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Clinical application of intracardiac echocardiography in the ablation of atrial fibrillation

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Abstract

Background: *The application of intracardiac echocardiography (ICE) in atrial fibrillation (AF) ablation may increase the success rate and decrease the complication rate of the procedure. We present our preliminary observations concerning the utility of ICE in AF ablation.*

Methods: *In February and July 2004 we performed 6 radiofrequency (RF) ablations guided by ICE (EP Med Systems) in patients with atrial tachyarrhythmia. All patients had undergone at least three months of oral anticoagulation therapy before the procedure. For three days before ablation enoxaparin was administered. During each procedure the ICE catheter was placed in the right atrium. Transseptal puncture was guided by fluoroscopy and ICE imaging. After placement of the introducer in the left atrium a bolus of heparin (100 IU/kg) was administered followed by additional boluses (1000 IU/h). Electroanatomical isolation of the pulmonary vein ostia was performed with a 4 mm ablation catheter (RF energy was set at 50–55°C and 25–35 W). RF energy was titrated if microbubble formation was observed and delivery was immediately terminated when a brisk shower of bubbles was detected.*

Results: *Transseptal puncture was performed at a typical location in all patients (atypical anatomy was not revealed by ICE). The microbubble effect was observed in all patients. In 1 patient the effect was observed despite a power reduction and the RF application had to be terminated. The following short (15–20 s) applications were performed with low RF energy. During the same procedure ICE imaging revealed 2 thrombi (2 mm and 5 mm) on the Lasso electrode. None of the patients experienced thromboembolic complications.*

Conclusions: *Intracardiac echocardiography is a useful imaging method in RF ablation. Low RF-energy and standard anticoagulation treatment do not prevent the microbubble effect and the formation of small thrombi.* (Folia Cardiol. 2006; 13: 596–599)

Key words: intracardiac echocardiography, atrial fibrillation, ablation

Introduction

Intracardiac echocardiography (ICE) is a cardiac imaging method routinely used in some institutions during catheter radiofrequency (RF) ablations [1, 2]. Atrial fibrillation (AF) ablations guided by ICE have a high success rate and a low complication rate [3]. We present our preliminary data on AF ablation guided by ICE.

Methods

In February and July 2004 six RF ablations guided by ICE (EP Med Systems) were performed in our institution. Intracardiac echocardiography was used in ablations of atrial tachyarrhythmias.

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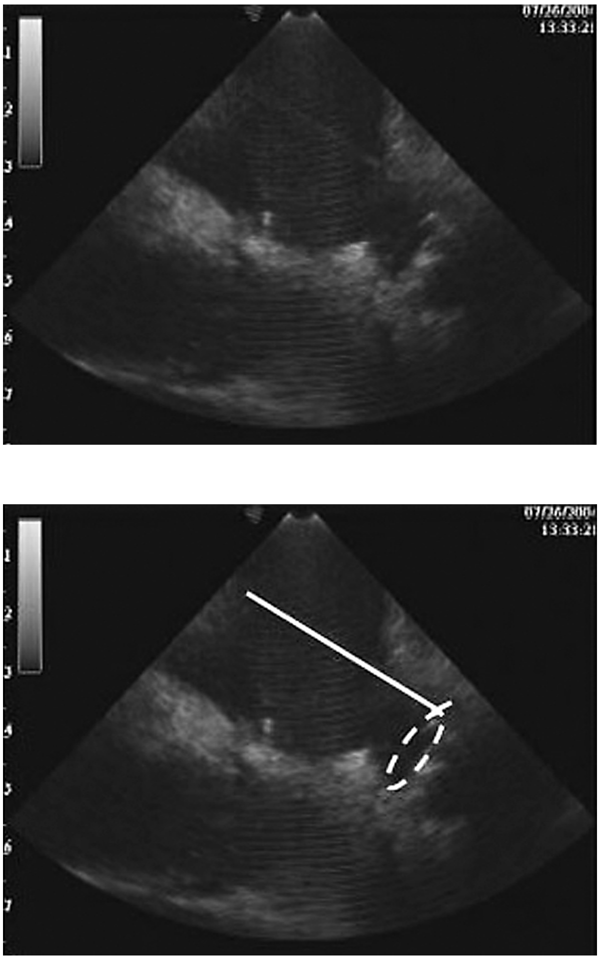

Figure 1. Lasso electrode at pulmonary vein ostium.

Venous access was obtained via femoral veins (two — 7 French sheaths, one — 8 French sheaths and one — 11 French sheaths). The ICE catheter was positioned in the middle of the right atrium (RA) to depict the fossa ovalis. Before transseptal puncture a diagnostic electrode was introduced to the coronary sinus and a mapping electrode was placed in the His area. Transseptal puncture was guided by fluoroscopy and ICE. After the introducer had been placed in the left atrium (LA), a bolus of heparin (100 IU/kg) was administered followed by infusion or additional boluses (1000 IU/h). All patients had been treated with acenocumarol for at least three months and with enoxaparin for three days before the procedure. Venography of the pulmonary veins (PV) was performed using a transseptal sheath. An ablation catheter and Lasso electrode were subsequently placed in the LA (Fig. 1).

