Percutaneous Pulmonary Valve Implantation Using Vision Technology Software

Pr Patrice Guérin
Institut du Thorax
University Hospital of Nantes, France
Clinical Context:

Percutaneous pulmonary valve implantation (PPVI) provides an alternative to early surgical re-intervention in patients suffering from congenital heart diseases involving the right ventricular outflow tract (RVOT).

PPVI has been recently introduced into routine clinical practice in different European Heart Centers. It was used for the first time in 2000 for the purpose of expanding the lifetime of valved conduits and to reduce the number of operations.

PPVI procedure involves implanting a valved stent assembly by using a double balloon catheter delivery system.

The valved stent used is The Melody valve.

The Melody valve is made from a cow's jugular vein valve that is sewn into a small metal stent (scaffolding). It comes in sizes 18, 20, and 22mm diameters and has a stent length of 28mm.

The Medtronic Ensemble Transcatheter Valve Delivery System is a catheter (long tube with small diameter) that helps guide the Melody into the heart. The Ensemble delivery system has catheters with balloon sizes of 18, 20, and 22mm.

Various investigations of McElhinney and coworkers found that Melody valves improve functional status and peak exercise parameters and in some of the patients, the Melody valves might improve biventricular function and efficiency.

Cath Lab Integration:

- Fused images are displayed on a dedicated monitor in the procedure room.
- A dedicated fusion algorithm is applied to optimize visualization of the X-ray area and of the 3D images in the fused area.
- Physicians can change image display settings, zoom and roam, display predefined landmarks or manually readjust the registration.
- All these functionalities, as well as Innova HeartVision sequence storage, can be controlled from the Innova Central touch screen at tableside.

In the following cases, we are going to show how to plan, guide and assess PPVI.
Case 1

Patient:
A young male patient, suffering from pulmonary atresia with a ventricular septal defect (VSD) was treated with a left Blalock-Taussig shunt shortly after birth.

History:
At the age of three, he surgically had a VSD closure and ventriculo pulmonary connection. At twelve, the stenosed VDAP tube was surgically replaced with a 20-mm Hancock** valved tube. At fourteen, he presented bilateral stenosis of the pulmonary arteries originating at the implanted tube. The stenoses were percutaneously treated with two stents with satisfactory results. Later, one of the stents fractured. (fig 1).

Current procedure:
When the neo-valve degenerated, it caused leakage and regurgitation leading to an increase of the right ventricular systolic pressure up to 2/3 of the systemic pressure. At that time, a decision was made to implant a Melody valve.

The procedure started with a dilatation of the left pulmonary artery on the fractured stent.
1. Plan
In order to prepare the procedure, the anatomy of interest is segmented on the AW* VolumeShare and then exported into Innova HeartVision. (fig. 2)

2. Guide
The 3D model is fused with fluoroscopic images and oriented in synchrony with Innova C-arm angulations. (fig 3 and fig 4)

Stent positioning, placement and inflation (fig 3a, 3b and 3c)
Valve positioning, placement and inflation (fig 4a, 4b and 4c)

Fig 4a  Fig 4b  Fig 4c

3. Assess
Fused fluoroscopic images obtained with the Innova Vision technology provided visual guidance during deployment of the valve (fig. 5 and fig 6).

Fig 5, Before treatment  Fig 6, After treatment

Non-fused fluoroscopic images before and after treatment (fig. 7 and fig 8).

Fig 7, before treatment  Fig 8, after treatment
Case 2

Patient:
A young male patient suffering from congenital double outlet right ventricle with pulmonary stenosis and a malposition of the great arteries.

History:
Shortly after birth, he received a right Blalock-Taussig shunt. At the age of 15, he had surgery to close an intraventricular communication and had a non-valved 18 mm Dacron** tube inserted.

Current procedure:
He then developed a right stenosis on the right pulmonary artery (due to initial Blalock Taussig) and stenosis on the Dacron tube causing the right systolic pressure to go up to 2/3 of the systemic pressure. This was an indication for a Melody valve implant.

