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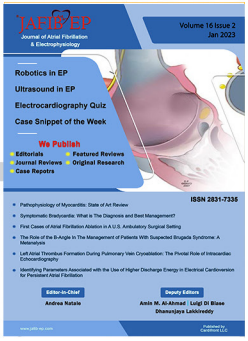

Left Atrial Thrombus Formation During Pulmonary Vein Cryoablation: The Pivotal Role of Intracardiac Echocardiography

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Abstract

Trans-septal puncture (TSP) is a challenging step in pulmonary vein isolation (PVI) procedure for atrial fibrillation. Fluoroscopy guidance alone is burdened by a high rate of complications. Therefore, additional transesophageal echocardiography or intracardiac echocardiography (ICE) guidance is recommended to reduce the risk of adverse events. We report the case of a PVI procedure using cryoablation complicated by the formation of a serpiginous left atrial swinging thrombus after TSP. This high-risk adverse event was resolved without sequelae using ICE guidance.

Introduction

Trans-septal puncture (TSP) is commonly performed to achieve left atrial (LA) access for a variety of common cardiac procedures, including pulmonary vein (PV) isolation (PVI) for atrial fibrillation (AF) treatment, catheter ablation of left-sided accessory pathways and ventricular tachycardia, LA appendage (LAA) closure and mitral valve procedures[1].

TSP has always been a challenge for the operator, due to the position of the fossa ovalis (FO), the site of lowest resistance, which is located within the inter-atrial septum (IAS) between the posterior atrial wall and the bulb of the aorta. Traditionally, it has been performed using only fluoroscopic guidance, in which anatomic structures are not visualized directly and the catheter position is estimated solely by its relationship to the cardiac silhouette. Using fluoroscopic guidance only, complications associated with TSP are estimated to occur in approximately 1% of procedures and are mostly related to perforation of the posterior atrial wall or aortic root[2].

Intracardiac echocardiography (ICE), first described in 1981, is a useful tool in cardiac catheterization and electrophysiology labs, capable of providing detailed near-field and far-field real-time images that can facilitate TSP[3]. For this reason, it has recently become a complementary tool to fluoroscopy for safer LA access, reducing complication rates[4]. As a matter of fact, when advanced in the right atrium, the ICE probe provides a cross-sectional view of the FO, where the correct positioning of both the needle and the sheath in the middle of the FO can be confirmed. This helps determine the exact puncture site by looking for tenting of the IAS induced by the needle[2].

We hereby report a case of intra-procedural LA thrombus formation, showing the importance of ICE guidance for TSP in order to avoid procedural complications.

A Case Description

A 59-year-old male patient without cardiovascular risk factors was referred to our center for PVI for paroxysmal AF episodes leading to dyspnea and palpitations, not well controlled with pharmacological

Key Words

Pulmonary Vein Isolation; Cryoablation; Atrial Fibrillation; Left Atrial Thrombus; Intracardiac Echocardiography; ICE.

