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Original Article

Impact of transesophageal echocardiography during transseptal puncture on atrial fibrillation ablation

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ABSTRACT

Background: The aim of our study was to demonstrate the added value of routine transesophageal echocardiography (TEE) for correctly positioning the transseptal system in the fossa ovalis (FO), thus potentially preventing complications during fluoroscopy-guided transseptal puncture (TP), and for assessing the optimal puncture site within the FO according to the expected procedure type.
Methods: Ninety-one patients undergoing pulmonary vein isolation (PVI) procedures by cryoballoon technique for drug-resistant paroxysmal or persistent atrial fibrillation (AF) were prospectively included. In 57 patients, the TP procedure was performed under fluoroscopic guidance and septal localization was confirmed by contrast injection through the needle and demonstration of septal tenting in both the anteroposterior and left lateral fluoroscopic projections. In 34 patients, TP was performed under TEE guidance and positioning was targeted to perform the TP procedure in the more anterior and inferior locations of the FO. Two patient groups were compared according to the incidence of complications directly attributable to transseptal catheterization, thromboembolic complications, recurrence rates after the ablation procedure, total procedural time, and fluoroscopy time.
Results: Fluoroscopy time ($p < 0.001$), total cryoablation time ($p = 0.002$), and total procedural time ($p < 0.001$) were shorter in the TEE-guided group. Left inferior pulmonary vein (LIPV) cryoablation time ($p = 0.007$) and right inferior pulmonary vein (RIPV) cryoablation time ($p = 0.004$) were significantly shorter and the number of applications to the LIPV ($p = 0.007$) and RIPV ($p = 0.005$) were significantly fewer in the TEE-guided group. Although there was a trend toward higher complication rates (20.6% vs. 31.6%, $p = 0.37$) and recurrence rates (11.8% vs. 20.1%, $p = 0.26$) in the fluoroscopy-guided group, the differences between the groups were not statistically significant.
Conclusions: TEE-guided TP for AF ablation is associated with shorter fluoroscopy time, shorter total cryoablation time, and shorter total procedural time. Importantly, TEE-guided TP facilitates cryoablation of the inferior pulmonary veins.

1. Introduction

Over the last decade, the unabated increase in the number of transseptal catheterizations has been related to an increase in atrial fibrillation (AF) ablation procedures. Transseptal puncture (TP) is usually safe in experienced hands [1,2]. However, it can be associated with life-threatening complications [3,4]. Conventionally, the procedure is performed under fluoroscopic guidance and pressure monitoring. To reduce the incidence of complications, TP can be performed under transesophageal echocardiography (TEE) or intracardiac echocardiography (ICE) guidance [5,6]. The use of echocardiographic guidance for TP allows direct visualization of the transseptal needle tip within the fossa ovalis (FO), and thus, a safe TP in every patient. It is also important to emphasize that the use of echocardiographic guidance enables puncture site selection within the FO according to the expected procedure type (e.g., a more anterior puncture for ablation of an accessory pathway at the mitral annulus or for ablation of ventricular tachycardia vs. a lower and more posterior puncture for ablation of AF). Thus, the puncture site location can make a significant difference in mapping and/or ablation catheter maneuverability. A neglected advantage of echocardiographic guidance during TP is the possibility of initiating anticoagulation safely before TP. This appears to be a very important

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additional benefit, especially in patients with AF. It has to be emphasized that the use of echocardiographic monitoring during the entire AF ablation procedure allows for additional benefits beyond safe TP. Echocardiographic monitoring throughout the ablation procedure may help in understanding the real-time anatomy of relevant cardiac structures such as the pulmonary veins, left atrial appendage, mitral isthmus, cavotricuspid isthmus, etc.

To date, no randomized trial has compared the clinical outcomes and success rates between TEE-guided and traditional fluoroscopic TP. Many studies conclude that cardiac imaging may be better than fluoroscopy for guiding TP [5,6] especially in less experienced hands, but the advantages in routine use of imaging modalities have not yet been demonstrated.

2. Materials and methods

2.1. Patients

In this prospective observational study, we enrolled 91 consecutive patients who underwent pulmonary vein isolation (PVI) by cryoballoon technique for documented AF between September 2012 and March 2014. All patients had symptomatic paroxysmal or persistent AF and had failed ≥ 1 antiarrhythmic drug(s) previously. Patients who had AF episodes lasting 7 days were defined as persistent and those whose episodes self-terminated within 7 days were defined as paroxysmal AF [7].

Patients who had moderate-severe valvular disease, thrombus in the left atrium (LA), TEE contraindications, uncontrolled thyroid dysfunction, preprocedural significant coronary artery stenosis, anticoagulation contraindications, previous AF ablation, and LA diameter > 55 mm and patients who were pregnant were excluded from the study. A detailed medical history regarding AF and related cardiovascular and/or systemic conditions was obtained from all patients. The patients' symptomatic severity was recorded according to the European Heart Rhythm Association (EHRA) score. CHA2DS2-VASc scores were calculated for each patient based on relevant guidelines [7]. Informed consent was obtained from each patient before enrollment. The study was conducted in compliance with the principles outlined in the Declaration of Helsinki and approved by the Institutional Ethics Committee.

