Rotational angiography supports clinical confidence in transcatheater stenting and valve replacement for adults with congenital heart defects

X-ray imaging technique using GE Innova* image guided systems aids in case planning, device guidance and post-procedure assessment.

Dr. Jamil Aboulhosn, Assistant Clinical Professor at UCLA School of Medicine, Los Angeles, Calif., has used 3D rotational angiography with a 30-cm detector GE Innova single-plane image guided system in treating adults with congenital heart defects.

Rotational angiography enhances fluoroscopic imaging by creating a 3D reconstructed model of the anatomy of interest using images from real-time 2D imaging. The image data is acquired in a 5-second, 200-degree gantry rotation, creating a 3D reconstructed model of the anatomy of interest, on the AW Workstation.

Jamil Aboulhosn, M.D., uses rotational angiography routinely in transcatheter stenting, valve replacements and other structural heart procedures. “We needed better visualization and hands-on 3D assessment of complex anatomy,” Aboulhosn observes. “Previously, we relied on 2D imaging using cameras in two planes – anterior/posterior and lateral – and extrapolating the 3D structure from the 2D images. In essence, the operator in the cath lab had to attempt to perform 3D reconstruction in his or her mind, as opposed to actually seeing the anatomy in three dimensions.”

Additionally, Innova HeartVision software can be used to fuse the acquired reconstructed 3D model to the fluoroscopic images acquired in real-time, enhancing the visualization of complex anatomy.

Aboulhosn reports that the 3D workflow is easy to use after appropriate training and practice. “I like the ease with which different structures can be segmented in a time-efficient manner,” he says. He also appreciates the ability to review completed cases with the click of a button – for teaching or for presentations, and for continuous improvement: “It’s good to be able to go back and look at what you did. It helps you see what you did well and what you could have done better. That’s very important to me.”

He adds, “The time invested in acquiring 3D images using rotational angiography is well worthwhile in patients with unusual or complex anatomy. Most operators who perform these procedures are used to working in biplane, and using single-plane rotational angiography instead takes some getting used to. But the ability to select the optimal working angle based on 3D rotational angiography images may help overcome the limitations of not having a second camera.”

A key to successful procedures, he observes, is close communication and coordination among all involved: anesthesiologist, operator, nurses and radiology technicians. “In performing multiple steps simultaneously, someone needs to function like a conductor, determining how things are to be done and the timing of each step.”
Transcatheter pulmonary valve replacement in an adult with a stenotic and regurgitant right-ventricle-to-pulmonary-artery conduit

Case submitted by: Jamil Aboulhosn, M.D., FACC, FSCAI

Patient history
A man in his 20s born with complex congenital heart disease was referred for treatment. His conditions included complete atrioventricular canal defect and tetralogy of Fallot. He had undergone numerous surgical interventions in infancy and childhood, including ASD and VSD closure, right ventricle to pulmonary artery conduit placement and defibrillator placement.

For the past three years the patient had suffered atrial and ventricular arrhythmias and had severely curtailed functional capacity. Living at altitude in another state, he was barely able to walk up a flight of stairs; he had moved to Los Angeles hoping to improve his tolerance for activity but remained highly symptomatic.

Patient evaluation
The evaluation included a clinical outpatient exam, review of history, and trans-thoracic echocardiography. The evaluation revealed moderate pulmonary valve/pulmonary artery stenosis with severe pulmonary regurgitation, and a dilated and dysfunctional right ventricle. Consultation with the patient, his family and the referring physician led to a decision to proceed with cardiac catheterization and possible transcatheter pulmonary valve implantation in the pulmonary position.

Procedure planning
The patient was placed under general anesthesia in the cath lab, where a diagnostic right and left heart catheterization was performed. To prepare for 3D rotational angiography, a temporary balloon-tipped pacing wire was placed in the right ventricle. An angiographic catheter was placed in the main pulmonary artery and a small test contrast injection was performed to help the clinician verify proper position. Respiration was then suspended and the right ventricle paced at 180 beats per minute while femoral artery pressure was actively monitored to ensure cessation of cardiac output. 3D rotational angiography was then performed with contrast injected at 10 cc per second over a 5-second, 200-degree gantry spin, after which pacing was discontinued and respiration restarted. (Fig. 1).

3D images reconstructed on the AW Workstation clearly revealed a narrowing in the conduit from the right ventricle to the pulmonary artery and located the narrowing in the distal portion of the conduit, near the pulmonary artery bifurcation. Contrast reflux into the right ventricle helped the clinician confirm severe pulmonary regurgitation (Fig. 2).

Procedure guidance
The next step was to balloon-dilate the conduit while taking care not to compress the coronary artery. A pigtail catheter was placed into the aortic root while balloon dilation of the right-ventricle-to-pulmonary-artery-conduit was performed, along with mechanical aortography. Respiration was suspended as in the previous step, right ventricular pacing was initiated, and the same contrast injection performed. The imaging helped the clinician confirm that the e was no coronary artery compression (Figs. 3 and 4).
Implantation of a transcatheter pulmonary valve in the narrowed conduit then went forward. Rotational angiography information acquired earlier aided the clinician in correct positioning of the valve. The location of the narrowing near the pulmonary artery bifurcation made it essential to place the device precisely: An inaccurate position would risk leaving the valve in an unstable position, or obstructing a branch of the pulmonary artery. The valve was deployed with suspension of respiration and pacing of the right ventricle at 180 beats per minute to stabilize the anatomy and duplicate the conditions used in imaging, thus enhancing positioning accuracy. Valve deployment proceeded without complications.

**Procedure assessment**

A post-procedure rotational angiogram was acquired, again following the same parameters with contrast injection into the main pulmonary artery. The imaging showed that the valve was positioned accurately; absence of contrast reflux into the right ventricle helped the clinician confirm that the valve was competent (Fig. 6).

**Patient outcome**

The patient was discharged the morning after the procedure. The pulmonary stenosis and pulmonary regurgitation had been treated. The patient’s symptoms improved dramatically, and his arrhythmia burden sharply declined. He went from difficulty negotiating stairs to being able to walk more than a mile. Six months after the procedure, the patient felt much improved.

**About the physician**

Jamil Aboulhosn, M.D., FACC, FSCAI, is an Assistant Clinical Professor at UCLA School of Medicine. Dr. Aboulhosn is a paid consultant for GE Healthcare and was compensated for preparing this case study.

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1 Humanitarian Device. Authorized by Federal law (USA) for use in pediatric and adult patients with a regurgitant or stenotic Right Ventricular Outflow Tract (RVOT) conduit ≥ 16 mm in diameter when originally implanted. The effectiveness of this device for this use has not been demonstrated.