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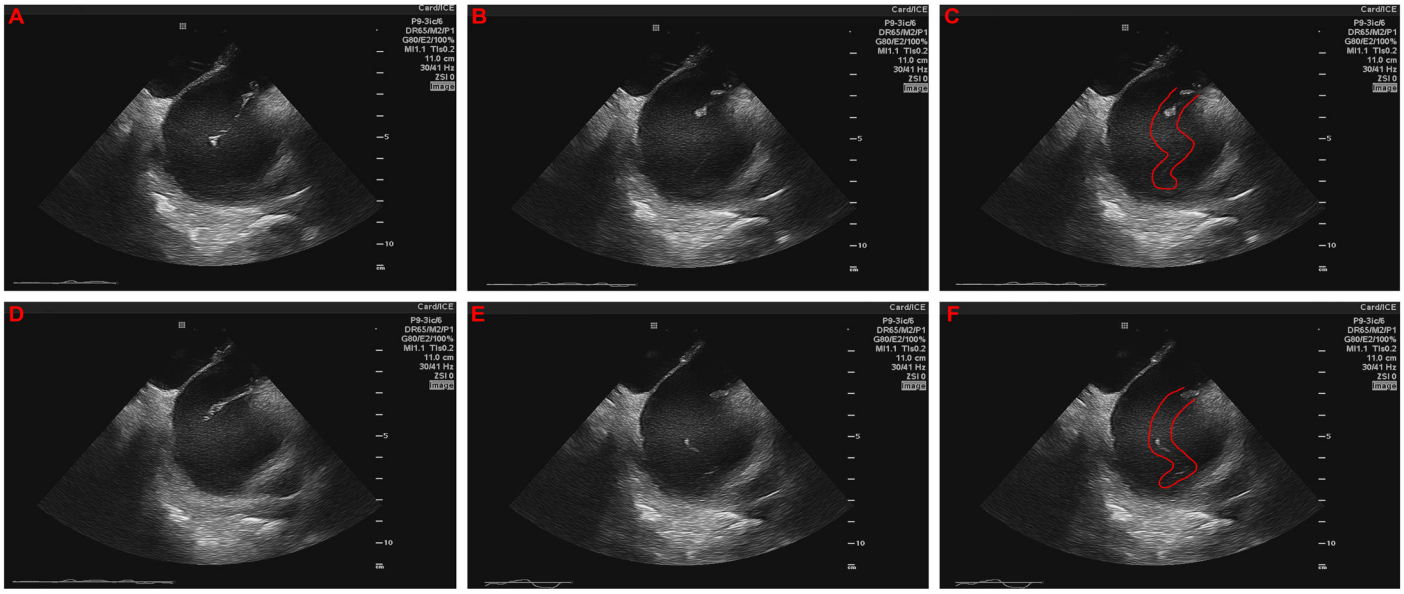

Figure 1: **Intracardiac echocardiography images (A-F) of a serpiginous thrombus swinging from the tip of the introducer in the left atrium, after transeptal puncture conducted for pulmonary vein cryoablation. Red markings externally to the contour of the thrombus were delineated in some images (C, F) to facilitate visualization.**

therapy at the maximum tolerated dose (Flecainide PR 200 mg/day and Bisoprolol 2.5 mg/day).

Considering that the patient missed a dose of his anticoagulation regimen with Rivaroxaban 20 mg qd in the week before the procedure, pre-procedural TEE was undertaken, showing preserved biventricular function with normal chambers size and morphology, except for mild LA dilation, and absence of significant valve disease or septal defects. LAA emptying velocity was normal (40 cm/sec) and LAA thrombosis was excluded.

Therefore, a PVI by cryoablation attempt was performed on the same day. Three femoral venous accesses were obtained, two in the right vein, one for TSP and the other for insertion of a decapolar diagnostic catheter (Dynamic Xt 10-poles, Boston Scientific), and the last in the left vein for insertion of the ICE probe (Viewflex Xtra ICE, 3Mhz, Abbott Medical). For TSP, an 8Fr Swartz introducer (Abbott Medical) with a Brockenbrough needle (Abbott Medical) inside of it was used. After some attempts due to elastic resistance by the floppy IAS, TSP with ICE guidance was performed safely. The patient assumed his last dose of Rivaroxaban approximately 16 hours before the procedure. An IV bolus of unfractionated heparin (UFH) was administered according to patient weight (10,000 UI). Before advancing PVI-tools, an angiography was performed to document PV anatomy, and LA and vascular integrity were confirmed using both ICE and angiography. Checking the correct position of the introducer in the LA with ICE, the formation of a hitherto undiagnosed serpiginous thrombus was noticed swinging from the tip of the introducer (Figure 1). Activated clotting time was therefore tested, being 221 sec. Therefore, an additional IV bolus of 2000 UI of UFH was administered. Under continuous ICE and fluoroscopic guidance, the introducer was carefully removed from the LA, taking care not to detach the clot from the introducer.

The patient remained asymptomatic throughout the procedure and was transferred to the cardiac intensive care unit for further monitoring and to continue anticoagulation therapy with UFH IV infusion. After 4 days, UFH anticoagulation therapy was switched to Rivaroxaban and the patient was discharged without documented thromboembolic complications.

Three weeks later, a second successful PVI attempt was conducted using the same TSP technique described above. The procedure was undertaken without suspension of the anticoagulation regimen. Intraprocedural anticoagulation was administered after TSP (IV bolus of 10'000 UI of unfractionated heparin), aiming to ACT >300 sec. However, considering that in this case ACT was <300 (i.e. 221 sec), an additional iv bolus of 2000 UI of unfractionated heparin was administered, reaching the target ACT.

