outcome in those ineligible for the protocol could not represent the general population.

Finally, no evidence-based criteria warrant revascularization for vulnerable lesions without ischemia. The FFR is the most sensitive index of ischemia in all clinical settings except ST-segment elevation myocardial infarction. Thus, LM-MLA may be useful to aid in decision making as to whether to treat, but choose the cutoff value wisely! If you still doubt about objective ischemia, please use the FFR!

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REFERENCES

1. Park SJ, Ahn JM, Kang SJ, et al. Intravascular ultrasound-derived minimal lumen area criteria for functionally significant left main coronary artery stenosis. J Am Coll Cardiol Intv 2014;7:868–74.

2. Jasti V, Ivan E, Yalamanchili V, Wongpraparut N, Leesar MA. Correlations between fractional flow reserve and intravascular ultrasound in patients with an ambiguous left main coronary artery stenosis. Circulation 2004;110:2831–6.

3. Rusinova RP, Mintz GS, Choi SY, et al. Intravascular ultrasound comparison of left main coronary artery disease between white and Asian patients. Am J Cardiol 2013;111:979–84.

4. de la Torre Hernandez JM, Hernandez Hernandez F, Alfonso F, et al. Prospective application of pre-defined intravascular ultrasound criteria for assessment of intermediate left main coronary artery lesions results from the multicenter LITRO study. J Am Coll Cardiol 2011;58:351–8.

Intracardiac Echocardiographic Imaging of the Left Atrial Appendage and Detection of a Peridevice Leak After Device Occlusion

We read with great interest the report by Berti et al. (1). We agree with their view point that intracardiac echocardiography (ICE) imaging can perform the tasks typically provided by transesophageal echocardiography (TEE) during transcatheter occlusion of the left atrial (LA) appendage (LAA). Although the authors presented utility and safety assessment of ICE-guided percutaneous LAA device closure (Amplatzer cardiac plug) in a relatively large cohort of 120 patients, there were several issues in methodology that need to be clarified and discussed.

Ideal ICE imaging views and accurate measurement of the LAA anatomy including the ostium, short- and long-axes, and the landing zone are critically important for proper sizing and delivery. Although they failed to present a uniform ICE examination protocol, they describe imaging the LAA with the transducer in the right atrium (RA) and coronary sinus (CS). In majority of the atrial fibrillation patients with LA enlargement, the RA transducer view does not provide anatomically detailed LAA imaging with sufficient resolution due to far-zone imaging features. The authors try to argue against this with a "best example" figure (Figure 2 [1]), but it appears that the transducer in this figure is actually in the LA because the interatrial septum is not imaged. In addition, when imaging from the CS, the LAA is often truncated, and it is difficult to obtain an ideal LAA ostium and LAA long-axis image due to the limited potential for transducer manipulation in the narrow CS lumen.

In our experience using ICE for cardiac diagnosis and left heart ablation in more than 3,000 cases, specific imaging views routinely provide important LAA anatomic features as part of a complete assessment (2). A transverse long-axis image of LAA with its orifice can be typically obtained with the transducer placed in the right ventricular outflow tract (RVOT). This imaging view is especially helpful for anatomic assessment and LAA size measurements (**Figure 1A**). Close-up imaging using higher ultrasonic frequency can be obtained with the transducer placed in the pulmonary artery (PA). These imaging views are especially helpful for differentiation of thrombus from variant pectinate muscles/sluggish flow and to properly image/measure LAA emptying flow (**Figure 1B**). Peripheral LAA-left ventricle imaging views can also be obtained with the transducer placed in PA for close-up evaluation of lobes and pectinate muscles (2). Therefore, the best view for measurement of the anatomy of the LAA is the ICE transducer placed in the RVOT. The LAA ostium is usually measured from the LAA junction with the upper left pulmonary vein (ULPV) ostium to the junction of the LA and LAA (**Figure 1A**). The landing-zone diameter can be accurately determined with a certain distance to the ostium. In addition, this view also provides the best imaging to guide proper sheath/device placement in the LA to LAA ostium, much better than the ideal lobe for sheath placement that was decided on based on fluoroscopic images indicated by the authors (1).

