

Photorealistic imaging of left atrial appendage occlusion/exclusion

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Abstract

Recent improvements in 3D TEE post processing rendering techniques referred to as TrueVue (Philips Medical Systems, Andover, MA, USA). It allows for novel photorealistic imaging of cardiac structures including left atrial appendage (LAA) and its closure devices. Here we present TrueVue images of the LAA prior to and after LAA exclusion/occlusion using various percutaneous and surgical techniques. TrueVue may improve delineation of LAA anatomy prior to occlusion as well as visualization of occluder device position within the LAA.

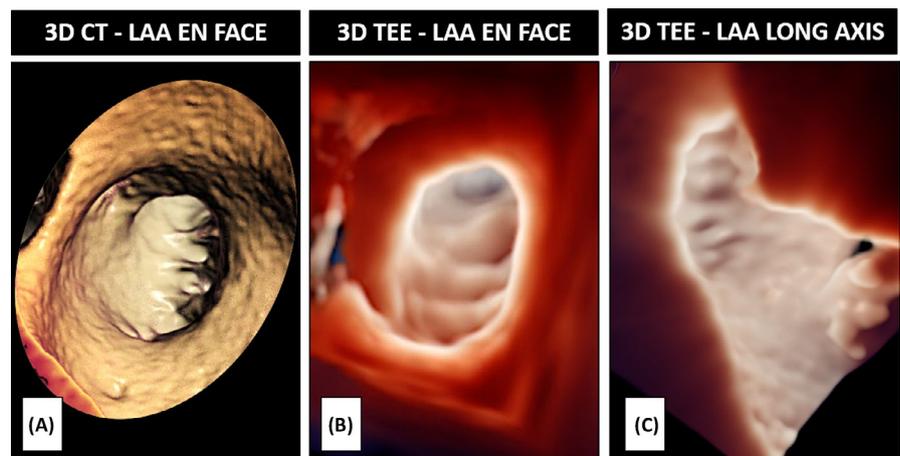
KEYWORDS

Amulet, AtriClip, LAA occlusion/exclusion, Lariat, Watchman, WaveCrest

Percutaneous or surgical left atrial appendage (LAA) closure is a proven alternative to systemic anticoagulation for prevention of systemic embolism in patients with nonvalvular atrial fibrillation (AF). Precise delineation of the LAA anatomy is essential for appropriate patient selection and intraprocedural guidance. In this setting, two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE) has been the primary imaging modality in addition to computed tomography.¹⁻³

Recent improvements in 3D TEE postprocessing rendering techniques referred to as TrueVue (Philips Medical Systems). It allows for novel photorealistic imaging of cardiac structures including left atrial appendage (LAA) and its closure devices. TrueVue is a three-dimensional (3D) imaging tool that is approved for commercial use by the Food and Drug Administration (FDA) and is currently available on Philips Epiq ultrasound systems. TrueVue is a postprocessing technique and thus does not require separate image acquisition. Any 3D

FIGURE 1 Normal Left Atrial Appendage. 3D imaging of the LAA from en face view using 3D CT (Panel A) and 3D TEE using TrueVue (Panels B and C)



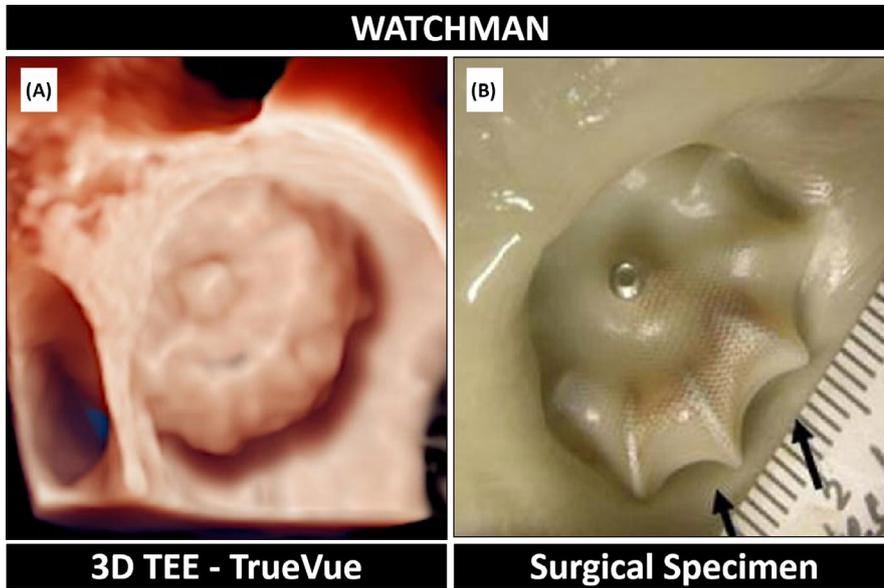


FIGURE 2 Watchman Device. Panel A, 3D TrueVue image of the Watchman device from en face perspective. Panel B, Equivalent surgical specimen of Watchman device from a similar en face perspective in an animal model. Reprinted with permission⁴

