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Special Article

The Year in Perioperative Echocardiography: Selected Highlights from 2017

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Abstract

This article is the second of an annual series reviewing the research highlights of the year pertaining to the subspecialty of perioperative echocardiography for the *Journal of Cardiothoracic and Vascular Anesthesia*. The authors thank the editor-in-chief, Dr. Kaplan, and the editorial board for the opportunity to start this series. In most cases, these will be research articles that are targeted at the perioperative echocardiography diagnosis and treatment of patients after cardiothoracic surgery; however, in some cases, these articles will target the use of perioperative echocardiography in general.

Key Words: perioperative echocardiography; atrial fibrillation; Lariat procedure; WATCHMAN device; stroke; strain imaging; speckle tracking; layer-specific strain imaging; echocardiographic guidelines; congenital heart disease; three-dimensional echocardiography; stress echocardiography; aortic valve stenosis, native valvular regurgitation; cardiac magnetic resonance

THIS SPECIAL ARTICLE is the second in an annual series for the *Journal of Cardiothoracic and Vascular Anesthesia*. The authors thank the editor-in-chief, Dr. Kaplan, and the editorial board for the opportunity to continue this series, namely the research highlights of the year that pertain to perioperative echocardiography in relation to cardiothoracic and vascular anesthesia. The major themes selected for 2017 are outlined in this introduction, and each highlight is reviewed in detail in the main body of the article. The literature highlights in the specialty for 2017 begin with the role of echocardiography in atrial fibrillation management with a particular focus on transesophageal echocardiography (TEE)-guided percutaneous left atrial appendage (LAA) occlusion or exclusion. Although electrophysiologists often use intracardiac echocardiography, these procedures continue to be guided predominantly with TEE. The second major theme in perioperative echocardiography in 2017 was the continued development of echocardiographic speckle-based strain imaging. A burgeoning new area of strain imaging is layer-specific strain imaging (LSSI), which attempts to recognize the different contributions to contraction from subendocardial versus mid-endocardial and epicardial myocardial layers. The third major theme for the subspecialty in 2017 was publication of numerous echocardiographic-based guidelines and expert consensus statements. These documents provide a significant review and update on 3-dimensional echocardiography in congenital heart disease, stress echocardiography, aortic stenosis (AS), and native valvular regurgitation. A review of each of the documents is included. The themes selected for this special article are only a sample of the advances in perioperative echocardiography during 2017. These highlights likely will further improve important perioperative outcomes for patients with cardiovascular disease.

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Echocardiography for Atrial Fibrillation

Atrial fibrillation is recognized as an independent risk factor for stroke and contributes to more than 20% of strokes in the United States. The 5-fold increase in risk conferred by atrial fibrillation combined with the yearly incidence (795,000) and impact (fourth leading cause of death) of stroke in the United States makes stroke prevention (eg, anticoagulation, WATCHMAN) or atrial fibrillation treatment (eg, medical management, pulmonary vein isolation) a rapidly expanding focus of interest.[1] Given that the LAA is a frequent source of thrombus (91% of left heart thrombi in nonrheumatic atrial fibrillation and 57% of thrombi in rheumatic atrial fibrillation[2]), many new devices, techniques, and research focus on the occlusion/exclusion as well as electrical isolation of the left atrial appendage.

The architects of the percutaneous alternative to the Maze procedure for the treatment of persistent or longstanding persistent atrial fibrillation (aMAZE trial) recognized the potential importance of the left atrial appendage in atrial fibrillation.[3] The goal of this prospective, multicenter, randomized study is to determine the safety and efficacy of isolation and ligation of the left atrial appendage by the LARIAT system (SentreHEART, Redwood City, CA) as an adjunctive therapy to pulmonary vein isolation. If this ongoing study confirms the safety and efficacy of the LARIAT system in the treatment of atrial fibrillation, one can surmise that the number of LARIAT procedures performed annually will increase.

