Percutaneous Pulmonary Vein Angioplasty for the Pulmonary Vein Stenosis After Catheter Ablation of Atrial Fibrillation

Ji Hoon Kim, MD, Seung Yong Shin, MD, Hyung Joon Joo, MD, Jong Il Choi, MD, Soon Jun Hong, MD, Hui-Nam Pak, MD and Young-Hoon Kim, MD
Department of Cardiology and Internal Medicine, Korea University College of Medicine, Seoul, Korea

ABSTRACT

Pulmonary vein (PV) stenosis after radiofrequency catheter ablation (RFCA) of atrial fibrillation (AF) is one of the frequent complications. Percutaneous PV angioplasty and stent implantation have been used as an effective therapy for this condition, yet the in-stent restenosis rate tends to increase after stent implantation at the stenotic PVs. This seems to be caused by neointimal hyperplasia within the stent. This is the first case report on using drug-eluting stent for the treatment of pulmonary vein stenosis that developed after RFCA of AF. (Korean Circ J 2008;38:170-173)

KEY WORDS: Pulmonary vein; Stenosis; Stents; Angioplasty.

Introduction

Pulmonary vein (PV) isolation by performing radiofrequency catheter ablation (RFCA) is a widely used treatment for PV-mediated atrial fibrillation (AF). A major complication that occurs after PV isolation is pulmonary vein stenosis. Percutaneous PV angioplasty and stent implantation have been adopted for the treatment of this relatively common complication, yet high rates of restenosis are common despite the excellent initial procedural and clinical outcome. We performed percutaneous PV angioplasty and drug-eluting stent implantation for the treatment of acquired pulmonary vein stenosis that developed after repeated RFCA.

Case

A 54-year old female was admitted with complaints of chest pain and shortness of breath with effort. She had a history of two RFCA procedures. Three years ago, the first catheter ablation was done because of recurrent symptomatic AF that was refractory to more than two antiarrhythmic drugs. No significant abnormalities of both the upper and lower pulmonary veins (PVs) were found on the pre-procedural PV computed tomogram (PV CT), and the right middle pulmonary vein (RMPV) was directly inserted into the right atrium. RFCA was applied to the common trunks of the left superior pulmonary vein (LSPV) and the left inferior pulmonary vein (LIPV) and the whole circumference of the right superior pulmonary vein (RSPV), the RMPV and the right inferior pulmonary vein (RIPV). However, AF recurred one year after the procedure and a significant sinus pause (>3-6 seconds) with dizziness followed upon termination of each episode of paroxysmal AF. The patient had been taken more than two antiarrhythmic drugs, including amiodarone, since the time she experienced recurrent symptoms of AF. Subsequently, a second ablation procedure was performed. Multi-view pulmonary venograms showed significant stenosis (>50%) in the ostia of the LIPV and RMPV, respectively. The two-dimensional echocardiography revealed a pulmonary arterial systolic pressure (PASySP) of 45 mmHg, as measured by pulse-wave Doppler, which was increased compared to the measurement before the first ablation (28 mmHg). Since the patient complained of palpitations that were mainly attributed to the AF, but she did not have any symptoms related to the PV stenosis, a second ablation procedure was attempted. Segmental ablations were performed for the reconnected pulmonary vein potentials (PVPs) in the LSPV and the intermediate PVPs at the anterior and posterior portions.
between the left atrium (LA) and the LSPV. Since the LIPV showed significant stenosis in the ostium, ablation was done as close as possible to the antral level. Finally, circumferential ablation was performed at the antra of the right-side PVs. Subsequently, a permanent pacemaker (DDDR) was implanted for correcting the sinus node dysfunction. The patient had no history of other cardiovascular disease or any other disease, and no history of smoking. On presentation, she complained of general weakness, palpitations and dyspnea, which accompanied the chest pain. The initial ECG exhibited an atrial-sensed ventricular rhythm with a rate of 100 beats per minute. The cardiac enzymes and D-dimer were within the normal limits. The chest roentgenogram revealed that the pacemaker leads were in the cardiac chambers without any remarkable change since the last study. The two-dimensional echocardiography showed a moderately decreased global function of 35%, with worsened pulmonary hypertension (PASYSP=48 mmHg) compared to the last measurement taken 1 year after the second procedure (38 mmHg). The three-dimensional reconstruction of the PV CT demonstrated a completely obliterated RMPV, RIPV and LIPV, compared to the baseline CT scan taken 3 years previously (Fig. 1A and B). The lung perfusion scan showed a diffuse decrease in perfusion in both lower lobes of the lung. The transesophageal echocardiography showed the absence of flow at the RIPV ostium, and the flow

**Fig. 1.** Pulmonary vein stenosis after radiofrequency ablation. A: three-dimensional spiral computed tomography scan of the PVs and LA before ablation. B: multislice computed tomography of the PVs and LA after ablation shows a total occluded RMPV, RIPV and LIPV. C: a high velocity jet from the LIPV is seen on transesophageal echocardiography. D: selective pulmonary venography on the LIPV. PV: pulmonary vein, LA: left atrium, RMPV: right middle pulmonary vein, RIPV: right inferior pulmonary vein, LIPV: left inferior pulmonary vein.