Another important issue is to evaluate/eliminate any peridevice leak immediately after device

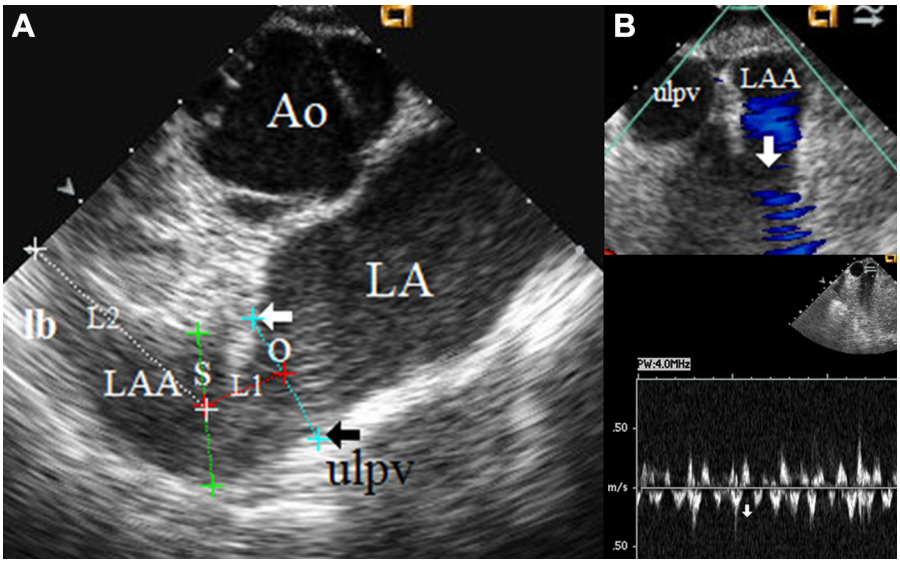

FIGURE 1 Intracardiac Echocardiographic Image of the LAA and its Emptying Flow

(A) With the transducer placed in the right ventricular outflow tract showing left atrial appendage (LAA) anatomic measurements including the ostium (19.9 mm, between 2 arrows), short axis (S = 22.0 mm) and long axis (L1 + L2 = 45.0 mm). A distinct protrusion from the windsock-like body represents a lobe (lb). **(B)** With the transducer placed in the pulmonary artery (near the junction of left pulmonary artery) showing color Doppler imaging of the LAA emptying flow **(blue area)** at the ostium **(arrow, upper panel)** and pulsed Doppler recording of LAA filling (upward) and emptying (downward) flow velocity **(arrow, lower panel)**. Ao = aortic root during systole; LA = left atrium; o = ostium; ulpv = upper left pulmonary vein.

implantation. The leak flow could not be accurately detected with the ICE RA or CS transducer due to sampling difficulty for parallel flow. The peridevice leak can be detected using color Doppler flow imaging, especially for LAA emptying leak flow in a close-up view with the ICE transducer positioned in the PA (3).

Of note, echocardiographic imaging measurement of the soft structural distance has been recognized as one of the most accurate methods. Echocardiographic distance measurement is much more reliable and accurate than fluoroscopic imaging, even with contrast. However, it is not possible that the ICE and TEE measurements of the ostium and landing zone were the same in 78.4% of the cases (1). From their Figure 6 (1), there were significant differences in anatomic landmarks selected for the LAA ostium and landing zone measurements between ICE and TEE. For the TEE measurements, the LAA ostium and landing zone were measured from the LAA junction with the ULPV ostium to the junction of LA and LAA (at mitral annulus, left panel Figure 6 [1]), whereas for ICE (CS transducer), these measurements seemed arbitrary without any strictly defined anatomic marks (right panel, Figure 6 [1]). Our previous measurements of LAA anatomy including long and short axes have shown a difference between ICE and TEE, even following similar anatomic landmarks (2).

The investigators should be congratulated for reporting on a relatively large cohort of patients who underwent LAA device closure. Although ICE has many advantages in interventional procedures, the methodology was not uniform and did not use the optimal transducer positions. These difficulties impair the power of this study and put into question the accuracy of their conclusions.

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http://dx.doi.org/10.1016/j.jcin.2014.10.007

REFERENCES

1. Berti S, Paradossi U, Meucci F, et al. Periprocedural intracardiac echocardiography for left atrial appendage closure: a dual-center experience. J Am Coll Cardiol Intv 2014;7:1036–44.

2. Ren JF, Marchlinski FE, Supple GE, et al. Intracardiac echocardiographic diagnosis of thrombus formation in the left atrial appendage: a complementary role to transesophageal echocardiography. Echocardiography 2013;30:72–8.

