A novel catheter for simultaneous angiography of ipsilateral pulmonary veins

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We designed a novel catheter for simultaneous angiography of ipsilateral pulmonary veins (PVs), so that the catheter tip with side holes can be introduced into the inferior PVs and a second curve with side holes into the superior PVs. The simultaneous angiogram of the ipsilateral PVs, using this novel catheter, reveals more clearly the PV ostium to antrum, because simultaneous injection of contrast medium into two adjacent PVs reduces the dilution of contrast medium by blood flow through these veins.

**KEYWORDS**

Pulmonary vein; Angiography

Identification of the pulmonary vein (PV) ostium is helpful in the PV ostial isolation technique.¹ For extensive PV ablation, it is helpful to obtain PV antrum anatomical images and understand the relationship between the ipsilateral PVs.² Some operators who perform PV ablation have substituted other techniques for PV angiograms to visualize the PV anatomy, such as the use of double circular catheters and electro-anatomical mapping, probably because PV angiograms cannot accurately identify the PV ostium or antrum.³,⁴ We developed a novel catheter for simultaneous angiography of ipsilateral PVs in order to overcome this difficulty and increase the value of the PV angiogram.

The catheter was designed by the first author such that the catheter tip with side holes could be introduced into the inferior PV and second curve with side holes into the superior PV of each side (Figure 1). This 6-F catheter was manufactured with the tip and shaft made of polyamide and curve made of polyamide plus polyurethane (Goodman Co., Ltd, Meito-ku, Nagoya, Japan). The pre-shaped curves of the catheter were handmade using a pre-shaped stainless mandrel. The catheter was sterilized with ethylene oxide.

Experimental data showed that the proportion of the contrast medium being discharged from the proximal holes (into superior PV) vs. the distal holes (into inferior PV) varied according to the volume per second (vol/s) of the fluid injected (range 36.0 ± 5.4 vs. 64.0 ± 5.4% to 61.4 ± 4.0 vs. 38.6 ± 4.0%). The greater the vol/s of the fluid injected, the greater was the proportion discharged from the distal holes. The preliminary study in humans showed that the greater the vol/s injection rate the better was the simultaneous angiogram of the ipsilateral PVs.

The catheter is introduced into the left atrial (LA) cavity through a transseptal sheath without a guidewire. If the catheter is pushed up after clockwise rotation towards the posterior wall of the LA, the second curve of the catheter can be easily introduced into the left superior PV. Thereafter, the tip of the catheter can be introduced into the left inferior PV by additional clockwise rotation. A rapid bolus injection of about 10 mL of contrast medium can achieve a simultaneous angiogram of the ipsilateral PVs (Figure 2). This catheter can also be used for simultaneous angiography of the right ipsilateral PVs (Figure 2). Individual PV angiograms cannot clearly reveal the PV ostium to antrum, because the contrast medium is diluted by the blood flow from the adjacent PV.

We planned a randomized study in order to investigate the efficacy of this novel catheter. The Institutional Review Board of Aichi Prefectural Cardiovascular and Respiratory Center approved the study protocol, and all patients provided written informed consent. Fifty atrial fibrillation patients were randomized for PV angiography using the novel catheter (Group I; 25 patients) or a standard catheter (Group II; 25 patients) before PV ablation. There were no significant differences in the clinical characteristics including the LA dimension between the two groups. The PV angiography was performed randomly by one of the two co-authors. The novel catheter could successfully achieve a simultaneous angiogram of the...
ipsilateral PVs in all the allotted cases. A catheter of the same design required a slightly stronger third curve in three Group I patients with a lower take-off of the right inferior PV, and a deeper insertion of the transseptal sheath was needed for the left PV angiography in two Group I patients with an enlarged left atrium (LA dimension >45 mm on the transthoracic echocardiographic image). The averages of total fluoroscopic time and volume of contrast medium needed to obtain PV angiograms were significantly smaller in Group I compared with Group II (1.8 ± 1.1 vs. 3.4 ± 2.8 min; P < 0.01 and 18 ± 6 vs. 25 ± 4 mL; P < 0.0001, respectively).

It was noted that the simultaneous angiogram of ipsilateral PVs, using this novel catheter, overcame the problem of contrast dilution with individual PV angiograms. It allowed clear delineation of PV ostium and antrum of both ipsilateral PVs. Further benefits accrued from this novel catheter in the reduction of fluoroscopic time and volume of contrast medium.

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References