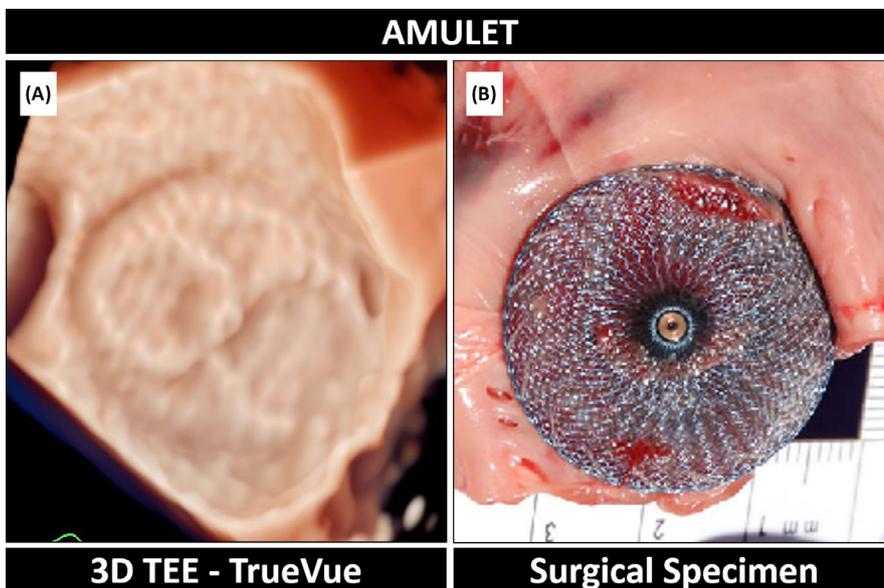


FIGURE 3 Amulet Device. Panel A, 3D TrueVue image of the Amulet device from en face perspective. Note that the 3D TEE TrueVue image demonstrates a “figure-of-8” artifact which has been reported with other 2D and 3D echocardiographic techniques and is not specific to TrueVue.⁵ Panel B, Equivalent surgical specimen of Amulet device from a similar en face perspective in an animal model. Reprinted with permission⁶

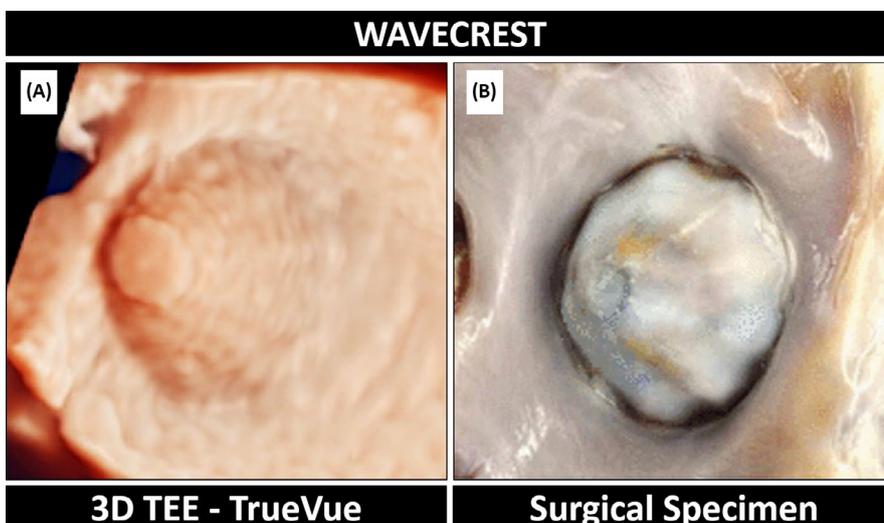


FIGURE 4 WaveCrest Device. Panel A, 3D TrueVue image of the WaveCrest device from en face perspective. Panel B, Equivalent surgical specimen of WaveCrest device from a similar en face perspective in an animal model. Reprinted with permission⁷

