



See Article page 146.

## Commentary: Use fusion to avoid confusion

James A. DiNardo, MD

The use of a catheter-based hybrid procedure for the treatment of both congenital and acquired cardiac lesions has become commonplace. One of the challenges involved in the performance of these procedures is finding methods to visualize vital structures in a spatial orientation that is meaningful to the operator when direct open visualization is either compromised or nonexistent. X-ray fluoroscopy allows excellent visualization of catheters and implantable devices, but sole use of this modality alone may be associated with prolonged procedure times, a large radiocontrast load, and prolonged x-ray exposure. In addition, standard fluoroscopy provides only 2-dimensional imaging in real time and does not provide good soft-tissue delineation and detailed analysis of blood flow direction and velocity. These limitations can be mitigated by the simultaneous use of 3-dimensional transesophageal echocardiography (3D TEE); however, there are considerable logistical issues associated with this approach.

With standard simultaneous use of fluoroscopy and 3D TEE imaging, the proceduralist must work guided by spatial orientation that is obtained by continuous mental integration of images obtained by 2 different operators presented in disconjugate coordinate systems. Obviously, during complex procedures in which delayed or malpositioned device deployment can result in serious morbidity, this scenario is less than ideal. Fortunately, there exists robust technology in the form of echocardiography–fluoroscopy fusion (EFF) to fuse the 2 imaging modalities by “registering” the TEE probe with fluoroscopy. This technology allows the proceduralist to simultaneously manipulate the 2 imaging modalities in the same spatial orientation.<sup>1</sup> The utility of this



James A. DiNardo, MD

### CENTRAL MESSAGE

Rapid evolution of both hybrid approaches to treat complex cardiac lesions and advances in image fusion technology require that there be alignment of imaging technology with procedural requirements.

technology during performance of high-complexity hybrid procedures has been well documented.<sup>1-3</sup>

In this issue of the *Journal*, Anselmi and colleagues<sup>4</sup> describe use of fusion of 3D TEE and computed tomography (CT) images of the mitral valve in conjunction with conventional fluoroscopy. This technique was used to facilitate placement of a transcatheter mitral valve implantation using a transapically delivered, apically tethered, and self-expandable prosthesis (Tendyne device; Abbott Laboratories, Abbott Park, Ill) in a patient with severe mitral annular calcification.<sup>4</sup> The purported advantage of this approach over EFF is that 3D CT fusion provides a more nuanced assessment of the extent and location of the mitral annular calcification than can be provided by EFF alone. Whether this is the best imaging modality in this situation remains to be seen, but the authors are to be congratulated for pursuing this innovative approach. Although not directly relevant to this case, one particular advantage of fusion of CT images with fluoroscopy and/or 3D TEE is the ability to precisely delineate coronary artery anatomy. This has been demonstrated to be useful in preventing inadvertent laceration of the left anterior descending coronary artery during percutaneous LV apical access.<sup>5,6</sup>

In summary, although it is clear that fusion reduces confusion, it remains to be seen which fused images will best display complex spatial and structural information for the myriad procedures being performed in the rapidly evolving field of hybrid surgery. Sharing experiences as Amedeo and colleagues have done here is a first step toward

From the Division of Cardiac Anesthesia, Boston Children's Hospital, Boston, Mass. Disclosures: The author reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

Received for publication June 17, 2020; revisions received June 17, 2020; accepted for publication June 19, 2020; available ahead of print June 30, 2020.

Address for reprints: James A. DiNardo, MD, Department of Anesthesiology, Critical Care and Pain Medicine, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115 (E-mail: [james.dinardo@childrens.harvard.edu](mailto:james.dinardo@childrens.harvard.edu)).

JTCVS Techniques 2020;3:152-3

2666-2507

Copyright © 2020 The Authors. Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jtc.2020.06.039>

aligning best practice in imaging technology with evolving hybrid techniques.

### References

1. Jone P-N, Haak A, Ross M, Wiktor DM, Gill E, Quaipe RA, et al. Congenital and structural heart disease interventions using echocardiography-fluoroscopy fusion imaging. *J Am Soc Echocardiogr*. 2019;32:1495-504.
2. Faletta FF, Pozzoli A, Agricola E, Guidotti A, Biasco L, Leo LA, et al. Echocardiographic-fluoroscopic fusion imaging for transcatheter mitral valve repair guidance. *Eur Heart J Cardiovasc Imaging*. 2018;19:715-26.
3. Jone P-N, Sandoval JP, Haak A, Hammers J, Rodriguez-Zanella H, Quaipe RA, et al. Echocardiography–fluoroscopy fusion imaging: the essential features used in congenital and structural heart disease interventional guidance. *Echocardiography*. 2020;37:769-80.
4. Anselmi A, Corbineau H, Verhoye J-P, Donal E. Transcatheter mitral valve implantation in mitral annular calcification: role of fusion imaging. *J Thorac Cardiovasc Surg Tech*. 2020;3:146-9.
5. Klinger C, Jelnin V, Sharma S, Panagoulas G, Einhorn BN, Kumar R, et al. CT Angiography-fluoroscopy fusion imaging for percutaneous transapical access. *JACC Cardiovasc Imaging*. 2014;7:169-77.
6. Bardeleben von RS, Colli A, Schulz E, Ruf T, Wrobel K, Vahl C-F, et al. First in human transcatheter COMBO mitral valve repair with direct ring annuloplasty and neo-chord leaflet implantation to treat degenerative mitral regurgitation: feasibility of the simultaneous toolbox concept guided by 3D echo and computed tomography fusion imaging. *Eur Heart J*. 2018;39:1314-5.