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Improvement of perioperative right heart assessment with additional cross-sectional transesophageal echocardiography views

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There are widely accepted guidelines for performing perioperative transesophageal echocardiography (TEE) examinations (1). Most of the 20 cross-sectional views recommended in these guidelines focus on the left side of the heart; only four of them focus on the right heart. As one or more views may be of poor quality, these four views may be insufficient for a comprehensive evaluation of the right heart. Given the importance of the right heart in perioperative morbidity and mortality, efforts have been made to better understand its function, and to monitor it more reliably with additional TEE views (2). At our institution, we routinely use five additional TEE views that focus on the right heart (Figure 1). We have analyzed the feasibility of these views and their added value for assessment of the right heart in a recently published study (3).

Our prospective study had four main goals: 1) To analyze the feasibility of these additional views; and to evaluate whether addition of these views to the standard views improves 2) comprehensive assessment of all wall segments of the right ventricle, 3) assessment of the right-sided valves in two or more planes, and 4) assessment of transvalvular flow through the tricuspid and pulmonary valves in an orthograde fashion.

Sixty patients undergoing cardiac surgery were studied. We found that most of the standard and the additional views could be imaged in sufficient quality in more than 80% of patients. The average feasibility of standard and additional views was similar.

Analysis of the visualization of segments of the right ventricular wall was based on a predefined nine-segment model designed specifically for this analysis. The model was based on the established anatomic division of the right ventricle into a basal inflow tract, an (basal) outflow tract, and an apical trabecular part (4, 5). In addition, it used topographical terms established for the left ventricle (i.e., anterior, lateral, inferior, and septal) (1). The model divided the right ventricle into 5 basal segments (3 in the inflow tract and 2 in the outflow tract) and 4 apical wall segments: basal anteroseptal (BAS), basal anterior (BA), basal lateral (BL), basal inferior (BI), basal inferoseptal (BIS), apical septal (AS), apical anterior (AA), apical lateral (AL), and apical inferior (AI) (Figure 2).

The standard views reliably enabled imaging of all 5 basal right ventricular segments and of the apical septal and lateral segments. However, the apical anterior and inferior segments were missed in most patients. Addition of the apical transgastric right ventricular short-axis view (Figure 1) significantly improved imaging of these segments.

Comprehensive evaluation of a valve requires its assessment in at least two planes (6). The standard views reliably enabled such comprehensive imaging of the tricuspid valve in most patients (97%) but of the pulmonary valve in only a minority of them (25%). The pulmonary valve was sufficiently visualized by the mid-esophageal right ventricular inflow-outflow view in 70%, by the upper esophageal aortic arch short-axis view

