3D Imaging Reveals Oval LVOT, Leading to Underestimation of LVOT and Aortic Valve Area by 2D Echo

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Background: Measurement of left ventricular outflow tract area (LVOTa) for estimation of aortic valve area (AVA) and for transcatheter aortic valve implantation (TAVI) using transthoracic 2D echocardiography (TTE) and the continuity equation assumes a round shape for the LVOT. The aim of this study was to determine the effect of direct measurement of LVOTa using 3D echocardiography (3DE) and cardiac computerized tomography (CT) on LVOTa and AVA estimation.

Methods: We prospectively studied 43 patients (age 68±12y, 21 males, 22 with aortic stenosis (AS) and 21 without AS). LVOTa and AVA were estimated using TTE and the continuity equation ($pai(LVOTd/2)^2$ assuming a circular LVOT). LVOTa and diameters (D1 & D2) were measured using 3DE and CT. AVA was also planimetered using CT in mid systole. LVOTa and AVA estimated by TTE were correlated with 3DE and CT measurements.

Results: LVOT was usually oval and not circular, with an eccentricity index (D2/D1) of 1.24±0.10 for CT and 1.17±0.11 for 3DE. There was good correlation between TTE and MDCT for LVOTa (r=0.88) but TTE systematically underestimated LVOTa (and therefore AVA) by 15±14% (AS vs. no AS p=0.4). The correlation between 3DE & CT for LVOTa was only moderate (r=0.72), due to inadequate 3DE image quality. AVA was 0.92±0.35 cm2 by TTE and 1.42±0.73 cm2 by CT. There was good correlation between TTE and CT for AVA (r=0.92), but TTE underestimated AVA by 50±32% (-0.5±0.43 cm2, p<0.0001).

Conclusions: 3D imaging revealed an oval LVOT in most patients, resulting in underestimation of LVOTa and AVA by 15% using TTE. This accounted for only part of the difference in AVA between TTE and CT, which are conceptually different (anatomical vs. effective valve area). Current 3D TTE image quality is inadequate to accurately determine LVOTa. These findings carry important implications for selecting AS patients for surgery or TAVI.