Cryoballoon Ablation for Paroxysmal Atrial Fibrillation

Courtesy: Markus Stühlinger, MD, and Florian Hintringer, MD, Medical University of Innsbruck, Austria

Patient history

A 52-year-old male patient was admitted for ablation of paroxysmal atrial fibrillation (Afib). After radio-frequency ablation of an accessory pathway 10 years earlier, he had now been suffering from frequent episodes of tachyarrhythmias for several years. In the past 12 months, the patient had been hospitalized three times due to highly symptomatic and fast Afib (EHRA class III). The arrhythmia had been refractory to flecainide. Additional cardiac risk factors included excess weight, hypertension, and hyper-cholesterolemia. However, blood pressure and cholesterol were well controlled via angiotensin receptor antagonist and statin therapy.

Diagnosis and evaluation

On admission, an ECG, a trans-esophageal echocardiogram (TOE), and a cardiac CT scan (cCT) were performed. The TOE showed mild dilatation of the left atrium (LA; 42 mm), but normal left ventricular function. A thrombus in the left atrium and specifically in the left atrial appendage was excluded.

A subsequent CT scan excluded coronary heart disease (Agatston Score 6.6). A small accessory right-middle pulmonary vein (PV)(diameter 7 mm) was found as a normal variant (Fig. 1, black arrow). A maximal diameter of 27 mm was measured at the common ostium of the right superior and middle PV (Fig. 1, petrol line). The right inferior and the two left PVs were regular in size (max. diameter 21, 22, and 24 mm).

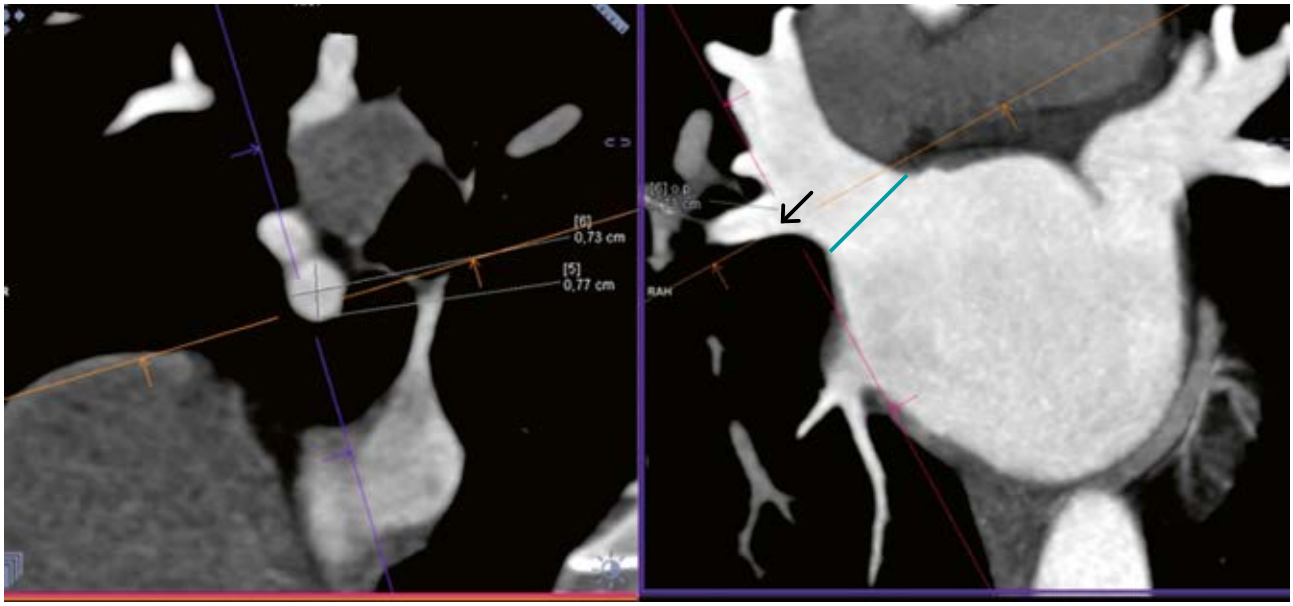
The common ostium of the right superior and middle PV was similar in diameter to the cryoballoon (28 mm), prompting concern about ablation deep in the vein and subsequent phrenic nerve palsy. After detailed review of the CT scan, however, the anatomy was deemed suitable for cryoballon ablation (CBA) and the procedure was planned for the next morning.

