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EDITORIAL COMMENT

Intracardiac Echocardiographic Guidance for Left Atrial Appendage Occlusion

Is This the ChoICE for the Future?*

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Left atrial appendage occlusion (LAAO) is increasingly recognized as a therapeutic option for patients with nonvalvular atrial fibrillation and absolute or relative contraindications to oral anticoagulation. Transesophageal echocardiography (TEE) is generally considered the most important imaging modality for the guidance of structural heart interventions, including LAAO. However, periprocedural TEE requires general anesthesia at most institutions, which may be a limitation for the expansion of LAAO.

SEE PAGE 1086

In this issue of *JACC: Cardiovascular Interventions*, Berti et al. (1) report on their experience with intracardiac echocardiography (ICE) as an imaging modality to guide LAAO at 16 Italian centers, comparing outcomes obtained with ICE guidance in 187 patients versus TEE guidance in 417 patients. Procedural success was similarly high (>94%) for both modalities, with comparable efficacy outcomes as measured by cerebral ischemic events during 1 to 3 years of follow-up. This led the investigators to conclude that ICE-guided LAAO is feasible, safe, and effective at early and midterm follow-up and that it is reasonable to consider ICE an alternative to TEE for the guidance of LAAO procedures.

Although TEE has been shown to be an adequate imaging tool to guide LAAO procedures, it has some important limitations, such as the need for general anesthesia and a dedicated TEE operator. This can make logistical planning in daily clinical practice cumbersome. Especially with anticipated growing volumes of LAAO procedures worldwide, there is a quest for simplification and optimization of the LAAO procedure. As ICE guidance brings with it the possibility to perform LAAO procedures under local anesthesia, this strategy has been increasingly tested and adopted at several centers across the world.

The use of ICE to guide other cardiac interventions, such as device closure of patent foramen ovale and secundum atrial septum defect, has become routine at many centers. However, when dealing with a complex and highly variable structure such as the left atrial appendage (LAA), ICE may not provide sufficient information. Pre-procedural TEE or multidetector computed tomography (MDCT) with an option for 3-dimensional imaging is advisable. These imaging modalities provide reliable information on both the morphology and size of the LAA and may thereby increase procedural success.

In the study by Berti et al. (1), pre-procedural TEE and MDCT were performed in, respectively, 44% and 74% of patients who underwent ICE-guided LAAO. Interestingly, in a similar report by Korsholm et al. (2), all 109 patients undergoing LAAO with ICE guidance underwent pre-procedural MDCT for LAA sizing. It should not be surprising that MDCT is increasingly replacing TEE for LAA sizing, as a similar evolution has been seen in the field of transcatheter aortic valve replacement. There are several potential advantages of using MDCT instead of TEE for LAA evaluation: 1) the possibility to digitally reconstruct a 3-dimensional LAA model, clearly discriminating the different lobes; 2) the option to measure the (perimeter-derived) mean diameter of the landing zone; 3) limited interoperator and interpatient variability of

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LAA measurements; 4) the possibility to determine the best fluoroscopic angle for device implantation; and 5) limited discomfort for the patient compared with TEE. Disadvantages of using MDCT are exposure to radiation, the use of contrast dye in case of impaired renal function, and the fact that image analysis is "off-line." However, it has been reported that LAAO device sizing is more accurate with MDCT as compared to TEE (3).

Interestingly, Berti et al. (1) report that TEE-guided procedures had shorter procedure and fluoroscopy times than ICE-guided procedures. However, the fact that ICE-guided LAAO procedures can be performed with local anesthesia means that the time consumed by setting up general anesthesia can be trimmed. This was also indicated in the study by Korsholm et al. (2), who reported that the "turnover" time in the catheterization laboratory was reduced with ICE-guided procedures compared with TEE-guided procedures.

Despite the promising results reported for ICE-guided LAAO, the question should be whether ICE guidance has the potential to become the new "gold standard" for LAAO. One issue is the cost of the ICE probe, which must be balanced against the potential savings (e.g., anesthesia team, higher procedural volume). Imaging the LAA from the left atrium or left upper pulmonary vein provides the best images for LAAO guidance; however, this transseptal approach may increase the risk for procedural complications. Finally, although ICE provides adequate images for guiding transseptal puncture and device implantation, the possibility to evaluate peridevice leak immediately after device implantation is limited. In the studies by Berti et al. (1) and Korsholm et al. (2), the rate and degree of peridevice leak as evaluated at 6- to 12-week TEE control did not differ between ICE- and TEE-guided LAAO procedures. However, it is known that not all leaks can be detected by TEE. MDCT is more sensitive to detect post-LAAO leaks, and there remains much to learn about this topic. It is obvious that, when aiming to optimize the LAAO procedure, this limited possibility to check for peridevice leakage with ICE should be considered an important limitation of this approach.

Ongoing studies are testing other imaging modalities for LAAO guidance, such as micro-TEE, which are promising and could theoretically overcome these limitations. Another evolving and promising technology is based on advanced computational modeling and the use of simulation software. Combining preprocedural MDCT with advanced computational modeling could provide unique insights into the interaction between a closure device and a patient's unique LAA, which may help in the selection of the best closure device (size) and position for complete sealing of the LAA.

In conclusion, ICE-guided LAAO appears feasible, safe, and effective with satisfying midterm follow-up results, especially when combined with preprocedural 3-dimensional TEE or MDCT. This approach could be the "gold standard" for the time being; however, other imaging modalities are expected to take over this role in the future.

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