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Transforming the interventional toolbox

The impact of 4D ICE NUVISION ultrasound catheter in structural heart procedures

For years, transesophageal echocardiography (TEE) has been the standard imaging modality for structural heart interventions, but not without tradeoffs. Acoustic shadowing, limited views of certain structures, and the frequent need for general anesthesia have pushed the field to explore alternatives. Now, 4D ICE is becoming an essential element of the modern interventional toolbox — with the 4D ICE NUVISION™[1] ultrasound catheter by Biosense Webster, Inc., part of Johnson & Johnson MedTech, helping to drive the shift.

A leader in advancing echocardiography, Professor Alex Lee was among the first physicians in the Asia-Pacific region to embrace 4D ICE. He also championed the early use of the first mini 4D TEE probe. Prof. Lee is a Cardiologist and serves as the Chair of the Education and Research Committee for the Asian Pacific Association of Echocardiography. He holds a position at a leading cardiovascular intervention centre in Hong Kong, which serves a population exceeding one million and provides advanced diagnosis and treatment for complex cardiac conditions.

As an early adopter, Prof. Lee has integrated the 4D ICE NUVISION catheter into routine practice, where it's already making an impact — shaping procedural strategies and broadening therapeutic options for patients. The advanced imaging tool, which can be used under conscious sedation, supports real-time, volumetric imaging and multiplanar visualization. It also features a 360° independent rotating tip, which enables crucial views of targeted anatomy and device-leaflet interactions with minimal manipulation.

Prof. Lee is part of a high-volume team that performs numerous mitral and tricuspid transcatheter edge-to-edge repair (TEER) procedures annually. The team also conducts a wide range of other structural heart interventions, including TAVI, TTVR, LAA closure, and septal defect closure.

We asked Professor Lee to share his thoughts on the addition of the 4D ICE NUVISION catheter — and how it, alongside the mini 4D TEE probe, is enhancing imaging capabilities in his practice.

What are the main challenges you encounter during structural heart procedures and how are you addressing the issues?

Prof. Lee: *In our experience, acoustic shadowing artifacts in the midesophageal TEE view may obscure right heart structures, particularly in*

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the presence of mechanical mitral or aortic valve prostheses, septal occluders, mitral TEER devices, or hiatal hernias. Since TEE transmits ultrasound posteriorly through the left atrium and aorta, these implanted structures can create significant shielding artifacts, impairing visualization of critical procedural steps, most notably, leaflet grasping during tricuspid edge-to-edge repair.

To overcome these challenges, we utilized the transgastric view (2D ± 4D MPR) to mitigate acoustic shadowing and optimize leaflet grasping monitoring. In this view, leaflet grasping could be assessed in the tricuspid valve short axis, or with the addition of a reconstructed long-axis view. However, a limitation of this approach is the potential uncertainty in determining the final depth of leaflet insertion.

You were among the first in Asia Pacific to adopt 4D ICE. What initially drew you to this technology, and what aspects have had the greatest impact on your procedures?

Prof. Lee: *We have long anticipated the arrival of 4D ICE because of its potential to revolutionize structural heart imaging. Since the implanted devices reside in the left heart — often obstructing ultrasound signals from TEE due to esophageal placement — it stands to reason that an alternative ultrasound source in the right atrium, adjacent to the tricuspid valve and free of intervening structures, would offer superior imaging.*

Moreover, proximity enhances resolution, further optimizing visualization. The value of 4D imaging cannot be overstated. Critical aspects like leaflet grasping and other dynamic interactions are best assessed in real-time 4D or reconstructed multiplanar views derived from 4D datasets. Undoubtedly, 4D ICE is a transformative advancement in the field. It’s an indispensable tool for precision and success in complex interventions.

From your perspective, what are the biggest benefits of the 4D ICE NUVISION catheter?

Prof. Lee: *In my practice, overall, 4D ICE NUVISION represents a true game changer. One of the most notable is its independent rotating tip. This feature is particularly useful in procedures such as LAAC, where the tip can be rotated 180° without moving the entire catheter. It simplifies maneuvering, making the process easier and more efficient.*

Another major benefit is image quality. It’s excellent. Because the probe is positioned close to the target — whether a clip or the tricuspid leaflet — it provides highly detailed images. The ultrasound beam crosses the tricuspid valve perpendicularly rather than obliquely, which greatly enhances clarity and minimizes interference from artifacts caused by the aorta or prosthetic materials.

Using the 4D ICE NUVISION catheter can also extend some procedures to patients who are unsuitable for general anesthesia due to high risk, allowing them to undergo the intervention under alternative forms of anesthesia.

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I’ve also talked about efficiency for some procedures like tricuspid. When you’re using ICE to perform the procedure, we save time because we don’t need to manipulate the TEE so many times to look at the leaflet capture and insertion, which can sometimes be difficult to see. With 4D ICE NUVISION catheter, we can see the leaflet so clearly that one attempt is often enough so the procedure time may be even shorter.

You mentioned the 4D ICE NUVISION catheter's unique design, including the independent rotating tip. Can you walk us through how you're incorporating these features into your imaging workflow during procedures?