Treatment

Transseptal puncture and positioning of the cryoballoon in the LA were performed safely under intracardiac echocardiography guidance (ICE; Fig. 2).

Meanwhile, the CT images were automatically segmented and the 3D anatomical model of the left atrium then imported for postprocessing.

1



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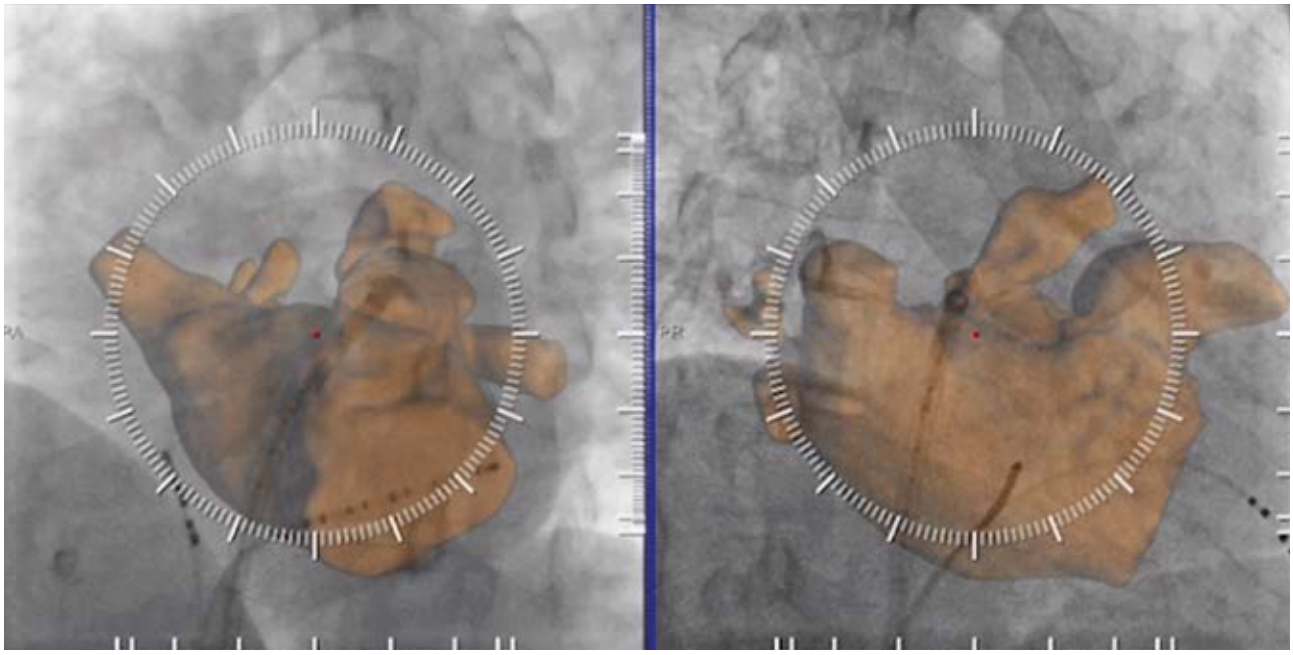
1 CT angiography (128 DSCT SOMATOM Definition FLASH scanner, Siemens Healthineers, Germany) of the left atrium revealed a common ostium of the right superior and right middle PV; the diameter of the common ostium was 28 mm (petrol line) and that of the right middle PV 7 mm (black arrow).

2 Transseptal puncture visible on intracardiac echocardiography (ICE): An AccuNav® catheter was introduced into the right atrium. The intra-atrial septum and the Brockenborough needle (white arrow) are shown.

3



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3 3D images fused on the Artis Q.zen imaging system: Automatically segmented CT images were imported to the Siemens *syngo* X Workplace via *syngo* 3D Roadmap.

