Cardiovascular Structural Interventions
— Echo/Computed Tomography-Fluoroscopy Fusion Imaging Atlas —

Manuel Barreiro-Perez, MD, PhD; Ignacio Cruz-Gonzalez, MD, PhD; Jose Carlos Moreno-Samos, MD; Monica Fuertes Barahona, MD; Pedro L. Sanchez, MD, PhD

Figure. C-arm projection and transesophageal echocardiography (TEE) position for each structure: tricuspid valve (TV; right anterior oblique [RAO] 43°/cranial [CRA] 0°/mid-esophageal 60°); pulmonary valve (PV; left anterior oblique [LAO] 71°/caudal [CAU] 4°/mid-esophageal 60°); mitral valve (MV; RAO 48°/CRA 0°/bi-commissural view); aortic valve (AV; LAO 21°/CAU 1°/left ventricular outflow tract view). Interatrial septum (IAS; LAO 28°/CRA B/mid-esophageal 100°, bicaval view); left atrial appendage (LAA; RAO 40°/CAU 22°/mid-esophageal 60°).
In order to show the correlation, all images were acquired during selective angiography, resulting in mild blurring and the presence of contrast bubbles on TEE. MV are also shown in Movies S1, S2. CT, computed tomography.
The use of transcatheter structural interventions is progressively increasing. Imaging techniques are crucial for detailed planning and guiding. At this point, fusion imaging techniques (FIT) are a helpful complement to improve the spatial comprehension and also the communication between interventional and imaging cardiologists as well as to reduce X-ray exposure.\textsuperscript{1,2}

Recently tools have been developed to provide real-time echo-fluoroscopic image overlay (EchoNavigator, Philips-Healthcare). Transesophageal echocardiography and fluoroscopy are synchronized immediately according to the probe tip spatial position with respect to the C-arm point of view. In the same way, fusion imaging is now possible with computed tomography (CT; HeartNavigator, Philips-Healthcare), but not in real time due to the lack of electrocardiography and of breathing synchronization during the procedure. This software automatically segments the CT dataset to cardiac chamber 3-D reconstructions. The co-registration is performed by overlaying the aorta 3-D reconstruction with two orthogonal aortic angiography images; movement of the C-arm is synchronized and allows both types of image to be superimposed.

There is a need, however, for a summary of the correlation of these fusion images with fluoroscopic images; we present for the first time to the best of our knowledge, a pictorial review of different FIT at each cardiac valve, as well as at the interatrial septum and left atrial appendage (Figure) compared with invasive angiography.

The specific fluoroscopic projections differ between patients, and FIT may help in identifying the patient-specific C-arm position more easily and with less contrast and radiation use. These examples could help interventional cardiologist to take advantage of the clinical potential of these new imaging techniques.

Disclosures
I.C.-G. is proctor for St. Jude Medical and for Boston Scientific. The other authors declare no conflicts of interest.

References

Supplementary Files
Supplementary File 1
\textbf{Movie S1.} Echo-fluoroscopic fusion imaging. A mid-esophageal bicommissural echocardiography view is coalesced with C-arm position over the fluoroscopy. Note the main advantage, for the interventional cardiologist, of been capable to see on real-time soft tissues as mitral valve and the fluoroscopic view.

Supplementary File 2
\textbf{Movie S2.} Computed tomography-fluoroscopic fusion imaging. The mitral valve annulus was segmented and coalesced with the C-arm position. A virtual prosthesis was deployed on mitral position.

Please find supplementary file(s); http://dx.doi.org/10.1253/circj.CJ-17-1229