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### Title

Transesophageal Echocardiography for the Detection of Patent Foramen Ovale

### Permalink

<https://escholarship.org/uc/item/20x218sc>

### Journal

Journal of the American Society of Echocardiography, 30(9)

### ISSN

0894-7317

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### Publication Date

2017-09-01

### DOI

10.1016/j.echo.2017.05.006

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Peer reviewed

### **Transesophageal Echocardiography for the Detection of Patent Foramen Ovale**



#### **To the Editor:**

We read with interest the recent article by Yamashita *et al.*<sup>1</sup> Given that an effective Valsalva maneuver can be difficult to perform with sedation during a transesophageal echo (TEE) bubble study, the authors investigated the diagnostic yield of TEE for the detection of patent foramen ovale (PFO) by comparing provocation maneuver with Valsalva versus inferior vena cava (IVC) compression. The study concluded that IVC compression yielded a higher detection of PFO compared with rest ( $P < .05$ ) and was noninferior to the Valsalva maneuver ( $P = NS$ ). We commend the authors for their work, but several factors should be considered when interpreting these results.

The final results of the study were not compared to transthoracic echo (TTE), transcranial Doppler (TCD), or right heart catheterization for correlation. While TEE bubble study is considered by many as the reference standard for the detection of PFO,<sup>2</sup> TEE can either miss or misdiagnose a PFO in ~10% of patients when one relies on TEE alone. A recent meta-analysis of prospective studies determined that TEE bubble study has a sensitivity of 89% and specificity of 91% when compared to confirmation by autopsy, surgery, and/or right heart catheterization.<sup>3</sup> The imperfect accuracy of TEE may be attributed to technical limitations including patient intolerance for the TEE probe, an inadequate Valsalva maneuver during sedation with a probe in the esophagus, variations in patient anatomy, and operator experience.<sup>4,5</sup> While provocation with the IVC compression method may overcome the limitation with Valsalva, certain other modifications to the bubble study protocol may enhance the diagnostic yield of TEE for the detection of PFO. First, for patients who are unable to perform a sustained Valsalva maneuver, unloading the left ventricle with nitroglycerin may reverse the interatrial pressure gradient, promote leftward bulging of the interatrial septum, and reduce the number of false negative TEEs.<sup>6</sup> Johansson *et al.* demonstrated that the sensitivity of TEE can be increased by using at least five contrast injections<sup>7</sup> in an attempt to visualize both the leftward bulging of the interatrial septum and dense right atrial contrast filling adjacent to the septum.<sup>8</sup> Furthermore, addition of the patient's blood to the agitated saline mixture has been found to increase the sensitivity of bubble studies without compromising specificity when compared to agitated saline alone and other contrast agents.<sup>9</sup> Bubble studies performed with echocardiography

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Dr. Tobis was a consultant for St. Jude Medical and W.L. Gore. No funding was provided to write this correspondence.

on harmonic imaging mode have a higher yield for the detection of PFO<sup>9</sup> compared to fundamental imaging.<sup>10</sup> Finally, if femoral venous access is present, femoral vein injection of echo contrast medium increases the sensitivity for the detection of PFO compared with brachial injection due to direct flow from the IVC toward the foramen ovale.<sup>11</sup>

Since a bubble study performed with TCD has a higher sensitivity for the detection of intracardiac right-to-left shunt compared to TTE or TEE,<sup>9,12,13</sup> our preferred screening method is with a TCD followed by confirmation with TEE or intracardiac echo.<sup>4</sup> However, TCD is limited by its inability to differentiate between a PFO, atrial septal defect, or transpulmonary shunt, providing no data on the shape and size of the defect.<sup>12</sup> TEE has the added benefit of accurately visualizing the atrial septal anatomy, differentiating between an intracardiac and transpulmonary shunt, and assessing other etiologies of stroke including presence of left atrial appendage thrombus and atherosclerotic aortic disease.<sup>4,14</sup>

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<http://dx.doi.org/10.1016/j.echo.2017.05.006>

## Authors' Reply

### To the Editor:

We thank Mojadidi *et al.* for their interest in our recent work<sup>1</sup> and for their thought-provoking comments. In their letter, Mojadidi *et al.* emphasize the importance of additional techniques to maximize the detection rate of patent foramen ovale (PFO). We agree that techniques such as nitroglycerin administration for left ventricular unloading, repeated contrast injections, and use of saline with blood as a contrast agent are useful for this purpose, as well as the inferior vena cava (IVC) compression maneuver that we proposed.<sup>1</sup> However, we have two concerns regarding the letter.

First, the sensitivity (89%) and specificity (91%) of transesophageal echocardiography (TEE) for the detection of PFO, which are based on a meta-analysis by Mojadidi *et al.*,<sup>2</sup> appear to be underestimated. Of the studies included in the analysis, crucial drawbacks exist in two studies in particular, which showed excessively low sensitivity or specificity. Although one of these studies showed very low specificity (33%) of TEE for PFO detection,<sup>3</sup> patients enrolled in the study were deemed eligible for transcatheter PFO closure. The specificity calculated using the small number of referential PFO-negative patients ( $n = 3$ ) might be statistically unreliable in this study. The other report by Augoustides *et al.*<sup>4</sup> revealed low sensitivity (67%) of TEE for the detection of PFO in adult cardiac surgery patients. Most of the enrolled patients (86.1%) had severe left-sided heart disease, such as coronary heart disease and valvular heart disease, or had received ventricular assist devices or undergone heart transplantation. Identifying a PFO depends on creating a situation in which pressure in the right atrium exceeds pressure in the left atrium; when severe left ventricular dysfunction is present, left atrial pressure is usually elevated, and this might be expected to make it more difficult to demonstrate a PFO even though one

