The Use of a Wire Control Catheter to Treat Complex Pulmonary Artery or Vein Anatomy

Volume 24 - Issue 7 - July 2012 Posted on: 7/2/12 0 Comments 4238 reads

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ABSTRACT: The difficult performance of certain percutaneous interventions in the field of congenital heart disease is well known. Crossing pulmonary arteries in patients who have previously undergone surgical repair or stenotic pulmonary veins in infants can be typical examples of these technical challenges in the catheterization laboratory.

The Venture wire 6 Fr control catheter (St Jude Medical) is compatible with a steerable tapered radiopaque tip that can be manually angulated (up to 90˚) by clockwise rotation of a knob located in the proximal handle. This mechanism directs any 0.014" guidewire and provides back-up support. This catheter has been successfully used in coronary artery intervention for crossing severely tortuous vessels, extreme angulations of side-branch ostia, jailed stents, saphenous vein graft anastomoses, and chronic total occlusions.

We report the first use of the Venture wire control catheter (St Jude Medical) in the field of congenital heart disease. Patient #1 was diagnosed with pulmonary atresia and ventricular septal defect and had a proximally migrated stent in the pulmonary trunk and severe left pulmonary artery stenosis. We have used this catheter in order to cross this stent and perform left pulmonary artery stent placement. Patient #2 had postoperative vein restenosis after surgery. The Venture catheter was used to reach the obstructed insertion of the right medium lobe pulmonary vein from a transseptal approach.

Techniques from coronary interventional colleagues can help interventional cardiologists in the field of congenital heart disease to treat complex situations.

J INVASIVE CARDIOL 2012;24(7):E148-E152

Key words: congenital heart defects, pulmonary atresia, pulmonary artery, stents

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It is not uncommon to use techniques or tools from coronary artery intervention to treat lesions in other fields of percutaneous intervention. The Venture wire control catheter (St Jude Medical) is a 6 French (Fr) compatible, over the wire or monorail, 140 cm braided support catheter. The steerable tapered radiopaque tip can be manually angulated (up to 90˚) by clockwise rotation of a knob located in the proximal handle. This mechanism directs any 0.014" guidewire and provides back-up support. This catheter has been used to cross severely tortuous vessels, extreme angulations of side-branch ostia, jailed stents, saphenous vein graft anastomoses, and chronic total occlusions.[1-7] The first extra coronary use of this catheter was reported in reaching a renal artery aneurysm.[8] It is well known that crossing pulmonary arteries or veins in patients who have previously undergone surgical repair of congenital heart defects can be technically challenging in the catheterization laboratory. To the best of our knowledge, there is no report on the use of this catheter for congenital heart defects in the published literature.

Case Reports

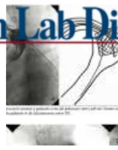
Patient 1. A 7-year-old boy with the diagnosis of pulmonary atresia and ventricular septal defect, hypoplastic pulmonary arteries, and major aortopulmonary collateral arteries (MAPCAs) was referred to our institution. The patient was previously palliated with a 5 mm right modified Blalock-Taussig shunt at 3 years of age. Two years later the patient underwent complete correction with patch ventricular septal defect closure, placement of a 16 mm Carpentier-Edwards bioprosthetic valved conduit (Edwards Lifesciences) from the right ventricle to the pulmonary artery, patch enlargement of the pulmonary arteries, and ascending aortoplasty. Cardiac catheterization performed 15 days post-surgery showed a tight stenosis at the origin of the left pulmonary artery (LPA) where a 17 mm JoStent (Abbott) was implanted, mounted on a 8 mm x 20 mm Cristal balloon (Balt), and MAPCAs from the descending aorta and right subclavian artery. One of these was embolized with a 3 mm x 5 loop coil. During follow-up CT scan, we noticed that the stent had dislodged into the conduit and there was severe stenosis of the LPA. After contact with our center, the boy was transferred for evaluation.

After positioning an extra-stiff guidewire in the right pulmonary artery (RPA), an 8 Fr Mullins sheath was advanced to the pulmonary artery trunk. Multiple injections confirmed the transversely positioned embolized stent in the pulmonary trunk and severe LPA stenosis with a right ventricular systolic pressure corresponding to 70% systemic pressure (Figure 1). The intended procedure was to reach the LPA through the previous implanted stent without passing through the stent struts, allowing new stent implantation. The alignment of the LPA stenosis was parallel to the stent position and the angle from it to the main pulmonary artery was almost 180˚.

