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GEOMETRIC ERRORS OF THE PULSED DOPPLER FLOW METHOD IN QUANTIFYING DEGENERATIVE MITRAL VALVE REGURGITATION: A THREE-DIMENSIONAL ECHOCARDIOGRAPHY STUDY

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Objectives To ascertain the geometric errors of the two-dimensional pulsed Doppler flow (2D PDF) method in calculating the regurgitant volume (R Vol) and effective regurgitant orifice area (EROA) in degenerative mitral regurgitation (MR) by comparing it to the 3D PDF method.

Methods We performed 2D transthoracic and 3D transesophageal echocardiography in 22 patients with moderate to severe degenerative MR. The R Vol and EROA were calculated conventionally using the 2D PDF method. Using the 3D PDF method, the cross-sectional areas (CSAs) of the mitral annulus (MA) and left ventricular outflow tract (LVOT) were measured directly in the 3D 'en face' views.

Results The 2D diameter of the MA was 38±5 mm and that of the LVOT was 22±2 mm. Both the MA and LVOT were oval in the 3D 'en face' views with a significant difference between the major and minor axis diameters (MA: 40±5 vs 30±4 mm; LVOT: 29±4 vs 21 ±2 mm; both $p<0.001$). The 2D diameters of the MA and LVOT were significantly different from their major and minor diameters (all $p<0.05$). Compared with the 3D measurements, the 2D measurements on average overestimated the CSA of MA by 13%±12% and underestimated the CSA of LVOT by 23%±10%. The R Vols were: 92±44 ml (3D PDF) vs 133±58 ml (2D PDF); the EROAs were: 67±35 mm^2 (3D PDF) vs 95±46 mm^2 (2D PDF) (both $p<0.05$). Although well correlated (2D PDF vs flow convergence $r^2=0.84$, 3D PDF vs flow convergence $r^2=0.90$), the R Vol and EROA were overestimated by the 2D PDF method by 26%±24%, but underestimated by the 3D PDF method by 16%±18%. Bland-Altman analysis showed that there was a smaller bias and tighter limits of agreements between the 3D PDF and flow convergence methods than between the 2D PDF and flow convergence methods. For the R Vol, the bias±2 SDs were 19±37 ml (2D PDF vs flow convergence) and −10±23 ml (3D PDF vs flow convergence). For the EROA, the bias±2SD were 25±47 cm^2 (2D PDF vs flow convergence) and −15±34 mm^2 (3D PDF vs flow convergence). The 3D PDF method was generally more reproducible than the 2D PDF method.

Conclusions The traditional 2D PDF method significantly overestimates mitral R Vol and EROA because the monoplanar 2D measurements represent the MA major axis diameter and LVOT minor axis diameter, and the assumed circular CSAs of the MA and LVOT are actually oval. The monoplanar 2D measurements and false geometry assumptions of the CSAs of the MA and LVOT result in the SV being overestimated at the MA level and underestimated at the LVOT level. The overestimates can be significantly corrected by the 3D PDF method in which the CSAs of the MA and LVOT are measured directly in the 'en face' views.