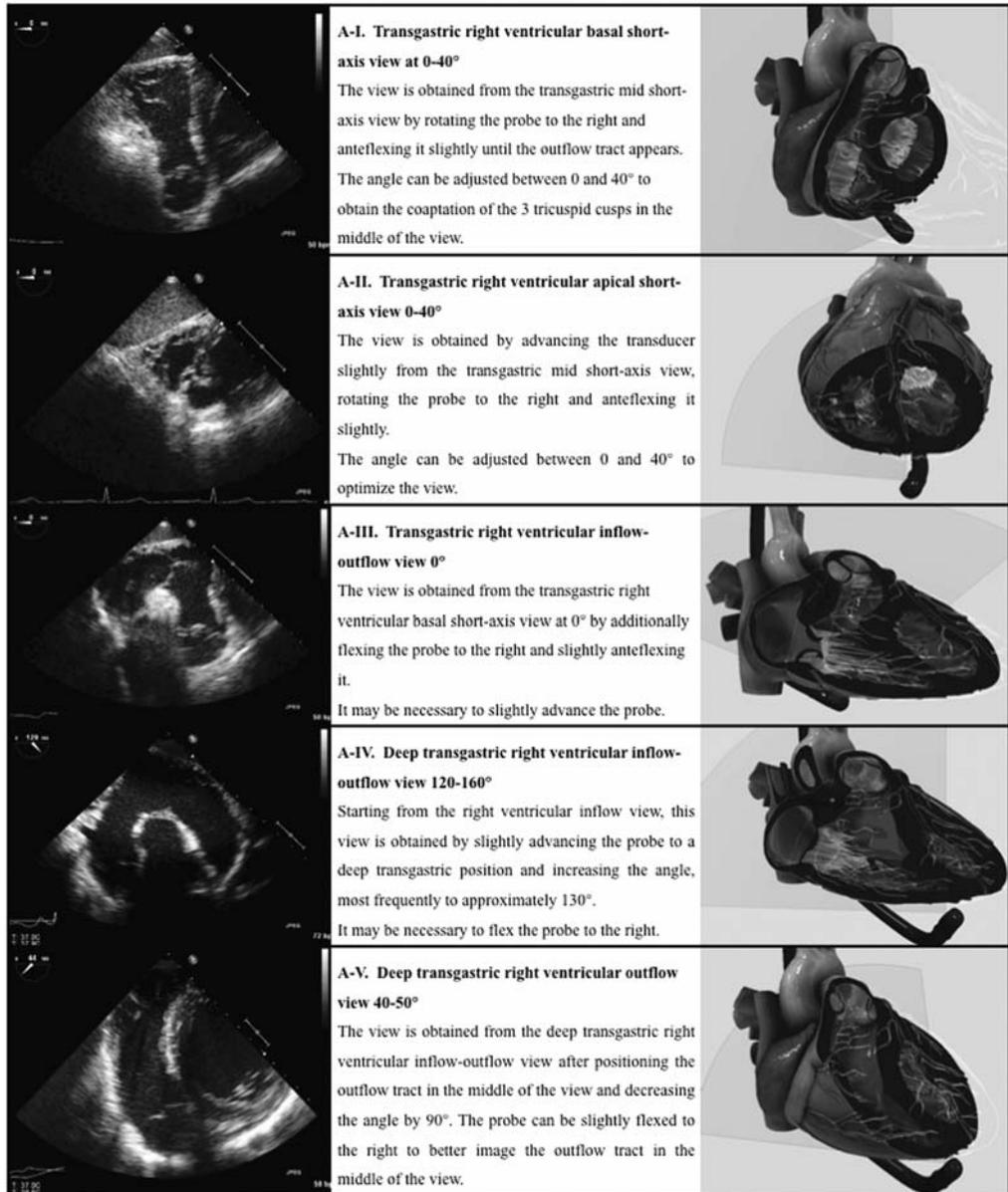


Figure 1: Still frames and corresponding images of an anatomical model of five additional transesophageal echocardiography cross-sectional views and descriptions on how to obtain these views. The images of the anatomical model with slice planes have been created with a HeartWorks transesophageal echocardiography simulator, courtesy of Inventive Medical Ltd., London, UK. (Reprinted with permission from Wolters Kluwer Health (figure 4, Kasper J, Bolliger D, Skarvan K, Busser P, Filipovic M, Seeberger MD. Additional cross-sectional transesophageal echocardiography views improve perioperative right heart assessment. *Anesthesiology* 2012; 117: 731)).

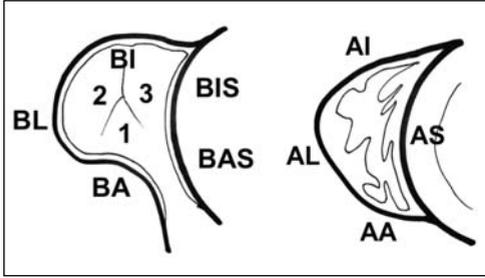


Figure 2: Transgastric right ventricular basal and apical short-axis views 0-40°.

A: The basal short-axis view images five basal segments and the tricuspid valve: BA = basal anterior; BAS = basal anteroseptal; BI = basal inferior; BIS = basal inferoseptal; BL = basal lateral. Tricuspid valve: 1 = anterior cusp; 2 = posterior cusp; 3 = septal cusp.

B: The apical short-axis view images four apical segments: AA = apical anterior; AI = apical inferior; AL = apical lateral; AS = apical septal.

in 20%, and by the mid-esophageal ascending aortic short-axis view in 18% of patients. These findings explain why the standard views did not allow for assessing the pulmonary valve in two or more planes in most patients. Addition of the two deep transgastric views to the standard views allowed imaging of the pulmonary valve in two or more planes in all patients (100%).

Orthograde assessment of tricuspid transvalvular blood flow was obtained by the standard views alone in 51% of the study patients and was not improved with the additional views. In contrast, orthograde assessment of pulmonary transvalvular blood flow was obtained by the standard views in only 28% of the study patients, and was significantly improved with the additional views. Adding any two of the three additional views that visualize the pulmonary valve (Figure 1) improved orthograde assessment of transvalvular flow through the pulmonary valve to 85%.

In summary, the study showed that imaging of additional views that focus on the right heart is highly feasible, and that three of these views improve comprehensive assessment of the right heart. The *apical transgas-*

tric right ventricular short-axis view improves assessment of the right ventricular wall by better imaging the apical segments. The *deep transgastric right ventricular inflow-outflow view* and the *deep transgastric right ventricular outflow view* improve the ability to assess the pulmonary valve in two or more planes, and to assess pulmonary transvalvular blood flow in an orthograde fashion. Thus, the findings suggest that these additional TEE views should be routinely monitored when performing a comprehensive intraoperative multiplane TEE examination.

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