Catheter ablation of atrial fibrillation in patients with persistent left superior vena cava is associated with major intraprocedural complications

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BACKGROUND A persistent left superior vena cava (PLSVC) is an uncommon cardiac anomaly.

OBJECTIVE The purpose of this study was to assess the complication rate and procedural outcome in patients with PLSVC who were referred for catheter ablation of atrial fibrillation (AF).

METHODS Between September 2006 and February 2009, seven patients referred for circumferential pulmonary vein (PV) isolation (PVI) demonstrated a PLSVC. PVI was confirmed by spiral catheter recording within the respective PVs. Ablation within the PLSVC was performed using an irrigated-tip catheter (energy settings 20 W, 43°C, flow rate 17 mL/min) or, alternatively, a cryoballoon catheter (28 mm balloon, 300-second energy application). Patients were analyzed according to procedural outcome and rate of complications.

RESULTS Among seven patients (three female, mean age 57 ± 8 years, two paroxysmal, five persistent AF, structural/congenital heart disease present in three patients, mean left atrial size 43 ± 6 mm), 14 ablation procedures were performed. Two major complications (left phrenic nerve injury and cardiac tamponade) occurred in two of four patients undergoing PLSVC ablation. Of four of seven patients undergoing PLSVC ablation, two patients needed one and one patient needed two redo PLSVC ablation procedures. The first-time procedural success rate was 29%, while the overall success rate reached 86% after a median follow-up period of 621 (339–1,289) days.

CONCLUSION In patients with ectopic activity from a PLSVC, the ablative strategy should include isolation of the PLSVC as a procedural endpoint, although multiple ablation procedures may be necessary to achieve stable sinus rhythm. Contrary to previous reports, complications are common if the PLSVC is targeted for ablation.

KEYWORDS Atrial fibrillation; Catheter ablation; Persistent left superior vena cava; Congenital anomaly; Complication rate

ABBREVIATIONS **AF** = atrial fibrillation; **CFAE** = complex fractionated atrial electrograms; **CS** = coronary sinus; **LA** = left atrial; **LAA** = left atrial appendage; **LAT** = left atrial tachycardia; **PLSVC** = persistent left superior vena cava; **PV** = pulmonary vein; **PVI** = pulmonary vein isolation; **SR** = sinus rhythm; **RFC** = radiofrequency current

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Introduction

Catheter ablation of atrial fibrillation (AF) is recommended in symptomatic patients refractory to antiarrhythmic drug therapy.[1,2] The pulmonary vein (PV) musculature plays a critical role in the initiation of AF[3]; hence PV isolation (PVI) serves as a common procedural endpoint during AF ablation.[1] Non-PV foci triggering AF have been described elsewhere.[4] With an estimated prevalence of 0.3%–0.5% in the general population, a persistent left superior vena cava (PLSVC) is an uncommon finding in patients referred for catheter ablation of AF.[5] Embryologically, the left superior cardinal vein regresses to become the ligament of Marshall. A PLSVC results if regression fails. There are limited data describing catheter ablation of AF in patients with PLSVC.[6–8] This study sought to assess the procedural outcome and complication rate of catheter ablation of AF in patients with concomitant PLSVC.

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Methods

Between September 2006 and February 2009, seven patients with PLSVC underwent catheter ablation of drug-refractory paroxysmal (2/7; 29%) or persistent (5/7; 71%) AF. Patient characteristics are listed in Table 1. Congenital heart disease was present in two patients. In five patients, the presence of a PLSVC was unknown before admission to the hospital. All patients underwent preprocedural transesophageal echocardiography to rule out left atrial (LA) thrombus. In three of five patients, an enlarged coronary sinus (CS) was noted echocardiographically and selective CS angiography confirmed the presence of a PLSVC, while in the remaining two of five patients diagnosis was confirmed intraoperatively. No additional preprocedural imaging was performed.

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Table 1 Patients' baseline demographic data, n = 7 (%)

Age	57 ± 8
Female gender	3 (43)
Persistent AF	5 (71)
LA diameter, mm	43 ± 6
Congenital heart disease	2 (29)
Atrial septal defect repair	1 (14)
Ventricular septal defect repair	1 (14)

PVI

Electrical PVI was achieved by wide-area circumferential ablation using open-irrigated radiofrequency current (RFC). Along the posterior LA wall, maximal power was limited to 30 W, a flow rate of 17 mL/min, and a target temperature of 43°C, while a maximal power of 40 W and a flow rate of 25 mL/min were used when ablating along the anterior aspect of the LA wall. Ablation sites were tagged on a reconstructed CARTO (Biosense Webster, Diamond Bar, CA) three-dimensional LA map. Bilateral circumferential linear lesion sets were deployed around the ipsilateral PVs to achieve PVI as described elsewhere in detail[9] (Figure 1). Irrigated RFC was applied for up to 30 seconds or until the maximal local electrogram amplitude decreased by 70% or double potentials were noted. The endpoint of PV ablation was defined as an absence of PV spikes registered on the spiral-mapping catheter (Lasso, Biosense Webster) positioned within the ipsilateral PV more than 30 minutes after the last RFC application.