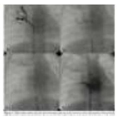
We decided to use the Mullins sheath system at the proximal part of the stent and leave an extrastiff guidewire in the LPA, even if it crossed the stent cells, to give better support for the catheters and guidewires to be used (Figure 2A). Five and 6 Fr right and left Judkins, Amplatz right, and internal mammary coronary artery catheters (Cordis) were then tried inside the Mullins sheath, positioned just distal to the proximal part of the stent, and a variety of standard guidewires (Terumo hydrophilic, 0.014" coronary guidewires such as Hi-Torque BMW [Abbott], and Whisper extrasupport [Abbott]) were used but failed to reach the LPA without passing through the stent cells.

Sometimes, when the guidewire and the catheter successfully crossed the whole stent without passing through the stent cells, it became very difficult to direct the tip of the catheter to the left side as the system then faced towards the RPA (Figure 2B). Even with a balloon occluding the origin of the RPA, it was impossible to reach the LPA due to the extremely acute angle between the delivery system and the vessel.

After numerous attempts t[...] ocedure time, a Venture wire control cathe[...] (St Jude Medical). We tried to direc[...] he left pulmonary artery. When it had just passed through the distal part of the stent, the tip of the catheter was directed to the LPA with a rotation of the knob in the proximal handle of the catheter. This maneuver enabled the distal bed of the LPA to be reached with the catheter and guidewire to give adequate support (Figure 3). Afterwards, the Venture catheter was ex[...] coronary wire. An extra-stiff [...] passing through the stent ce[...] 8 mm x 30 mm (Balt) perform[...] later advancement of a Mulli[...] (Figure 4A). The procedure after the choice of the Venture catheter took 20 minutes.



Stent implantation was performed with a JoStent 28 mm (Abbott) mounted on an 8 mm x 30 mm Cristal balloon post-dilated with a 14 mm x 40 mm FoxCross balloon (Abbott) with a good hemodynamic and angiographic result and a final right ventricular to systolic pressure/systemic pressure ratio of 0.5. Eventually, the previous stent rearranged a better orientation towards the LPA (Figures 4B and 4C).



Patient 2. A 10-month-old infant was referred to our hospital with the diagnosis of bilateral pulmonary veins restenosis after surgical procedure with sutureless technique in the right-sided ostium and patch angioplasty on the left-sided ostium. During the surgical procedure, the surgeon left a small atrial septal defect. The patient presented clinically unstable with signs of supra-systemic pulmonary artery pressures at echocardiography and was referred for an attempt of percutaneous balloon dilatation of the pulmonary veins. At cardiac catheterization, right ventricular pressure was 120% of the systemic pressure. Selective angiography at the ostium of the right upper pulmonary veins clearly demonstrated stenosis that was dilated with 3 mm x 20 mm and 3.5 mm x 20 mm Hiryu balloon (Terumo) and post-dilated with 5 mm x 20 mm Quantum Maverick balloon (Boston Scientific) (Figure 5A). However, it was very difficult to cannulate the insertion of the medium and inferior lobe drainage due to an extreme angulation. After various attempts with usual catheters and guidewires, we used the Venture catheter to inject contrast and confirm the stenosis and then to cannulate with a 0.014" support guidewire. We then performed successful balloon dilatation with 3.5 mm x 20 mm Hiryu balloon (Terumo) and post-dilation with 5 mm x 20 mm Quantum Maverick balloon (Boston Scientific) (Figures 5B-5D). Using a 5 mm x 20 mm Quantum Maverick balloon, we performed dilatation of the obstructed ostium of the left-sided pulmonary veins. Procedure was uneventful and pressure in the right ventricle decreased to 60% of the systemic pressure. The patient was discharged 10 days later clinically well and with a stable result.

Discussion. Branch pulmonary artery stenosis is not an uncommon problem following complete repair of pulmonary atresia and ventricular septal defects. It can be iatrogenic, induced by a previous systemic to pulmonary shunt operation, or even due to congenital hypoplastic pulmonary arteries. Clinically these patients can be asymptomatic even with right ventricular hypertension or can present with exercise intolerance. Right ventricular dysfunction, arrhythmias, and sudden death are avoidable complications by treatment with stents.

Surgical access to distal pulmonary arteries, particularly in patients previously operated on that have tissue adhesions, is technically difficult and the incidence of restenosis and necessity for another intervention is not inconsiderable. The excellent long-term follow-up results of percutaneous pulmonary artery stent implantation recently published in the literature make this technique the standard of care for the management of branch pulmonary artery stenosis.[9]

1 2 next › last »