4 3D anatomical model imported via *syngo* 3D Roadmap: Visualization of the PV ostia in an RAO 45° view during CBA in the right superior PV; the black ring shows the inflated cryoballoon.

Following angular adjustment, the 3D volume overlay was combined with live fluoroscopy to guide placement of the catheters and cryoballoon in real time. Notably, the 3D model followed changes in angulation and table movements based on fluoroscopy (Fig. 3).

CBA in the two left and the right inferior PVs was performed without complications. Balloon occlusion was monitored via contrast media injection through the distal lumen of the device. Temperatures below -40°C were reached and PV isolation was shown after two freezes in each PV. CBA in the right superior PV was complicated by suspected phrenic nerve palsy two minutes after the start of the first freeze. After full recovery of phrenic nerve function, the guiding catheter and the tip of the cryoballoon were placed in the right middle PV. CBA was attempted in both branches simultaneously, resulting in successful PV isolation with two cryoballoon freezes in the side branch without any damage to the phrenic nerve (Fig. 4).

After 15 minutes, isolation of all five PVs with an exit block by pacing from the vein ostia via circular mapping catheter was confirmed. Phrenic nerve function was deemed adequate and pericardial effusion was excluded using ICE at the end of the procedure. Data transfer to the recording system enabled automatic documentation of the case.

Follow-up

Routine follow-up included a resting ECG and Holter monitoring at three and six months after CBA at our outpatient clinic. The patient had no symptomatic arrhythmias, although not on antiarrhythmic medication. Moreover, sinus rhythm without any sustained atrial tachycardia was documented in periodic resting ECGs and Holter monitoring.

Comments

Atrial fibrillation is the most common cardiac arrhythmia. It is caused by fast-rotating impulses in both atria leading to an irregular ventricular rhythm. Patients with Afib suffer from palpitations, tachycardia, and exercise intolerance leading to severely impaired quality of life. Furthermore, thrombo-embolism and heart failure are known consequences of this rhythm disorder in patients at risk.[1]

Electrophysiological studies from the late 1990s were able to show that ectopy originating in the pulmonary veins can initiate Afib.[2] Radio frequency application at the PV ostia was shown to block conduction of ectopy from the PVs to the left atrium and, therefore, suppress paroxysmal Afib. Recently, a novel cryoballoon ablation technique using the Arctic Front® ablation system (Medtronic Cryocath®, USA) was shown to suppress paroxysmal Afib with an efficacy similar to radio-frequency ablation. CBA is a simple and fast procedure to suppress symptomatic recurrences of atrial tachyarrhythmias in up to 80% of patients. However, phrenic nerve palsy during ablation at the ostia of the right PVs occurred more often as a complication in a randomized comparison of radiofrequency and CBA techniques.[3]

Fluoroscopic guidance of electro-physiology catheters and specifically of the cryoballoon catheter is simplified significantly through integration of the reconstructed CT images of the left atrium in *syngo* 3D Roadmap. In our case, the right superior PV was isolated after insertion of the catheter in the right middle PV, and phrenic nerve palsy was avoided. In conclusion, integrating segmented images, acquired using ultra-low-dose settings on the Artis Q.zen system, automatically into live fluoroscopy offers significant advantages for both patients and physicians. ●

References

[1] Prystowsky EN, Padanilam BJ, Fogel RI. Treatment of Atrial Fibrillation. J Am Med Assoc. 2015; 314 (3): 278-88.

[2] Haïssaguerre M, Jaïs P, Shah DC, Takahashi A, Hocini M, Quiniou G, Garrigue S, Le Mouroux A, Le Métayer P, Clémenty J. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. N Engl J Med. 1998; 339(10): 659-66.

[3] Kuck KH, Brugada J, Fürnkranz A, Metzner A, Ouyang F, Chun KR, Elvan A, Arentz T, Bestehorn K, Pocock SJ, Albenque JP, Tondo C; FIRE AND ICE Investigators. Cryoballoon or Radiofrequency Ablation for Paroxysmal Atrial Fibrillation. N Engl J Med. 2016; 374 (23): 2235-45.

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Contact
Dietrich Till
dietrich.till@siemens-healthineers.com

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