The patient was discharged in sinus rhythm after a two-day observation period, switching from Flecainide to Propafenone 300 mg tid and maintaining anticoagulation therapy with Rivaroxaban 20 mg qd. At 3-month follow-up, no AF recurrences were reported.

Discussion

The use of ICE guidance as a complementary tool to fluoroscopy for TSP has many advantages.

First, considering that ablation procedures may last long (up to 3-4 hours in complex cases), with an effective mean radiation dose up to 15 mSv (equivalent to 150 chest X-ray scans), the use of complementary imaging techniques, such as ICE or TEE, may allow to reduce fluoroscopy times. Razminia et al6 showed, in a retrospective study on 500 patients, that ablation procedures may be performed safely and effectively without fluoroscopy, using only ICE and electro-anatomical mapping with dedicated probes.

The use of TEE was widespread in ablation procedures before

the advent of ICE and is currently still used in some centers due to operator preferences. However, even if TEE may reduce radiation exposure, it has less favorable characteristics compared to ICE. First, it reduces patient discomfort, the probe being is introduced through the femoral vein under local anesthesia, thus avoiding general anesthesia (with or without endotracheal intubation) that is needed for TEE. This prevents the risk associated with anesthesia, such as aspiration pneumonia and anesthesia awareness, and may reduce procedural times (i.e. no anesthesia induction and recovery times). Superiority of ICE in this regard was proven by Bartel et al[5] in a study in which ICE was compared to TEE in device closure of IAS communications, showing that ICE was better tolerated and reduced fluoroscopy and procedural times. Second, ICE avoids the risk of pharyngeal and esophageal injury, which is common with TEE. As a matter of fact, Freitas-Ferraz et al demonstrated, in a prospective study on 50 patients undergoing structural cardiac interventions, that most of them had some form of esophageal injury associated with TEE, with longer procedural time and poor or suboptimal image quality determining an increased risk[7]. Moreover, ICE allows continuous monitoring of the needle position by the first operator, without the need for additional specialized medical personnel (i.e. TEE operator)[5]. In addition, ICE is cost-effective and reduces procedural times. In the study by Hemam et al, in which ICE versus TEE was confronted in 50 patients undergoing LAA closure, it was shown that costs were comparable between the two techniques, with a significant reduction in procedural times in the ICE group[8], confirming the results of Bartel et al[5]. Finally, ICE is usable when TEE is contraindicated, i.e. when esophageal varices, stenosis or lesions are present. Fassini et al[9] presented a case of LAA closure using ICE guidance in a patient who was not candidable for TEE.

Other situations where ICE guidance is desirable are pacemaker lead implantation in pregnant women, extraction of cardiac devices, retrograde balloon valvuloplasty, and endomyocardial biopsy[10].

In our case, ICE guidance allowed early diagnosis of LA thrombus formation on the tip of the introducer used for PVI after introduction into the LA, thus avoiding thromboembolic complications. If only fluoroscopy guidance had been used, it would not have been possible to diagnose such thrombus formation and therefore prevent thromboembolic complications, such as ischemic stroke. The diagnosis of the thrombus may also have been missed using TEE. This is a further potential limitation of this technique, while ICE has a complementary value in re-screening the LA for thrombus. Symptomatic thromboembolic events are a rare (0.4%)4 yet devastating complication of PVI. However, asymptomatic embolic brain infraction and micro-bleeds at the same location of micro-infarctions were detected in 87.5% and 65% of patients, respectively, by magnetic resonance imaging performed 1-3 days after PVI with only fluoroscopic guidance and subsequently after 6 months[11]. Future research is warranted to understand the long-term consequences of these lesions and to determine optimal strategies to avoid them. In this context, ICE guidance could reduce both symptomatic and asymptomatic thrombo-embolism, with fewer complications and better tolerability compared to TEE.

With this case report, we have shown that the use of ICE for TSP and during the whole PVI procedure improves procedural safety and efficacy. We hope to encourage further research in that direction, comparing outcomes and complications of PVI with ICE and TEE guidance to fluoroscopic guidance alone.

Authors Disclosures

D.G. is an employee of Biotronik Italy; F.G. is an employee of Abbott Medical Italy. Other authors: no disclosures.

Supplementary material – Video 1

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