The LARIAT procedure, which involves establishing a magnetic link between a trans-septally positioned catheter and an epicardial catheter followed by epicardial suture ligation of the left atrial appendage, possesses the unique advantage of not only eliminating a potential source of thrombus but also electrically isolating the LAA. Furthermore, the procedure does not result in any foreign material in the left atrium. Therefore, the LARIAT procedure can be performed in patients who cannot tolerate even brief periods of anticoagulation post-procedure. Although the LASSO device (Aegis Medical Innovations, Vancouver, BC, Canada) also can ligate the left atrial appendage, it is not currently Food and Drug Administration (FDA) approved. Interestingly, the LARIAT device is not approved specifically for percutaneous exclusion of the LAA by the FDA but has received class II clearance under the 501(k) protocol.[2]

Despite the unique features of the procedure and LARIAT device, reliance upon periprocedure TEE persists. The recent review article by Vainrib et al. in the *Journal of the American Society of Echocardiography* extensively described LAA exclusion/occlusion procedures as well as the nuances of procedural TEE. Given that pericardial access is required, contraindications unique to the LARIAT procedure include a history of cardiac surgery or pericarditis. In addition, a large LAA body (eg, >45 mm) and a superiorly oriented LAA preclude percutaneous pericardial suture ligation.[2] As with any of the occlusion/exclusion procedures described, intraprocedure TEE also is invaluable for catheter guidance, the rapid identification of pericardial effusions, and the determination of procedural success. However, TEE also is used during to confirm that the right ventricle has not been punctured while obtaining pericardial access in the LARIAT procedure.

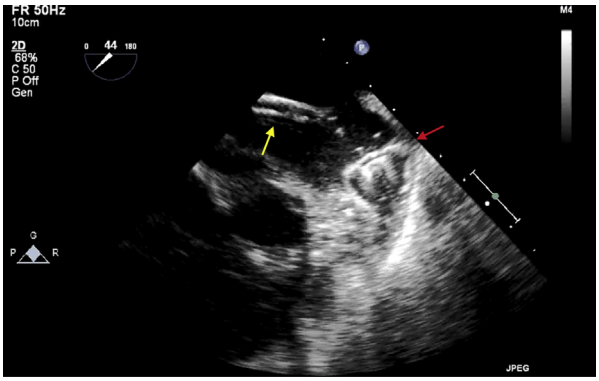

Fig 1. Midesophageal left atrial appendage view during WATCHMAN device deployment. The yellow arrow indicates the trans-septal catheter while the red arrow denotes the WATCHMAN device within the left atrial appendage.

Although there are multiple endocardial closure devices available worldwide, the WATCHMAN device (Boston Scientific, Marlborough, MA) is currently the only FDA-approved device (Fig 1). The Amulet device (St. Jude Medical, Minneapolis, MN), a second-generation LAA occluder, currently is under investigation in the United States. The reviews by Vainrib et al. and Mitrev et al. highlighted the importance of echocardiography in the successful deployment of a WATCHMAN device.[1,2] Not only does the echocardiographer determine the morphology of the appendage (eg, cactus, chicken wing, windsock, cauliflower, or broccoli), ostium size, and depth of the main lobe, guide the septal puncture, and confirm the adequacy of occlusion (eg, peridevice leaks <5 mm are acceptable, device diameter compression), but also is relied upon to identify any additional contraindications to device implantation (eg, atrial septal defect, patent foramen ovale, prior interatrial occlusion device, aneurysmal interatrial septum, intracardiac thrombus, significant mitral valve pathology) and procedural complications (eg, pericardial effusion, mechanical compression of pulmonary vein flow).[1] Although intracardiac echocardiography of the LAA has been described, the procedure presently relies upon TEE guidance. Given that Reddy et al. recently reported that LAA occlusion with the WATCHMAN provided comparable stroke prevention to warfarin in nonvalvular atrial fibrillation, the number of WATCHMAN devices deployed with TEE guidance may increase steadily.[4]

The role of the anesthesiologist during pulmonary vein catheter ablations also is expanding beyond the provision of general anesthesia. The case report by Khamooshian et al. and subsequent editorial by Amir et al. highlighted the importance of 2-dimensional (2D) as well as 3-dimensional (3D) echocardiography in the diagnosis and management of pulmonary vein stenosis, a complication of atrial fibrillation procedures that occurs in 0.4% to 1.0% of cases.[5,6] Given the number of pulmonary catheter ablations completed in the United States

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