Left atrial radiofrequency catheter ablation has been recognized as an important treatment option for drug-refractory symptomatic atrial fibrillation. Recent consensus on technique favors catheter ablation directed to the left atrium near the pulmonary vein (PV) ostium to achieve PV isolation. However, ablation in the region of the ligament of Marshall (LOM) to achieve electrical isolation of the left PVs can be difficult because of variable catheter stability. The superior extent of the LOM protrudes into the body of the left atrium between the anterior region of the left PV antrum and the left atrial appendage (Figure 1A). Inadvertent misdirection of ablative lesions anterior to the LOM in the region of the left atrial appendage increases the risk of cardiac perforation and does not contribute to successful PV isolation, and misdirection of ablative lesions posteriorly into the left PV or posterior left PV antrum can result in PV stenosis or fatal esophageal injury, respectively. Thus, circumferential isolation of the left PVs via precise delivery of ablative lesions outside the PV ostium, including the region of the LOM ridge, would be expected to enhance procedural safety and efficacy. More specifically, enhanced imaging technologies like 3-dimensional (3D) echocardiography, if able to image the ablation catheter and endocardium in real time, would be expected to minimize procedural complications such as PV stenosis, esophageal injury, and cardiac perforation. Although these complications are rare, occurring at rates <1% when contemporary techniques are used, they can be serious or fatal.

Intracardiac echocardiography and advanced mapping systems have been used to guide ablation lesion delivery in this and other regions. Electroanatomic mapping systems in particular can display a non–real-time 3D rendering of the left atrial endocardial surface; however, accurate representation of the region of the LOM can be difficult to achieve. We report here on the use of real-time 3D transesophageal echocardiography (RT 3D TEE) to image catheter tip placement and tissue contact to guide left atrial catheter ablation at the LOM.

Left atrial catheter ablation was performed in a 53-year-old man with paroxysmal, drug-refractory, symptomatic atrial fibrillation. The 2-dimensional TEE view demonstrates the transseptal sheath and the ablation catheter within the left atrium near the ostium of the left inferior PV. CATH indicates ablation catheter; LSPV, left superior PV; LAA, left atrial appendage; MV, mitral valve; LA, left atrium; RA, right atrium; and LIPV, left inferior PV.
fibrillation. The patient was under general anesthesia during the procedure. During ablation in the region of the LOM, 3D echocardiographic images were acquired with the recently released RT 3D TEE Matrix transducer (IE33 system; Philips Medical Systems, Andover, Mass) to confirm registration of a segmented magnetic resonance rendering of the left atrium imported into the CARTO electroanatomic mapping system (Biosense Webster, Diamond Bar, Calif) and to guide ablative lesion delivery. The RT 3D TEE system represents a novel cardiovascular imaging modality that allows for live 3D imaging as it circumvents most of the disadvantages of reconstructive 3D methods. In this instance, conventional 2-dimensional TEE (Figure 1A; Data Supplement Movie IA) and intracardiac ultrasound images (intracardiac echocardiography; Figure 1B; Data Supplement Movie IB) allow for limited visualization of catheter placement in the region of the LOM because of the movement of the 2-dimensional imaging plane during the cardiac cycle. In distinction, RT 3D TEE provides clear definition of the topographical relationships among the LOM, the anterior region of the left PV antrum, the left atrial appendage, and the ablation catheter throughout the cardiac cycle (Figure 2A; Data Supplement Movie IIA). Furthermore, RT 3D TEE allows for real-time imaging of the full span of the LOM so that catheter position and tissue contact can be continuously assessed during ablation at the LOM from the region adjacent to the left inferior PV to the region adjacent to the left superior PV without the need for excessive manipulation of the imaging plane as is required with 2-dimensional imaging systems (Figure 2A through 2C; Data Supplement Movie IIA through IIC). The procedure was completed without complication, and at 2 months’ follow-up, the patient remains arrhythmia free.

In summary, we report the successful application of RT 3D TEE to confirm stable catheter position along the entire length of the LOM during left atrial catheter ablation for atrial fibrillation. This technology could potentially enhance lesion delivery during left atrial catheter ablation for atrial fibrillation to improve efficacy and safety.

Disclosures
David B. Adams holds stock in Volumetrics, Inc. Dr Bahnson reports limited advisory services to Biosense Webster, Inc, and to Philips Medical Systems. Dr Mackensen has served as an invited speaker for Philips Medical Systems. The other authors report no conflicts.

References
Real-Time 3-Dimensional Transesophageal Echocardiography During Left Atrial Radiofrequency Catheter Ablation for Atrial Fibrillation
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