose of LMWH was administered (0.75 mg/kg twice daily) with verification (using the heparin anti-Xa test after two doses) and dosage intensification if lower than the required range (ie, around the lower limit of therapeutic range). Two additional TEEs were performed, one at the end of surgery and one before discharge.

(3) HEPARIN AND ATRICLIP PROTOCOL. Heparin and postoperative anticoagulation was administered as in the heparin protocol. The ablation through the right side of the chest was then followed by occlusion of the LAA through the left side of the chest with an AtriClip Pro device (AtriCure, Cincinnati, OH). This procedure has been previously described in detail [10]. Two additional TEEs were performed, one at the end of surgery and one before discharge.

Visual Control Group

Because the thrombi findings were extremely disturbing, ablation with the COBRA Fusion device was carried out during open-heart surgery in a small group of patients with the intention to visualize the endocardial appearance of the lesions. Patients scheduled for aortic valve surgery and pulmonary veins isolation were enrolled with no other inclusion or exclusion criteria. All study participants signed an informed consent for RF ablation of the PVs and a possible further inspection of the left atrium. After sternotomy and standard cardiopulmonary bypass cannulation, with ACT values more than 480 seconds, an ablation was performed with the same settings and duration as that used during the thoracoscopic procedure. Cardiopulmonary bypass was then started, the cross clamp was put in place, and the heart was arrested with cardioplegia. The LAA was resected, and