Ablation was performed with a 4 mm electrode. RF applications were delivered proximal to PV junctions (RF energy was set at 50–55°C and 25–35 W).

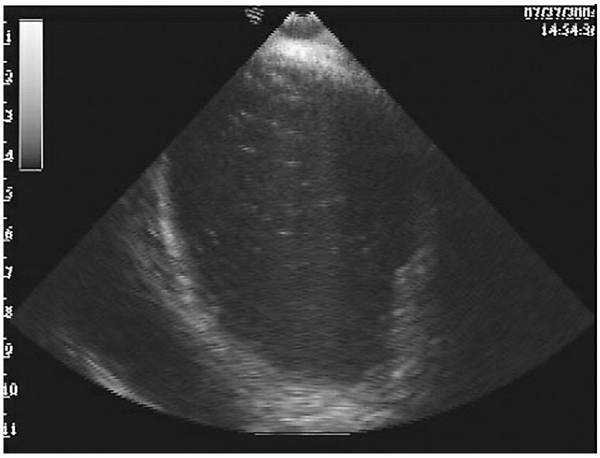

Figure 2. Spontaneous echo contrast in left atrium.

The RF energy was titrated if microbubble formation was observed. RF delivery was immediately terminated when a brisk shower of bubbles was detected. Heparin infusion (ACT 120–160 s) was administered for 12 hours after the procedure.

Results

Transseptal puncture was performed at a typical location in all patients (atypical anatomy was not revealed by ICE). The microbubble effect was observed in all patients (Fig. 2). In 1 patient the effect was observed despite a power reduction and RF application had to be terminated. Successive short (15–20 s) applications were performed with low RF energy. During the same procedure ICE imaging revealed 2 thrombi (2 mm and 5 mm) on the Lasso electrode (Fig. 3).

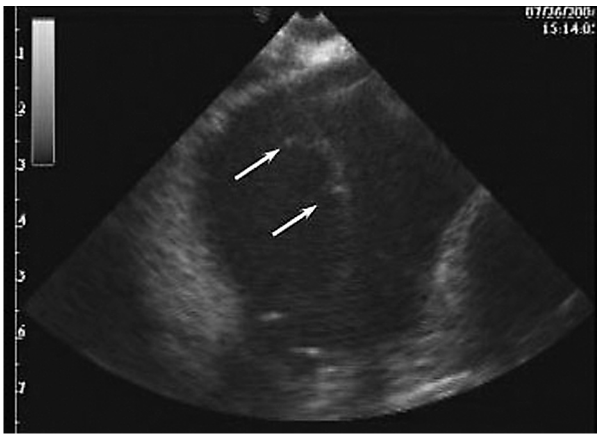

Figure 3. Intracardiac echocardiography image of two thrombi (2 mm and 5 mm) on the Lasso electrode.

Additional infusion of heparin was started. The transseptal sheath was gradually moved over the Lasso electrode from the RA to the LA. The thrombi were aspirated and disappeared out of ICE view. No signs of any thromboembolic event were detected. The Lasso electrode and transseptal sheath were removed from the LA. The procedure was continued after ACT control.

None of the patients experienced thromboembolic complications.

Discussion

Intracardiac echocardiography is a cardiac imaging method which is particularly useful in AF ablation procedures. ICE guidance increases the safety of transseptal puncture and helps in precise electrode localisation at the PV antrum. Moreover, with ICE it is possible to detect spontaneous echo contrast and thrombi formation during the procedure.

Transseptal puncture is associated with a low risk of complication. However, in cases of atypical anatomy ICE may be particularly useful. In centres with long experience of ICE-guided ablations puncture of the posterior septum is usually performed [2], which helps in directing the catheters toward the pulmonary veins. We have observed no complications of transseptal puncture in our institution (156 patients with AF scheduled for PV isolation). Transseptal puncture was successfully performed in all patients scheduled for LA arrhythmia ablation, despite cases of atypical anatomy. In 1 patient with significant rotation of the heart the procedure was performed under trans-oesophageal echocardiographic guidance in general anaesthesia (ICE was not available).

