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SESSION TITLE: ECHOCARDIOGRAPHY: STRUCTURAL HEART DISEASE AND INTERVENTIONS

Abstract 16775: Severity Assessment of Transcatheter Aortic Valve Paravalvular Regurgitation: A New Approach Based on the Leakage Momentum Flux

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Originally published 14 Nov 2017 | Circulation. 2017;136:A16775

Abstract

Introduction: The circumferential extent (CE) of paravalvular regurgitation (PVR) is commonly used for semiquantitative evaluation of transcatheter aortic valve (TAV) PVR severity. This study points out to the shortcomings of such assessment method.

Hypothesis: A novel approach based on fluid mechanics is proposed to evaluate TAV PVR. The method also applies to the central aortic valve regurgitation in surgical aortic valves (SAVs), which is conventionally evaluated by leakage jet width at its origin. The proposed method is based on the estimation of the maximum momentum flux of the leakage flow, J_{\max} , from the parameters that are conventionally measured for aortic regurgitation (AR) evaluation: CE of PVR, central jet velocity/width, and the aortic/ventricular pressures.

Methods: A patient-specific geometry of the left ventricle, ascending aorta, and the coronary arteries was reconstructed from computed tomographic angiography (CTA) images (Figure 1a). Idealized computational models of a TAV (Figure 1b) and a SAV with different levels of leakage were then developed. 3D flow fields were simulated (Figure 1c) and used to accurately calculate the regurgitant volume (RV) as well as the corresponding semi-quantitative assessment parameters. In addition, 3D printed TAV and SAV models with different levels of regurgitation were tested in an in-vitro pulse-duplicator system and the aforementioned parameters for AR evaluation were obtained using Doppler echocardiography (Figure 1d).

Results: The results demonstrated a considerable inaccuracy in assessment of TAV PVR severity via CE of PVR. In addition, the computational results showed a nearly linear correlation ($R^2=0.986$)

between J_{\max} , and RV (Figure 1e), indicating the capability of J_{\max} in TAV PVR assessment, and AR in general.

Conclusions: The new approach in assessment of the severity of PVR based on estimation of J_{\max} showed a significant improvement in terms of accuracy compared to the commonly used CE of PVR.

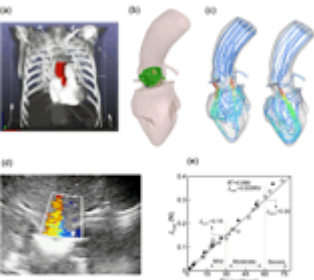


Figure 1. (a) Reconstruction of patient-specific geometry from CTA images. (b) Idealized computational model for TAV. (c) Sample simulation result for TAV paravalvular and SAV central leakage. (d) Sample results of echocardiography of central leakage in an in-vitro experimental setup. (e) Linear correlation between regurgitant volume and the leakage jet maximum momentum flux. Empty symbols correspond to TAV PVR and filled symbols correspond to SAV central leakage.

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Footnotes

Author Disclosures: **K. Vahidkhah:** None. **M.S. Barakat:** None. **A.N. Azadani:** None.

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