Prof. Lee: *My standard imaging protocol begins with the home view on ICE, which I then adjust to 30–45 degrees to obtain the RV inflow-outflow view. Next, I activate biplane imaging, displaying the leaflet grasping view on the right panel, which typically provides excellent 2D visualization of the TEER device, with clips fully opened and optimally positioned for leaflet capture.*

If further refinement is needed, I switch to 4D ICE with the anatomic marker placed at the aortic valve and use FlexiSlice to dynamically assess leaflet grasping and clip deployment in real time — rotating the aortic valve to the 5 o'clock position on 4D imaging for standard display.

What types of procedures have benefited most from using the 4D ICE NUVISION catheter, and how has it changed your approach?

Prof. Lee: *The 4D ICE NUVISION catheter is a game changer — reducing reliance on TEE and providing unprecedented visualization for tricuspid valve interventions. It delivers superior image resolution by positioning the probe close to the tricuspid valve, eliminating interference from surrounding structures. Its 4D capability ensures stable image orientation and enables real-time adjustments for optimal views, so the visualization of the leaflet and leaflet insertion, leaflet capture, is something unprecedented for ICE.*

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For procedures like tricuspid TEER, where precise visualization of leaflet grasping is critical, I have moved from TEE-only guidance to a hybrid approach, supplementing TEE with 4D ICE. Unlike 2D ICE, which cannot consistently provide the necessary imaging planes or rotational adjustments, 4D ICE reliably overcomes these limitations.

In the past, we only used 4D TEE to guide LAA closure. But now, we try to use 4D ICE to guide LAA procedures so patients don't have to undergo general anesthesia. So it's a transformative technology.

Can you elaborate on your hybrid approach and the value of each tool in tricuspid TEER procedures?

Prof. Lee: *I use both ICE and TEE simultaneously because each has distinct advantages for different aspects of the procedure. ICE is particularly useful for leaflet grasping. TEE, on the other hand, excels in clip steering and positioning due to its wider field of view. For now, this is how I integrate both imaging modalities, but I anticipate that future advancements in ICE technology may reduce the reliance on TEE.*

What advice would you offer to other centers considering the adoption of 4D ICE NUVISION catheter for structural heart interventions?

Prof. Lee: *Good teamwork between the imager and interventionalist is key to get the best results. The interventionalist should direct where to place the ICE probe, while the imager handles the imaging — adjusting settings, optimizing the images, and deciding when to use tools like 4D, FlexiSlice, or 4D Markers. Working together smoothly leads to clearer pictures and a more efficient procedure.*

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You are also an early adopter of the 9VT-D miniaturized probe. How has this technology enhanced imaging capabilities and patient comfort in interventional procedures?

Prof. Lee: *The mini 4D TEE probe offers a compelling balance of advanced imaging and enhanced patient comfort. With a 57% reduction in tip volume compared to conventional probes, it maintains full functionality — including real-time 4D (90° × 90°), diagnostic 2D, comprehensive Doppler (Color, PW, CW, TDI), and FlexiSlice reconstruction while preserving the familiar 180° manual array rotation. Clinically, the smaller profile improves tolerability during procedures such as LAA occlusion and valvular interventions — reducing the need for sedation in both pediatric and adult patients. The imaging quality remains robust, making it a practical option for cases where maneuverability and patient comfort are priorities.*

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From a clinical perspective, what do you see as the most significant benefits of adopting the mini 4D TEE probe?

Prof. Lee: *Looking ahead, this innovation brings us closer to the long-term goal of performing more interventions under local anesthesia, gradually reducing the reliance on general anesthesia. Another key benefit is cost-effectiveness. Unlike ICE catheters, which are single-use, the mini 4D TEE probe can be reused across many procedures. For patients and healthcare systems where cost is a concern, this makes the mini 4D TEE probe a practical and sustainable alternative while still delivering high-quality imaging.*

> *“The mini 4D TEE probe offers a compelling balance of advanced imaging and enhanced patient comfort.”*

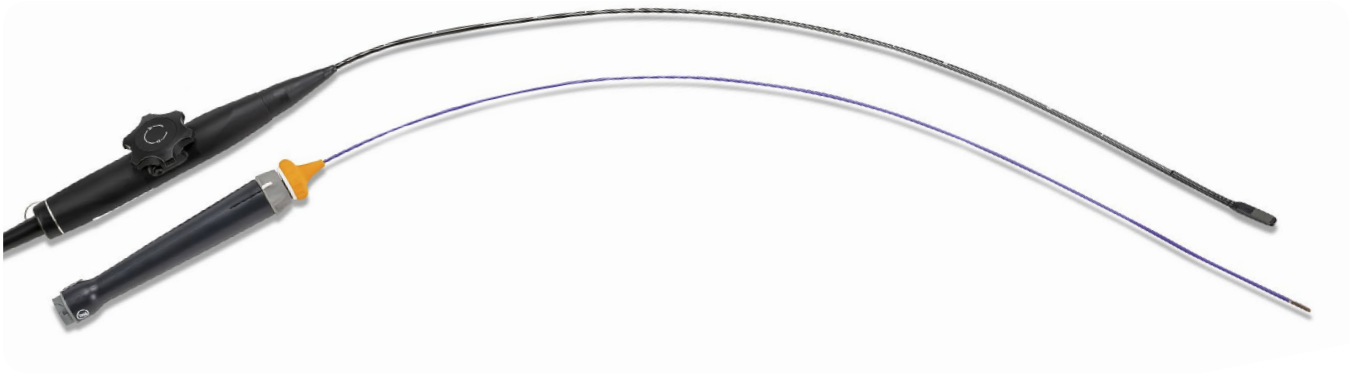
Have you discovered any unexpected advantages or clinical insights from using the mini 4D TEE probe in real-world clinical scenarios?