The procedure started by the dilatation of the right pulmonary artery.

1. Plan
In order to prepare the procedure, the anatomy of interest is segmented on the AW* VolumeShare and then exported into Innova HeartVision. (fig. 9)

Fig 9

2. Guide
Prior to the deployment of the prosthesis, coronary flow is verified through simultaneous balloon inflation in the pulmonary artery and contrast media injection in the aortic root (fig 10 and 11).

Fig 10   Fig 11

**Dacron is a trademark of Invista Inc
3. Assess
Retrogade injection in the pulmonary artery using fluoroscopy

Fig 12, Fused image before treatment
Fig 13, Fused image after treatment
Fig 14, Non-fused image before treatment
Fig 15, Non-fused image after treatment

*Dacron is a trademark of Invista Inc.*
Conclusion

During PPVI, Innova Vision technology meets the challenges of moving anatomy, such as pulmonary structures, by using dedicated algorithms to compensate not only for heart motion but also for patient movement.

Innova Vision assists the Interventional Cardiologist in the localization of the stenosis, in the implantation of the stent, and in the assessment of the result after implantation. Potential benefits for the patients include the use of less contrast media and less X-ray exposure.

"Innova Vision Technologies bring a significant help to the Interventional Cardiologist during the procedure, allowing the ability to:
1. View CT images in the catheterization room
2. Use CT images in order to guide and position the devices and deploy them in a precise manner

Brings a benefit to the patient by potentially limiting multiple X-ray exposures and repeated contrast injections."
Commitment for excellence

**Innova Image Guided System (IGS) 520³**
This cardiovascular and vascular X-ray system incorporates GE’s exclusive solid-state digital detector to consistently provide excellent imaging performance for a full range of Interventional X-ray procedures (angiograms, device placement and non-vascular).

**AW workstation**
Advantage Workstation Premium (AW) for Interventional allows multimodality visualization, analysis and navigation. Physicians can access 3D anatomy directly in the Cath Lab based on 3D datasets from CT, MR or rotational angiography. The 3D images are displayed in-room on the monitor boom and can be easily controlled at tableside using a dedicated user interface.

**Volume Viewer**
is the environment of choice for 3D processing of any CT, MR, 3D X-ray, PET and PET/CT dataset. It provides exceptional tools for analysis, segmentation, measurements, annotation, filming and exporting of clinically relevant images.

**VessellIQ* Xpress**
facilitates vessel analysis by fast multibranch tracking and automated stenosis measurement. It also features an automated aorta and iliacs tracking and thrombus segmentation and analysis tool.

**Valve Assist**
Valve Assist assists you in planning your procedure by helping you to understand patient anatomy and plan appropriate therapy strategy and delivery path. Valve Assist helps you in guiding the procedure by fusing in real time the 2D fluoroscopy with 3D anatomy models.

**Innova Vision technology offers:**
- Automatic image registration with patient position and image orientation
- Real-time adjustments for all modifications of gantry position, source- to-image distance
- Motion tracking features such as ECG-gated display and Image Stabilization
- To enhance workflow, all these functionalities can be controlled from the Innova Central touch screen at tableside
About GE Healthcare

GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our broad expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, biopharmaceutical manufacturing technologies, performance improvement and performance solutions services help our customers to deliver better care to more people around the world at a lower cost. In addition, we partner with healthcare leaders, striving to leverage the global policy change necessary to implement a successful shift to sustainable healthcare systems.

Our “healthymagination” vision for the future invites the world to join us on our journey as we continuously develop innovations focused on reducing costs, increasing access and improving quality and efficiency around the world. Headquartered in the United Kingdom, GE Healthcare is a $17 billion unit of General Electric Company (NYSE: GE). Worldwide, GE Healthcare employs more than 46,000 people committed to serving healthcare professionals and their patients in more than 100 countries. For more information about GE Healthcare, visit our website at http://www.gehealthcare.com.

GE Healthcare
Chalfont St. Giles,
Buckinghamshire,
UK

www.gehealthcare.com