3. Ren JF. Accurate echocardiographic assessment of left atrial appendage ostium and peri-device flow in device closure. J Am Coll Cardiol 2012;60:1432–3; author reply 1433–4.

REPLY: Intracardiac Echocardiographic Imaging of the Left Atrial Appendage and Detection of a Peridevice Leak After Device Occlusion

We would like to thank Dr. Ren and colleagues for their much appreciated interest in our paper (1), particularly because they are such long-standing experts in the field of intracardiac echocardiography (ICE). In the following response, we will attempt to address the points made in their letter.

Left atrial appendage (LAA) closure procedures should be carefully planned in the pre-operation phase. Not all data can be obtained from a single imaging technique, and we recommend using different imaging sources to perform a safe and effective procedure.

1. We agree that, in case of enlarged left atrium, the right atrium/coronary sinus view of the LAA could be suboptimal. However, in our experience, the combined use of fluoroscopy and ICE was adequate for delivery system positioning, device placement, and release. The final aim is to perform the procedure avoiding general anesthesia.
2. In **Figure 1** (Figure 2A from our paper [1] without superimposed drawings), all of the anatomical structures are clearly visible. In Figure 2B of our paper (1), the probe is advanced in the deep coronary sinus. From this view, the interatrial septum is not already visible; furthermore, the image was magnified and cut for editorial reasons.
3. We agree that placing the probe in the right ventricular outflow tract and/or in the pulmonary artery provides optimal LAA views, and this is a useful suggestion for operators; unfortunately, this approach is challenging and time consuming.
4. We also agree with the limitation of ICE from the right atrium and coronary sinus in the evaluation/elimination of peridevice leaks due to sampling difficulty for parallel flow. We have already indicated that ICE alone is not the correct method to rule out any peridevice leaks; we recommend the integrated use of angiography and ICE.
5. As for the peridevice leak evaluation, we rely on angiography combined with ICE. We consider small peridevice leaks to be benign, as it has been shown that they are common, tend to disappear during the follow-up, and have little clinical relevance (2).
6. We agree that ICE and transesophageal echocardiography (TEE) measurements might be discordant; in our paper, the 21.6% of disagreement supports the argument of Ren and colleagues. However, the detected differences were not so important as to cause selection of a different device. The significant correlation between the angiographic and ICE measurements corroborates the effectiveness of our strategy (pre-procedural TEE evaluation followed by ICE and angiographic confirmation). We are aware that a careful pre-procedural evaluation with TEE could represent a bias in the ICE intraprocedural evaluation.
7. In response to the comments by Ren and colleagues about Figure 6 of our paper (1), we suggest that, using TEE and ICE, it is possible to obtain similar results. In particular, as in Figure 6 of our paper (1), we measure the ostium of the LAA and the landing zone 1 cm inside according to the Instructions for Use of the Amplatzer Cardiac Plug device.

On the basis of the above considerations, although we are aware of ICE's technical limitations, we maintain the convictions expressed in our paper (1).

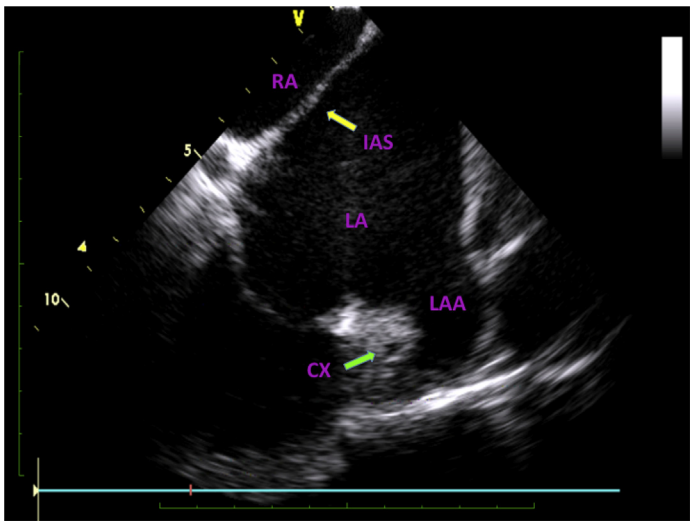

FIGURE 1 ICE View of Anatomical Structures From Right Atrium

The intracardiac echocardiography (ICE) view of the left atrium (LA) and left atrial appendage (LAA) as seen from the right atrium (RA). We can see the long axis of the LAA, the interatrial septum (IAS) **(yellow arrow)**, and the circumflex artery (CX) **(green arrow)**.