FIGURE 5 Lariat Procedure. Panel A, 3D TrueVue en face image of the LAA post percutaneous exclusion using the Lariat device. Black arrow points to location of the Lariat suture from the endocardial side of the LAA. Panel B, Equivalent 3D CT en face image of the LAA post percutaneous exclusion using the Lariat device from the same patient

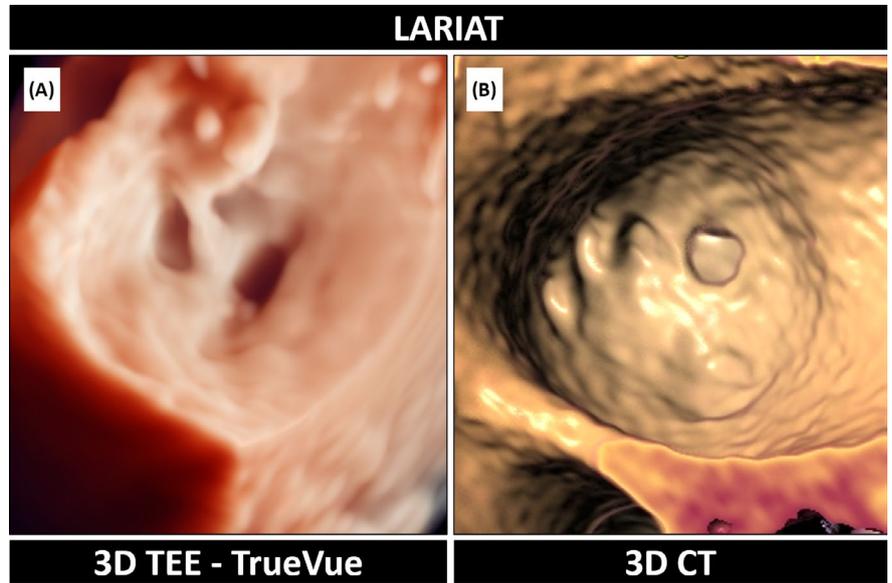


FIGURE 6 Suture LAA ligation. Panel A, 3D TrueVue en face image of the LAA after surgical suture exclusion. Black arrows point to sutures visible from the endocardial side of the LAA. Panel B, Equivalent endoscopic view of a surgically excluded LAA using suture in a human. Reprinted with permission³

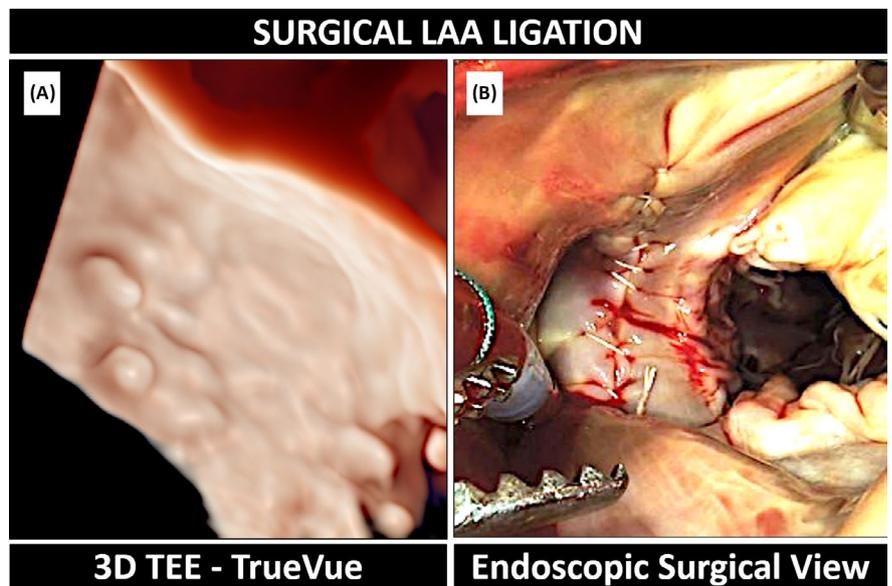
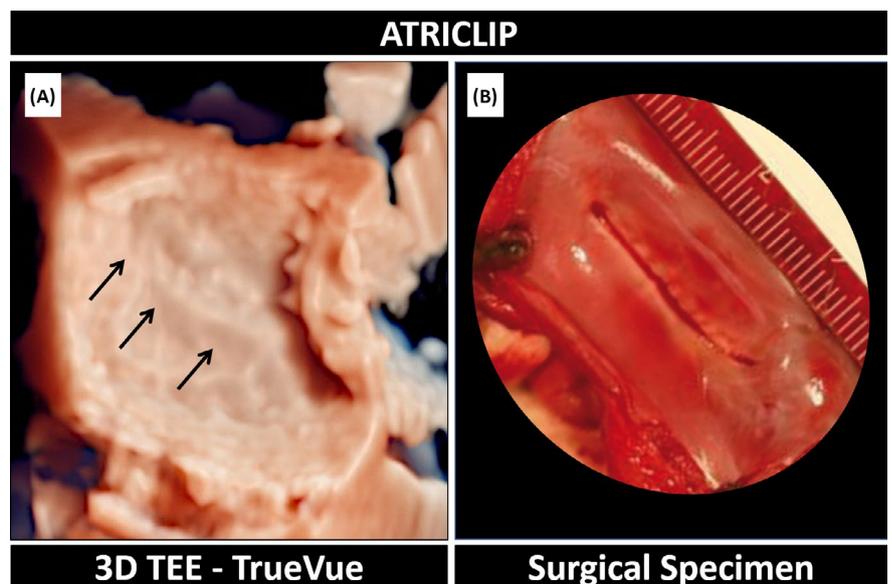