Prof. Lee: *The 4D imaging capacity has improved significantly. Just last week, we treated a patient with osteogenesis imperfecta, a condition that causes severe bone deformities. Because of spinal abnormalities and a narrowed esophagus, a standard TEE probe could not be used. Instead, we were able to complete the procedure with the mini 4D TEE probe. In this case, the MitraClip also had to be delivered via the jugular vein rather than the femoral vein, since abdominal deformities prevented femoral access. Situations like this highlight the importance of having the mini 4D TEE probe available, as it gives us the ability to successfully treat patients who otherwise could not undergo the procedure.*

With a toolbox that includes both the 4D ICE NUVISION catheter and the mini 4D TEE probe, will it enable more structural heart procedures to be performed under conscious sedation?

Prof. Lee: *Yes, both interventionalists and imagers aim to perform these procedures under conscious sedation, as it reduces procedural time and lowers risks for certain high-risk patients. Currently, the need for standard TEE is the primary reason general anesthesia is required. However, for 4D ICE or the mini 4D TEE probe to fully replace TEE, they must offer superior imaging capabilities — including a wider field of view, higher resolution, and real-time 4D visualization. Advances in 4D ICE and the mini 4D TEE probe are progressing precisely toward these goals. Currently, LAA occlusion is one procedure where 4D ICE offers sufficient imaging quality while avoiding the need for general anesthesia, making it well-suited for conscious sedation. As a result, I have encountered a growing trend toward performing LAA occlusion under conscious sedation.*

> *“By minimizing general anesthesia requirements, they enable shorter postoperative recovery times and reduced complications, thereby accelerating rehabilitation. Importantly, these innovations demonstrate significant potential to enhance procedural success rates while maintaining cost-effectiveness — a crucial consideration in contemporary healthcare systems.”*



What impact do you think 4D ICE NUVISION and the mini 4D TEE probe have on patient outcomes and the broader field of structural heart interventions?

Prof. Lee: *The 4D ICE NUVISION catheter and the mini 4D TEE probe represent transformative advancements in structural heart interventions, offering superior imaging quality and improved patient tolerability. These technologies are particularly valuable for high-risk patients considered ineligible for conventional surgery due to general anesthesia concerns. By minimizing general anesthesia requirements, they enable shorter postoperative recovery times and reduced complications, thereby accelerating rehabilitation. Importantly, these innovations demonstrate significant potential to enhance procedural success rates while maintaining cost-effectiveness — a crucial consideration in contemporary healthcare systems.*

What emerging technologies or innovations do you believe will have the greatest impact on the future of echocardiography?

Prof. Lee: *The most transformative advancements on the horizon include next-generation real-time 3D imaging systems with enhanced spatial resolution and multi-modal fusion capabilities for structural heart interventions, and sophisticated AI-driven platforms capable of automating complex quantitative analyses. These innovations promise to revolutionize procedural planning, intraoperative guidance, and long-term patient management in structural heart disease.* ■

> *“The 4D ICE NUVISION catheter and the mini 4D TEE probe represent transformative advancements in structural heart interventions, offering superior imaging quality and improved patient tolerability.”*

Alex Lee, M.D., is a Cardiologist and serves as the Chair of the Education and Research Committee at the Asian Pacific Association of Echocardiography. Prof. Lee specializes in echocardiographic and his research covers heart valve disease, heart failure, and the use of advanced echocardiographic techniques such as 3D imaging, strain imaging and contrast echocardiography to guide structural interventions. Prof. Lee has made significant contributions to understanding the mechanisms of functional mitral regurgitation and mitral annular disjunction in degenerative and mitral regurgitation. He’s published over 300 peer-reviewed articles.

1 4D ICE NUVISION catheter is not available in all markets. The 4D ICE NUVISION Catheter is not CE-marked. 4D ICE NUVISION is distributed by Biosense Webster, Inc., part of Johnson & Johnson MedTech.

Prof. Lee is a paid consultant for GE HealthCare. The statements by Prof. Lee described here are based on his own opinions and on results that were achieved in his unique setting. Since there is no “typical” hospital/clinical setting and many variables exist, i.e., hospital size, case mix, staff expertise, etc. there can be no guarantee that others will achieve the same results.

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