Journal of the Society for Cardiovascular Angiography & Interventions 4 (2025) 102613

JSCAI

The official journal of the Society for Cardiovascular Angiography & Interventions

JSCAI Image

Fluoroscopy-Guided Intracardiac Echocardiography Navigation: A Novel Landmark-Based Imaging Technique for Transcatheter Tricuspid Valve Replacement

Georgi Fram, MD *, Hussayn Alrayes, DO, Leo Kar Lok Lai, MD, John Dawdy, MD, Bryan Zweig, MD, Sachin Parikh, MD, Thomas Song, MD, Milan Pantelic, MD, James Alter, RT(R)(CT), Pedro Engel Gonzalez, MD, Brian O'Neill, MD, Tiberio Frisoli, MD, Pedro Villablanca, MD, James Lee, MD

Center for Structural Heart, Henry Ford Hospital, Detroit, Michigan

Transcatheter tricuspid valve replacement (TTVR) is a complex procedure requiring meticulous interrogation of 9 separate anchors during valve expansion to ensure adequate capture of native leaflet to secure the prosthesis.[1] Inadequate leaflet capture can lead to catastrophic complications such as device migration.[2] Safe implantation requires high-fidelity echocardiographic images throughout the procedure with transesophageal echocardiogram (TEE) with live multiplanar reformat (MPR) guidance as the traditional imaging modality used for periprocedural guidance. However, TEE is susceptible to acoustic shadowing, particularly in patient populations with intracardiac devices or bioprosthetic valves.

In patients with challenging TEE imaging, 3-dimensional (3D) intracardiac echocardiography (ICE) has become a valuable adjunctive imaging technique.[3] Despite rapid advancements in 3D ICE technology, the miniaturization of the transducer can compromise imaging quality, particularly in MPR mode, leading to diagnostic uncertainty during TTVR.[4] Advanced maneuvers that bring the ICE transducer closer to the valve can improve visualization but often result in complex and nonstandardized imaging orientations. We describe a novel fluoroscopy-guided ICE technique utilizing valve landmark colocalization to maximize ICE imaging resolution and ensure reliable leaflet capture at each anchor of interest.

Two subsequent patients with symptomatic severe tricuspid regurgitation were referred for TTVR with the EVOQUE (Edwards Lifesciences) bioprosthetic valve. Patient A was a 79-year-old woman with a history of surgical aortic valve replacement, as well as transcatheter mitral valve replacement, and patient B was an 86-year-old man with a history of coronary artery bypass grafts.

In each of these patients, ICE was deployed to complement TEE imaging. Traditional MPR techniques were inadequate to visualize leaflet capture in all anchors. On fluoroscopy, an en face view of the valve was obtained in a left anterior oblique projection with removal of parallax of each anchor (Figure 1A-D). The ICE catheter was positioned directly behind each leaflet and anchor in question and accurately demonstrated leaflet capture (Figure 1C, E). Using this technique, both valves were successfully deployed securely in optimal positions (Figure 1F-I). Both patients were successfully discharged home within 72 hours. On postprocedural transthoracic echocardiogram, both patients had mild or less central valvular regurgitation and no paravalvular regurgitation.

This is the first report, to our knowledge, describing the utilization of the fluoroscopy to colocalize ICE catheter position to precise EVOQUE anchor positions. The use of the 2D ICE imaging mode maximizes image quality while using fluoroscopy to maintain spatial awareness. Fluoroscopy-guided ICE is technically simple to perform and may reduce the risk of trauma that could be caused by more extreme manipulations. This can be a valuable adjunctive technique when traditional MPR images on TEE and/or ICE are inadequate. This technique could also be adapted to other transcatheter tricuspid procedures such as tricuspid edge-to-edge repair. Transcatheter tricuspid valve interventions are highly complex and imaging intensive, and this technique holds promise for decreasing case length and procedural success.

Keywords: fluoroscopy; intracardiac echocardiography; transcatheter tricuspid valve replacement.

* Corresponding author: gfram1@hfhs.org (G. Fram).

https://doi.org/10.1016/j.jscai.2025.102613

Received 13 December 2024; Received in revised form 20 January 2025; Accepted 23 January 2025; Available online 7 March 2025

