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Pulmonary vein orientation assessment: Is it necessary in patients undergoing contact force sensing guided radiofrequency catheter ablation of atrial fibrillation

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ABSTRACT

Purpose: We hypothesized that pulmonary vein (PV) orientation influences tissue contact of the contact force (CF) sensing radiofrequency ablation catheter (CFC) and therefore atrial fibrillation (AF) free survival after pulmonary vein isolation (PVI). The aim of this study was to determine the association between PV orientation, CF and AF free survival in patients undergoing CFC PVI.
Methods: Sixty consecutive patients undergoing CFC PVI were included. ECG-triggered cardiac CT scans were obtained in all patients before PVI, and the PV orientation was measured at the insertion in the LA for all PVs in both the transverse and frontal plane. PVs were assigned to 1 of 4 orientation groups: ventral–caudal, dorsal–caudal, ventral–cranial and dorsal–cranial.
Results: Mean age was 59 years, 88% had paroxysmal AF. AF free survival off anti-arrhythmic drugs after a median follow-up of 12 months was 58% after a single PVI procedure. No association was found between PV orientation and CF. Furthermore, no association was found between PV orientation and AF free survival. In univariate analysis, the number of lesions with a mean CF of 10 g was associated with AF free survival. However, in multivariate analysis, only the AF duration was significantly associated with AF free survival.
Conclusions: This study shows that in patients undergoing PVI with the CFC ablation system, PV orientation does not affect CF and is not associated with AF free survival. PV orientation assessment does not appear to be necessary in patients undergoing CFC PVI.

1. Introduction

Pulmonary vein isolation (PVI) is considered the cornerstone in the ablative treatment of atrial fibrillation (AF) [1,2]. Multiple techniques have been developed to perform PVI [3–5]. Currently, the most widely used technique is point-by-point radiofrequency (RF) ablation guided by a 3D electro-anatomical mapping system. Earlier reports attempting to identify geometrical characteristics of pulmonary veins (PVs) that influence AF free survival in patients undergoing point-by-point PVI yielded conflicting results [6,7]. A recent study showed that PV orientation is associated with AF free survival after laser balloon PVI [8]. We hypothesized that PV orientation influences optimal contact between the ablation catheter and atrial tissue, resulting in less durable lesion sets. The aim of this study was to determine whether PV orientation influences contact force and AF free survival after PVI with a contact force sensing catheter ablation system (CFC).

2. Methods

Sixty consecutive patients with highly symptomatic, drug-refractory AF who underwent a primo PVI using CFC were included. Exclusion criteria were: previous PVI attempt, severe valvular heart disease and contraindications to post-procedural anti-coagulation. A transesophageal echocardiogram to rule out LA thrombus was performed in all patients directly prior to the PVI.

2.1. CT characteristics

All patients underwent CT scanning of the left atrium to guide the procedure. Cardiac multislice CT (MSCT) angiography was performed by a team of very experienced CT technologists using a 64-slice scanner (Lightspeed VCT XT, GE Healthcare). A bolus of 70 ml of nonionic contrast medium of agent (Optiray 350, Mallinckrodt, The Netherlands)

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was infused through a large antecubital vein at a rate of 5 ml/s, followed by 50-ml saline solution flush. Automatic detection of the contrast bolus in the left atrium was used to time the start of the scan. Delay times varied significantly because of flow rate differences in patients, but were generally in the range of 5–15 s. Craniocaudal scanning was performed during breath-hold and using retrospective ECG gating (to be able to determine volume changes of the LA, but not used in this study). The collimation was 64 × 0.5 mm, rotation time 400 ms, and the tube voltage was 120 kV with mA dose modulation variable between 80 and 200 mA. All images were checked for adequacy before the end of the procedure to guarantee adequate image quality in all patients. After acquisition, the raw MSCT data were exported, post-processed, and analyzed on a dedicated workstation (GE Healthcare). The images were reviewed by an independent investigator who was not involved in the CFC guided PVI ablation procedures and was not informed about the PVI outcome in these patients.

2.2. Pulmonary vein orientation measurement

The PV trunk orientation measurement has been described before ([9,10], Association between pulmonary vein orientation and atrial fibrillation free survival in patients undergoing endoscopic laser balloon ablation [8]). The orientation of the PV trunk at the site of insertion into the LA was assessed for all PVs in both the transverse and frontal plane. A line was drawn in the direction of each PV trunk in both the transverse and frontal plane. Thereafter, the angle between the PV trunk direction and the intersection line of the sagittal plane was measured in the transverse and frontal plane (Fig. 1). Median PV trunk angles were calculated in the transverse and frontal plane for all four PV trunks. PVs were assigned to a ventral/dorsal or caudal/cranial orientation depending on the PV trunk angle as compared to the median angle. So, each PV trunk was assigned to one of four orientation groups: ventral–caudal, dorsal–caudal, ventral–cranial and dorsal–cranial.

