The wλăŜ 2ŦűKŜ LYI·ƎλyƎ {LJŜŎλI·fλăű

Laura Gerik, MS

HOUSTON METHODIST DEBAKEY HEART & VASCULAR CENTER, HOUSTON, TEXAS

"Excerpta" columns are editorials to supplement reviews in each journal issue with author interviews and a look at the practical aspects of the science reviewed in the Journal. Any opinions stated are the author's own. Quotations reflect the ideas of the persons interviewed and do not represent their respective institutions.

Published online November 29, 2017; Updated June 14, 2021

Rapid advances in imaging modalities are fueling the rise of minimally invasive cardiac procedures and dramatically reshaping interventional cardiology and cardiac surgery. For patients, this means less trauma and faster recovery. For interventionalists and surgeons, it means increasingly relying on specially trained imaging specialists and technology for guidance. Imagers become the surgeonsô eyes, using the latest 3D imaging technologies to create detailed maps of their patientsô unique anatomy, planning access routes and device sizes with precision to ensure safe and accurate minimally invasive procedures.

òIn my experience, imaging plays an exceptionally important role in how surgeons plan their procedures,ó says Faisal Nabi, M.D., cardiologist and imaging specialist at Houston Methodist Hospital. òIn the old days, the surgeon split the chest and the surgeon was viewing everything. Heôs cutting, heôs excising the annulus. Now thereôs no cutting. All of this is done noninvasively with very powerful equipment to image inside the chest with accuracy but without an incision. As imagers, we provide surgeons with a lot of information that hopefully makes their job a little easier with fewer surprises when they get to the surgical suite.ó

Although this means fewer hands onñor inñthe patient, the room around the patient becomes surprisingly crowded. òMinimally invasive procedures require a lot of manpower,ó says Mohammad Hussain, M.D. Hussain is a Houston Methodist internal medicine resident learning the ins and outs of cardiac imaging from Nabi. In Hussainôs early experiences with minimally invasive procedures, he was struck by both the powerful new imaging technology and the sheer number of specialists packed around the patient. Indeed, procedures such as transcatheter aortic valve replacement (TAVR) that are guided by fusion imaging require a structural imager and a biomedical engineer in addition to an interventional cardiologist, surgeon, anesthesiologist, and support staff. Add in the fluoroscopy unitôs 6-foot C-arm rotating around the patient to capture real-time images, and everyone has to stay on their toes (Figure 1, Online Video 1).

Figure 1, Online Video 1.
The fluoroscopy C-arm rotates around a patient during a percutaneous procedure.

Nabi and Hussain (Figure 2) recently published a review article in the *Methodist DeBakey Cardiovascular Journal* discussing the roles of computed tomography (CT), fluoroscopy, and fusion imaging in percutaneous cardiovascular procedures. TAVR is one of the new techniques made possible by the latest imaging modalities and imaging specialists. A single TAVR procedure often involves 3D CT, transesophageal or transthoracic echocardiography (TEE, TTE), and fluoroscopy—and a team of imaging experts to translate the complex images into clinically useful information for interventionalists.

“Our role starts months before the procedure itself,” Hussain explains. “We use imaging technology to give surgeons and interventionalists accurate measurements so that they can tailor each procedure.” Nabi adds, “A lot of these CT scans are done before the actual test to make sure the patient qualifies

Figure 2
Mohammad Hussain, M.D., and Faisal Nabi, M.D. in the imaging suite.

for the test and to help surgeons define what kind of valve is needed and plan the procedure. Then there's another host of imaging that goes on in the lab itself. It's very comprehensive."

Three-dimensional (3D) CT is replacing 2D echocardiography as the modality of choice for pre-TAVR imaging. It provides a much more detailed view of a patient's vessels and valves, and because it can assess every axis of the oval-shaped aortic annulus, it consistently provides more accurate measurements that help interventionalists pick the correct device. Moreover, it scans a much larger area than TEE or TTE, which is key for procedures that involve passing catheters from the femoral artery to the heart. Nabi explains:

"With CT, you can think of it as a one-stop shop. It's going to image not only the area you need for annulus sizing but also the entire thorax all the way down to the pelvis. You're seeing all the access vessels, discovering other incidental findings, getting information about the coronaries, and learning about plaque in the aorta and how much calcium is in the root. All of these things influence the procedure."

Once the patient is in the surgical suite, the challenge is translating the preprocedural CT images into practical roadmaps for the procedure. That's where fusion imaging comes in. Fusion imaging combines multiple imaging modalities into a single view. For instance, modalities that emphasize form (e.g., CT, MRI, fluoroscopy) can be combined with those that show function (e.g., echocardiography, PET), producing a hybrid view that shows what is happening where.

In TAVR procedures, fusion imaging layers preprocedure 3D CT images onto real-time 2D fluoroscopy (essentially live-action X-ray) during procedures. Thus, interventionalists can look at detailed virtual images of their patients' vessels and valves as they guide devices through the body. Fusion imaging provides a window into the patient's body, allowing physicians to see what they're doing, anticipate problems, and make adjustments as needed.

"The imager is there to help them with any imaging that's involved and answer any questions regarding the different views they're seeing with the imaging modalities," Nabi explains. The structural imager—often a different physician from the one who did the CT—also has advanced training in 3D TEE and TTE in case those modalities are needed. The engineer does the actual fusion—a process called "registration"—during the procedure. He or she uses unique calcifications on valves and within vessels as landmarks, matching like structures to correctly overlay the CT and fluoroscopy images.

As imaging tools become more complex and powerful, specially trained imaging specialists are becoming even more important members of the heart valve team. "Coming from general medicine, I feel that previously the general cardiologist could read the echo and see what's happening. But now imaging has become so intricate and specialized that consulting with a cardiac imaging specialist is essential," Hussain says.

Indeed, Nabi has seen the cardiovascular imaging field "blossom" and the imager's relationship with interventionalists and surgeons strengthen. "We have such sophisticated toys, CT and MRI, so you need specialists with advanced training. There's a lot of training involved before people can do this well." Nabi spent an additional 2 years training in cardiovascular imaging after his general cardiology fellowship. In today's new world of minimally invasive interventions, highly trained imagers are vital to a procedure's success.

Corresponding Author:
lgerik@houstonmethodist.org

Conflict of Interest Disclosure:
Laura Gerik is Assistant Managing Editor of the *Methodist DeBakey Cardiovascular Journal.*

Keywords:
multimodality cardiovascular imaging, cardiac MRI, computed tomography, fluoroscopy, echocardiography