Intracardiac echocardiography helps in the precise localisation of catheters in relation to the PV ostia. This is crucial for PV stenosis avoidance and successful isolation. In contrast to electroanatomical systems (such as CARTO), which reconstruct virtual anatomy from a limited number of points, ICE depicts online the actual atrium anatomy and is associated with a lower rate of complications. Saad assessed the number of significant PV stenoses in 608 patients after AF ablation [4]. In 71 patients pure anatomical ablation was performed with the CARTO system (separate ablation of upper and lower veins). In 537 patients Lasso PV isolation was performed (distal isolation: 25, ostial isolation based on PV angiography: 102; guided by intracardiac echocardiography: 140; with energy delivery based on visualisation of microbubbles: 270). SCT revealed PV narrowing ≥ 70% as follows: in anatomical ablation — 15.5%, in distal isolation — 20%, in ostial isolation based on PV angiography — 2.9%; when guided by intracardiac echocardiography — 1.4% and with energy delivery based on visualisation of microbubbles — 0%.

Intracardiac echocardiography should not be the only method used to assess LA anatomy before ablation. Spiral computed tomographic angiography (SCTA) should be performed in all patients scheduled for AF ablation. Jongbloed et al. assessed PVs in 42 patients with SCTA and ICE [5]. The PV diameters assessed by ICE were significantly smaller in comparison with SCTA. Moreover ICE revealed a lower sensitivity in atypical PV anatomy assessment. In our institution SCTA with three-dimensional LA reconstruction is performed in all patients scheduled for ablation in the LA. Since the anatomy of the LA had already been assessed, ICE was used only to find optimal catheter position in relation to the PV ostia.

Spontaneous echo contrast during AF ablation is associated with cerebral microembolic events detected by transcranial Doppler [6]. It is extremely important that microemboli formation does not correlate with RF application energy parameters (impedance and temperature). Power titration and high doses of heparin (ACT up to 350–400 s) are the best ways to avoid thromboembolic events and thrombi formation during the procedure [2, 7]. Flushing transseptal sheaths in high concentration heparin solution may also be important in the prevention of thrombi formation [8].

We observed spontaneous echo contrast in all the study group patients. In 1 patient microbubbles were detected even during low energy (25 W) applications. In all patients standard doses of heparin were administered. No patient showed neurological symptoms after this procedure. Ablations in the LA and LV are usually performed with high energy applications with a low complication rate. However, in AF ablation the lowest energy to result in successful ablation should be used.

Intracardiac echocardiography allows early detection of thrombi formation in the LA. Ren et al. [9] observed thrombi formation in over 10% of 232 patients during ICE-guided AF ablation despite anticoagulation to ACT > 250 s. Thrombi developed most commonly on sheaths and Lasso electrodes but not ablation catheters. Spontaneous echo contrast was the strongest risk factor of thrombi formation. The majority of thrombi were successfully withdrawn into the RA under ICE imaging monitoring with no overt complications. LA thrombus formation occurred after transseptal catheterisation but before RF applications in 50% of patients. Administration of heparin before transseptal puncture may prevent early thrombi formation. However, this strategy should be reserved for centres using ICE.

Anticoagulation treatment protocols used in leading AF ablation centres differ considerably. In Bordeaux (M. Haissaguerre) heparin is administered 24 hours before and again after the procedure (ACT 90–120 s) [10]. Heparin is stopped 6 hours before the procedure. Following transseptal access, an intravenous bolus of heparin (100 IU/kg body weight) is administered and repeated only in cases where the procedure duration is > 4 h. In Cleveland (A. Natale) an intravenous bolus of heparin (140 IU/kg body weight) is administered before the first transseptal puncture and an infusion of 15 IU/kg/h is started [2]. An additional 70 IU/kg bolus is given before the second transseptal puncture. The target ACT during the procedure is 350 to 400 s. At the end of the procedure heparin is stopped and a maximum of 15 mg protamine is administered. The venous sheaths are removed when ACT is < 300 s. In Milan (C. Pappone) heparin infusion is started the night before the procedure (ACT 200–250 s) [11] and stopped 2 hours before ablation. After transseptal puncture heparin is restarted as an initial bolus (5,000 IU) followed by infusion or additional boluses to maintain an ACT between 250 and 350 s. After the procedure heparin is administered for 24 hours at 1000 IU/h. In our institution enoxaparin (2 mg/kg) is administered for 3 days before the procedure. After transseptal puncture, an intravenous bolus of heparin (100 IU/kg body weight) is administered. This used to be followed by additional boluses (1000 IU/h) but we have recently started to administer heparin infusion during the procedure (initial dose 1000 IU/h) to maintain an ACT > 200 s. After the ablation heparin is continued for 12 hours (ACT 120–160 s). However, in the group of 156 patients who underwent AF ablation in our institution with the anticoagulation protocol described in the method above we have observed only 1 case of TIA. None of the patients suffered a stroke.

Conclusions

Intracardiac echocardiography provides important new data and is a complementary method to other cardiac imaging techniques guiding RF ablation. Conventional anticoagulation therapy and low-energy applications do not prevent spontaneous echo contrast and thrombus formation in the LA.

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