Percutaneous mitral valve repair (PMVR) using the MitraClip system is an innovative method allowing treatment of mitral regurgitation (MR) for a patient that is not accessible by conventional operation. Consequently, novel pitfalls and obstacles become apparent. PMVR is generally performed through transesophageal echocardiographic guidance. However, in some patients, visualization of structures by transesophageal echocardiography (TOE) is not sufficient. Furthermore, as a consequence of continuous TOE during PMVR, general anesthesia and/or tracheal intubation are required and represent a major weakness of the procedure, bringing about drops in blood pressure, potential aspiration, or neurological disorders to these frail patients. Intracardiac echocardiography (ICE) from the right atrium has been shown to be a safe imaging method during procedures such as atrial septal defect or complex PFO closure. Here, we report visualization of a PMVR procedure via left atrial ICE.

Case
A 76-year-old man with a grade-IV functional mitral valve regurgitation (Figure, A) and severely impaired left ventricular (LV) function (LV ejection fraction, 30%) resulting from dilated cardiomyopathy was admitted to our intensive care unit with recurrent left ventricular decompensation. He had recently had multiple implantable cardioverter defibrillator shocks as a consequence of repeated ventricular tachycardias, which had been treated by ablation with radiofrequency. A mechanical aortic valve had been implanted 24 years ago and presently showed a regular function. After exclusion of other causes for recurrent cardiac decompensation under medical therapy and severe comorbidities, the decision for PMVR was made by our heart team. Because screening TOE for MR had shown to be difficult in this patient, and the interatrial septal defect from the ablation procedure was still detectable, we decided to complement the regular TOE-guided procedure with left atrial ICE.

After the MitraClip guide was in place, we used a 7Fr solid-tip radiofrequency ablation catheter (Marinr, Medtronic) to probe the left atrium via the remaining small defect in the septum secundum (Figure, B) without any trauma to the septum and advanced the ICE catheter via a 10Fr transseptal sheath (St. Jude Medical) into the left atrium. In the Figure, C and F show 2 distinct positions of the ICE probe. All maneuvers such as stirring the clip toward the mitral valve (Figure, D and Movie I in the online-only Data Supplement), positioning underneath the mitral valve plane (Figure, E and Movies II and III in the online-only Data Supplement), approach of the anchored first clip by the second one (Figure, G and Movie IV in the online-only Data Supplement), or the correct final position of both clips (Figure, H and Movie V in the online-only Data Supplement) could be readily visualized by ICE. Successful reduction of MR, correct positioning, and exclusion of mitral stenosis was verified by conventional TOE (Figure, I through K).

Discussion
Monitoring procedures such as closure of a persistent foramen ovale by right atrial ICE is safe and provides high-resolution images of structures in close proximity to the interatrial septum. However, visualization of the mitral valve by ICE from the right atrium in our and others’ experience does not provide sufficient image quality. Nonetheless, in some patients, such as the one presented, heart anatomy does not allow perfect imaging of the mitral valve by TOE only, and additional imaging modalities are urgently needed for the evolving technique of interventional mitral valve repair. Therefore, we decided to image our PMVR procedure by ICE, and to our knowledge, this is the first reported left atrial intracardiac ultrasound procedure in this setting. In our case, steering down the clip was facilitated because the superior and lateral wall of the left atrium were well monitorable with ICE. All additional steps, such as alignment of the clip guided by conventional TOE in a perpendicular position or documentation of the correct position of the anchored clips, could be well documented by ICE. However, as a single imaging modality,
at its present technical stage, ICE may not be sufficient to guide all necessary maneuvers during PMVR, particularly grasping of the anterior and posterior leaflet and assessment of having grasped a minimum length within the clip arms. In case of further technical improvement, such as upgrading the single plane image sections to the possibility of performing x-plane views and 3D echocardiography, and in case of improved maneuverability of the ICE probe, intracardiac ultrasound could be an attractive imaging mode complementary to TOE.

Disclosures
Dr Schreieck has received speaker fees from Medtronic and St. Jude Medical. The other authors report no conflicts.

Figure. Images of transesophageal echocardiography (TOE), fluoroscopy, and intracardiac echocardiography (ICE) during percutaneous edge-to-edge mitral valve repair (PMVR). A, TOE revealed a functional mitral regurgitation grade IV. B, Because of a remaining small defect (->) in the septum secundum after ablation therapy, the ICE catheter could be advanced to the left atrium via a 10 F sheath without any additional trauma. C, Position of the ICE catheter (->) in parallel to the MitraClip delivery system providing images (D and E). D, MitraClip approaching the mitral valve (clip in closed position, ->; also see Movie I in the online-only Data Supplement). E, MitraClip positioned beneath mitral valve plane (clip in opened position, ->; also see Movies II and III in the online-only Data Supplement). F, Different location of the ICE catheter providing images (G and H). G, Second MitraClip approaching the mitral valve with first clip in position (also see Movie IV). H, Both clips in correct position (also see Movie V in the online-only Data Supplement). I–K, Final TOE image documenting successful reduction of MR, correct positioning of the clips and exclusion of mitral stenosis.

References
Percutaneous Edge-to-Edge Mitral Valve Repair Escorted by Left Atrial Intracardiac Echocardiography (ICE)
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