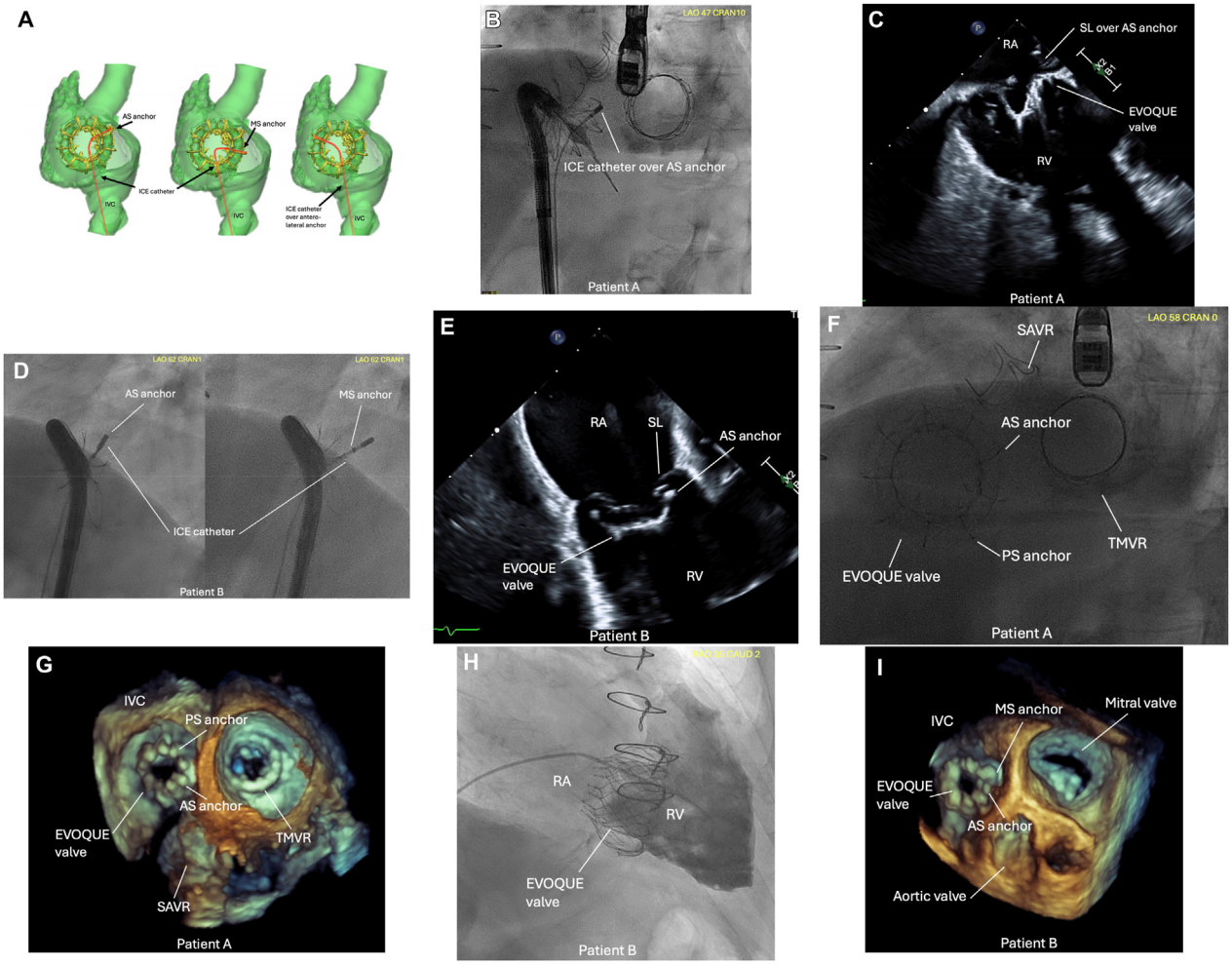

Figure 1.
(**A**) Schematic diagrams representing en face view of the tricuspid valve, with simulated positioning of ICE over the different anchors via different manipulations of the catheter, with right steer capturing leaflet over septal anchors and left steer capturing leaflet over lateral anchors. (**B**) En face fluoroscopy demonstrating positioning of ICE over AS anchor of the EVOQUE valve in patient A. (**C**) ICE image demonstrating clear septal leaflet capture within the anchor of the EVOQUE valve in patient A. (**D**) En face fluoroscopy demonstrating positioning of ICE over the AS and MS anchors of the EVOQUE valve in patient B. (**E**) ICE image demonstrating clear septal leaflet capture within the anchor of the EVOQUE valve in patient B. (**F**) Final fluoroscopic view demonstrating successful deployment of the TTVR in patient A. (**G**) 3D TEE image postvalve deployment in patient A. (**H**) Final right ventriculogram demonstrating successful TTVR in patient B. (**I**) 3D TEE image postvalve deployment in patient B. AL, anterior leaflet; AS, anteroseptal; ICE, intracardiac echocardiogram; IVC, inferior vena cava; LL, lateral leaflet; MS, midseptal; PS, posteroseptal; RA, right atrium; RV, right ventricle; SAVR, surgical aortic valve replacement; SL, septal leaflet; TEE, transesophageal echocardiogram; TMVR, transcatheter mitral valve replacement.

Declaration of competing interest

Pedro Villablanca is a consultant for Edwards Lifesciences and Teleflex. Brian O'Neill is a consultant for Edwards Lifesciences and has received research support from Edwards Lifesciences. James Lee is a consultant for Edwards Lifesciences and is a proctor for Abbott. Tiberio Frisoli is a proctor for Edwards Lifesciences, Abbott, Boston Scientific, and Medtronic. The other authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding sources

This work was not supported by funding agencies in the public, commercial, or not-for-profit sectors.

Ethics statement and patient consent

All relevant ethical guidelines were adhered, and patient consent was obtained from all subjects described in this article.

References

1. Hahn RT, Makkar R, Makar M, et al. EVOQUE tricuspid valve replacement system: state-of-the-art screening and intraprocedural guidance. *J Am Coll Cardiol Intv.* 2024;17(18):2093–2112. https://doi.org/10.1016/j.jcin.2024.07.034
2. Kodali S, Hahn RT, George I, et al. Transfemoral tricuspid valve replacement in patients with tricuspid regurgitation: TRISCEND study 30-day results. *J Am Coll Cardiol Intv.* 2022;15(5):471–480. https://doi.org/10.1016/j.jcin.2022.01.016
3. Davidson CJ, Abramson S, Smith RL, et al. Transcatheter tricuspid repair with the use of 4-dimensional intracardiac echocardiography. *J Am Coll Cardiol Img.* 2022;15(3):533–538. https://doi.org/10.1016/j.jcmg.2021.01.029
4. Alkhouli M, Hijazi ZM, Holmes Jr DR, Rihal CS, Wiegers SE. Intracardiac echocardiography in structural heart disease interventions. *J Am Coll Cardiol Intv.* 2018;11(21):2133–2147. https://doi.org/10.1016/j.jcin.2018.06.056