2.2. Methods

All patients underwent standard transthoracic echocardiography to rule out structural abnormality and TEE to rule out thrombus in the LA. In patients undergoing TEE, sedation was achieved by 2.5 mg midazolam intravenous bolus dose. If necessary, an additional 1 mg or a total maximum 8 mg dose at 5-min intervals was administered intravenously. Antiarrhythmic drugs were discontinued five half-lives before the procedure. Anticoagulation was stopped at least 48–72 h before the procedure. In the patient group in whom the TP procedure was performed under fluoroscopic guidance, a 70 UI/kg heparin intravenous bolus was administered after gaining LA access. In the other patient group in whom the TP procedure was performed under TEE guidance, the same heparin dose was administered at the beginning of the procedure. In all patients, activated clotting time (ACT) > 250 s was maintained during the procedure.

In both groups, all procedures were performed under conscious sedation using midazolam boluses. In all patients, invasive arterial blood pressure, oxygen saturation, and electrocardiogram (ECG) were continuously monitored throughout the procedure.

For the TP procedure in the fluoroscopic guidance group, the TP sheath and dilator were advanced into the superior vena cava (SVC) over a guidewire via the right femoral vein. After removing the guidewire and aspirating and flushing the dilator, a Brockenbrough needle (BRK-1, St. Jude Medical, Minnetonka, MN, USA) was inserted in the dilator. Thereafter, the sheath/dilator/needle assembly was slowly withdrawn while monitoring fluoroscopy. Under fluoroscopic guidance (anteroposterior projection), during gradual sheath/dilator/needle withdrawal oriented between the 3:30 and 5:30 handle position, the FO was engaged, indicated by a sudden displacement of the sheath tip and/or septal tenting. Septal localization was also confirmed by contrast injection through the needle and demonstration of septal tenting in both the anteroposterior and left lateral fluoroscopic projections.

In the TEE-guided group, the operator confirmed that the transseptal needle was in a correct position for TP with TEE guidance. After appropriate positioning, TP was performed in the more anterior and inferior locations of the FO. The TEE probe was removed after successful TP.

In both groups, the sheath was then exchanged for a 12-Fr steerable transseptal sheath (FlexCath, Medtronic CryoCath, Minneapolis, USA) over a guidewire (0.032-in., 180-cm Super Stiff, St. Jude Medical, St. Paul, MN, USA). Baseline potentials of all PVs were recorded with a lasso catheter (Biosense Webster, Inc., Diamond Bar, CA, USA). Distal coronary sinus pacing was performed to confirm the presence of the left PV potentials. In all patients, a 28-mm cryoballoon catheter (Arctic Front, Medtronic CryoCath LP) was used for PVI. The cryoballoon was maneuvered to all PV ostia by means of the steerable 12-Fr sheath and a guidewire inserted through the lumen of the balloon catheter. The balloon was inflated in the LA and then directed toward the PV ostia. Assessment of balloon occlusion was performed by injecting 50% diluted contrast through the cryoballoon catheter's central lumen. The duration of each freezing cycle was 240 s. A minimum of two consecutive freezing cycles was performed with excellent or good occlusion for each targeted PV. The procedure systematically began with the left superior PV, followed by the left inferior, right superior, and right inferior PVs, respectively. The right phrenic nerve was constantly paced from the SVC during freezing at the right-sided PVs. Direct palpation of right hemidiaphragmatic excursions was performed during phrenic nerve stimulation. At the end of the procedure, PV conduction was re-evaluated with a lasso catheter. Successful PVI was defined as the elimination (or dissociation) of all PV potentials.

The patients remained under continuous hemodynamic and ECG monitoring for 24 h. Immediately after the procedure and 24 h following the procedure, transthoracic echocardiography was performed to ascertain the absence of pericardial effusion. Oral anticoagulation with warfarin was initiated 4–6 h after the procedure and concomitant enoxaparin 1 mg/kg was also administered until the target international normalized ratio of 2.0–3.0 was reached. The patients remained on the antiarrhythmic drug regimen that was prescribed before ablation for a period of 3 months following the procedure. Thereafter, procedural outcomes were assessed off of the antiarrhythmic drug regimen. Regular follow-up visits including medical history, clinical evaluation, 12-lead surface ECG, and 24-h Holter monitoring were conducted 3, 6, 9, and 12 months after ablation and every 6 months thereafter or earlier if symptoms consistent with recurrent AF developed. The need for oral anticoagulation was also evaluated 3 months after ablation, based on the CHA2DS2-VASc score [7].

Acute procedural success was defined as electrical isolation of all PVs. The first 3 months after AF ablation were defined as the blanking period. AF recurrence was defined as the detection of AF (≥ 30 s duration when assessed with 24-h ECG monitoring) after 3 months following AF ablation [8]. The TP success rate was evaluated in terms of number of puncture attempts to gain access to the LA. Procedural time was quantified as the time from catheter positioning in the SVC to time of LA access. Total