**Fig. 2.** Treatment of left inferior pulmonary vein stenosis by PV angioplasty and drug-eluting stent implantation. A: the guide catheter is introduced into the left inferior pulmonary vein (LIPV) ostium. B: stent placement. C: post-stent pulmonary venography at the LIPV. PV: pulmonary vein.
velocity and turbulence at the RSPV and LSPV were significantly increased. The LIPV showed a high velocity jet (LIPV ostium) with a maximum lumen diameter of 1.3 mm (Fig. 1C). Since the patient was symptomatic, percutaneous PV angioplasty was performed. Seven days before the procedure, low molecular weight heparin was started with overlapping warfarin administration, and the prothrombin time was targeted to reach the international normalized ratio of 2.5. A transseptal puncture was performed via the right femoral vein. We obtained the left atrialogram to define the anatomical relationship between the LA and the stenotic PVs. There was no stump of the RIPV identified and a significant stenosis was found at the LIPV (Fig. 1D). The first attempt was to recannalize the totally occluded RIPV, but this failed because of the absence of a stump. Then we decided to perform angioplasty at the LIPV. We inserted the guidewire into the LIPV lumen and introduced a Voyage 1 2.5/15 mm balloon into the ostium of the LIPV and inflated it up to eight atms for 60 seconds (Fig. 2A). Then we introduced a Voyage 1 3.5/15 mm balloon into the lumen and inflated it up to eight atms for 100 seconds. After that, we introduced an Endeavor 4.0/9 mm stent and initially inflated it up to nine atms for 20 seconds and finally we inflated the stent balloon up to 14 atms for 20 seconds (Fig. 2B). The post-stent venogram of the LIPV showed significant improvement of flow (Fig. 2C). The symptoms gradually subsided after successful deployment of the stent at the LIPV. The follow-up transesophageal echocardiogram, taken two days later, showed a well apposed stent (sten lumen diameter=3.7 mm) in the LIPV with improved flow velocity (1.0 m/sec). The PASYSP decreased to 35 mmHg. Treatment with aspirin 100 mg and clopidogrel 75 mg was started from the procedure day and this was continued. There have been no further events during the 3 months of clinical follow up.

Discussion

PV stenosis is a relatively common major complication that develops after RFCA for treating AF. The incidence of PV stenosis had been reported to be up to 40% when focal triggers inside the PVs are targeted.12 The incidence of severe stenosis has decreased to 0.5-2% with the evolution of PV isolation techniques, which mostly target at more proximal to the PV-LA junction or the PV antrum.3,5,7 The incidence of PV stenosis as an acute and chronic complication after circumferential PV ablation is currently known to be 0.4% and 1.31%, respectively.6,30

Development of severe symptoms depends on whether multiple pulmonary veins are involved and on the degree of PV stenosis.39 This patient had undergone two RFCA procedures three years and two years ago, respectively. The first procedure was the ablation of the common trunks of the LSPV and the LIPV and the whole circumference of the RSPV, RMPV and RIPV. Segmental ostial ablation of the LSPV and LIPV with repeated ablation of the right sided PVs were carried out in the second procedure. The patient complained of chest pain and dyspnea, and she was revealed to have significant stenosis of the right and left upper PVs and a totally occluded RMPV, RIPV and LIPV. Percutaneous intervention has previously been successfully used for the treatment of this complication. Packer et al.10 evaluated 23 patients with PV stenosis of 34 veins that developed after RFCA for AF. The symptoms were relieved after successful reduction of the stenosis and a trans-stenotic gradient of approximately 10 mmHg was achieved. Bedogni et al.11 reported that the procedural success rate using the balloon alone or with stent implantation was 86%. Similar to other previous studies, the patient in our report showed immediate symptomatic improvement after percutaneous PV angioplasty with the lumen diameter of the target vessel being increased from 1.3 mm to 3.7 mm, as measured by transesophageal echocardiography.12-14 This is the first Korean case report of treating pulmonary stenosis, as a complication of RFCA for AF, by percutaneous PV angioplasty and implanting a drug eluting stent. Drug eluting stents have been successfully used for coronary artery disease with achieving significantly decreased rates of restenosis.15 Although the symptomatic response and procedural success rate of percutaneous stent implantation for PV stenosis is relatively good, the incidence of restenosis is known to be as high as fifty to sixty percent. Qureshi et al.14 reported a 47% rate of restenosis at 11 months after intervention. Saad et al.39 reported a 47% rate of restenosis and the in-stent restenosis rate was 40% (4/10). Packer et al.10 reported a 57% rate of restenosis (8/14). However, Neumann et al.10 showed no recurrence of PV stenosis after stenting at a median follow-up of 12 months. Restenosis within the body of the stent is likely caused by neointimal hyperplasia and fibrosis,10 and this is likely the same mechanism that’s involved with in-stent restenosis after percutaneous coronary intervention.10 Accordingly, we anticipate that drug-eluting stents could reduce the long-term PV restenosis rate. Further imaging studies to evaluate PV restenosis are needed.

The pathophysiology of PV stenosis remains to be determined. The thermal injury to the PVs causes intimal proliferation with an organizing thrombus, necrotic myocardium, endovascular contraction and elastic lamina proliferation.10 Percutaneous angioplasty and stent implantation could be successful for treating fibrous waste, yet thrombus formation might be a major limitation. Since we used a drug-eluting stent in an attempt to prevent neointimal hyperplasia, additional efforts must
be made for preventing thrombus formation with using anti-platelet agents, which is a strategy adopted from the experience with coronary interventions.\(^{15}\)

Although the incidence of acquired severe PV stenosis appears to be declining with the application of better imaging techniques, circumferential ablation at the more antral level in most patients, with efficient RF power titration, remains harmful and it should be avoided whenever possible. The patient reported on here, who underwent angioplasty with drug-eluting stent implantation, showed immediate clinical improvement. Since our follow up period was extremely short, mid-term and long-term follow-up is needed in this case.

REFERENCES