Ablation of complex fractionated atrial electrograms

The definition of complex fractionated atrial electrograms (CFAE) has been reported elsewhere in detail.[10] Ablation of CFAEs was solely performed if electrical cardioversion failed after PVI.[11] Target sites included the base of the LA appendage (LAA), anterior LA, LA septum, mitral annulus, within the CS, and eventually the right atrium.

Outside the CS os, ablation was performed with a maximal power of 30 W, a flow rate of 17 mL/min, and a target temperature of 43°C.

Ablation targeting the PLSVC and CS

The PLSVC and CS were targeted for ablation if the shortest AF cycle length was demonstrated within these structures (Figure 2). Before ablation, selective venography of the CS and PLSVC was performed (Figure 3). The proximal portion of the PLSVC originates from the distal CS, while its midportion runs along the left lateral ridge and anterior to the left PVs. The distal PLSVC extends beyond the left PVs. A spiral-mapping catheter (Lasso, Biosense Webster) positioned within the distal portion of the PLSVC was used to record local ectopic activity. Ablation of high-frequency signals targeting the midportion of the PLSVC was followed by catheter withdrawal to the proximal portion of the PLSVC and the CS until all local high-frequency signals were eliminated (Figure 4). RFC was applied using an open-irrigated 3.5-mm-tip ablation catheter limiting energy to 20 W with a maximal temperature of 43°C and a flow rate of 17 mL/min. Cryothermal energy ablation via a balloon catheter (Arctic Front, Cryocath, Montreal, Canada) was used in two patients who demonstrated a significantly enlarged proximal CS. A 28-mm cryoballoon catheter using a steerable sheath was advanced via the right femoral vein to the proximal CS. Each cryothermal energy application lasted 300 seconds targeting a temperature of −80°C.

Postablation protocol and patient follow-up

Routine transthoracic echocardiography and thoracic fluoroscopy were performed postoperatively to rule out pericardial effusion and pneumothorax, respectively. Patients were treated with intravenous unfractionated heparin targeting a partial thromboplastin time (PTT) of 50–70 seconds starting 4–6 hours after the procedure, while oral anticoagulation was started 1 day postoperatively, targeting an international normalized ratio of 2.0–3.0. Oral anticoagulation was continued for at least 3 months after ablation and maintained thereafter according to the individual patient's risk score

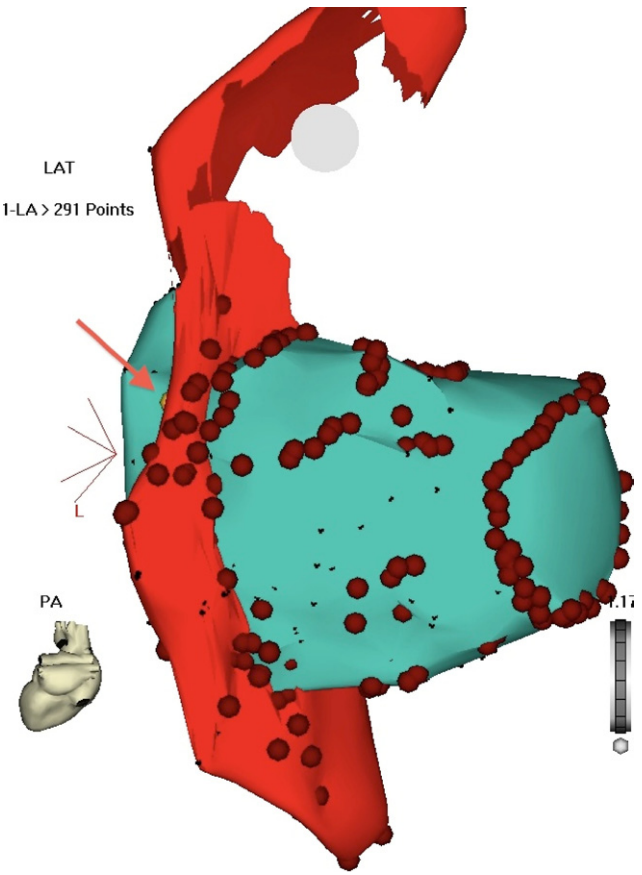

Figure 1 Three-dimensional CARTO map of the LA (*green*) and CS/PLSVC (*red*) in a posterior-anterior projection during the initial procedure in patient no. 1. Circumferential linear lesion sets encircling the ipsilateral septal and lateral PVs (*dark red dots*). In addition, several lesion sets were deployed within the LA, CS, and PLSVC. Note the cumulative lesion sets at the midposterior level of the PLSVC. The *yellow dot* (*arrow*) indicates the site of isolation of the midportion of the PLSVC from the LA.