2.3. Electrophysiological procedure

All patients underwent CFC guided PVI under general anesthesia supervised by a cardiovascular anesthesiologist. First, a 6F quadripolar catheter was placed in the coronary sinus to obtain a procedural intracardiac electrogram. Two transseptal punctures were performed using a Brockenbrough needle under fluoroscopy and pressure guidance. 10,000 IU of unfractionated heparin was administered after the first transseptal puncture. A circular mapping catheter (LASSO®, Biosense Webster Inc., Diamond Bar, CA, USA) was inserted into the LA through an 8.5F sheath (SL-1, St. Jude Medical, Minnetonka, MN, USA) and an 8.5F sheath (SL-1, St. Jude Medical, Minnetonka, MN, USA) was used for PV angiography. Both sheaths were flushed continuously with a saline solution containing 2500 UI heparin per 500 ml saline. The targeted activated clotting time was between 300 and 350 s and additional heparin was administered when necessary. The activated clotting time was assessed every 30 min. The CFC catheter was inserted in the LA through an 8.5F sheath and the CFC sensor in the tip electrode was calibrated after positioning the catheter tip in a free floating position in the LA cavity.

2.4. Contact force sensing radiofrequency ablation

The CFC (Smarttouch™, Biosense Webster Inc., Diamond Bar, CA, USA) [3,11] is an externally irrigated catheter with a 3.5 mm tip electrode. The tip electrode is equipped with a contact force sensor which

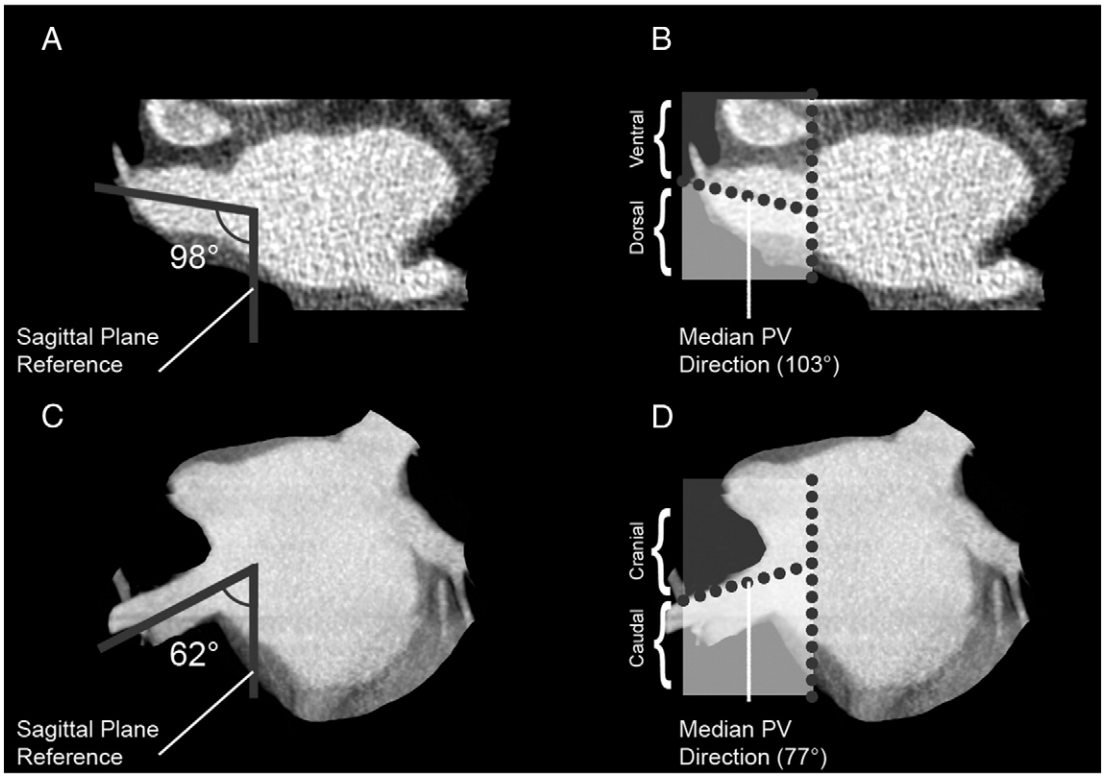

Fig. 1. Example of right upper pulmonary vein orientation measurement in the transverse and frontal planes. This figure displays the PV orientation measurement in the transverse and frontal plane of the RUPV. In panels A and B, the allocation of the RUPV in this patient in the transverse plane is displayed. The angle between the PV direction and the sagittal plane reference is 98°, as is displayed in panel A. The median RUPV direction in the transverse plane is 103° as can be appreciated from table 2, categorizing this RUPV to the dorsal RUPV orientation group. In panels C and D, the allocation of the RUPV of this patient in the frontal plane is displayed. The angle between the PV direction and the sagittal plane reference is 62°, as is displayed in panel C. The median RUPV direction in the frontal plane is 77°, as can be appreciated from table 2, categorizing this RUPV to the caudal RUPV orientation group. Combining the frontal and transverse plane, the RUPV of this patient is categorized to the dorsal–caudal RUPV orientation group. PV: pulmonary vein; RUPV: right upper pulmonary vein.