FIGURE 7 AtriClip. Panel A, 3D TrueVue image of a surgically excluded LAA using the AtriClip device. Black arrows indicate the location of the AtriClip from the endocardial side of the LAA. Panel B, Equivalent surgical specimen of an excluded LAA using the AtriClip device (right image). Reprinted with permission⁸



echocardiographic dataset obtained by conventional means on a Philips Epiq system during a routine clinically indicated study can be converted into a TrueVue image post hoc.

This technology uses a virtual light source which enhances depth perception and provides computer-generated transillumination. These features may improve delineation of LAA anatomy prior to occlusion as well as visualization of occluder device position within the LAA. Here we present TrueVue images of LAA appendage obtained during routine clinically indicated 3D TEEs. In Figures, we also provide either equivalent computed tomography or surgical views. 3D TEE and CT images were obtained from the same patient in each case whereas surgical views were obtained from the literature with appropriate copyright approval.

The images are presented in long- and short-axis prior to occlusion (Figure 1 & Movie S1). In addition we provide images of LAA occlusion using a variety of percutaneous occlusion procedures: Watchman (Boston Scientific, Maple Grove, MN) (Figure 2 & Movie S2), Amulet (St. Jude Medical, Minneapolis, MN) (Figure 3 & Movie S3) and WaveCrest (Biosense Webster, Irvine, CA) (Figure 4 & Movie S4). Finally we provide images of LAA exclusion from the left atrium (LA) using the Lariat (Sentre-HEART, Palo Alto, CA) (Figure 5 & Movie S5) surgical suture ligation (Figure 6 & Movie S6) and the AtriClip device (AtriCure, Mason, OH) (Figure 7 & Movie S7).

CONFLICT OF INTERESTS

Muhammed Saric is a member of a Philips and Medtronic speaker's bureau and member of Siemens advisory board. Alan Vainrib is a consultant for Micro Interventional Devices.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Movie S1. Normal left atrial appendage. 3D TEE TrueVue imaging of the LAA from en face view.

Movie S2. Watchman device. 3D TEE TrueVue imaging of the Watchman device within the LAA from en face view. Abbreviations: MV, mitral valve; LUPV, left upper pulmonary vein.

Movie S3. Amulet Device. 3D TEE TrueVue imaging of the Amulet device within the LAA from en face view. Abbreviations: MV, mitral valve; LUPV, left upper pulmonary vein.

Movie S4. WaveCrest device. 3D TEE TrueVue imaging of the WaveCrest device within the LAA from en face view.

Movie S5. Lariat procedure. 3D TEE TrueVue en face image of the LAA post percutaneous exclusion using the Lariat device. Black arrow points to location of the Lariat suture from the endocardial side of the LAA.

Movie S6. Suture LAA ligation. 3D TEE TrueVue en face image of the LAA after surgical suture exclusion. Abbreviations: MV, mitral valve.

Movie S7. AtriClip. 3D TEE TrueVue image of a surgically excluded LAA using the AtriClip device.

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