Assessing Aortic Annular Dynamics by Four-Dimensional Multislice CT: Implications for TAVI

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Background: Sizing for transcatheter aortic valve implantation (TAVI) requires fitting device dimensions to those of the implantation site. Since aortic annular geometry might vary periodically in size and shape, we sought to assess its dynamics throughout the cardiac cycle using four-dimensional computed tomography (4DCT).

Methods: Ten patients with severe aortic stenosis underwent 256-slice CT for assessment of the aortic annulus before TAVI. Three-dimensional images were reconstructed in 10% increments of the RR-interval to generate a 4DCT dataset. For each phase in the cardiac cycle we assessed: Eccentricity index (EI; the ratio of maximal to minimal diameter), mean diameter (average of maximal and minimal diameters), circumference and derived circumferential diameter, cross-sectional area and derived cross-sectional diameter.

Results: 4DCT demonstrated an ellipsoid shape of the aortic annulus, with significantly greater ellipticity during diastole (1.29 ± 0.06) than systole (1.20 ± 0.06), ($P < 0.001$). The systolic decrease in ellipticity was associated with a mild increase in area (431 ± 130 to 458 ± 132 mm^2; $p < 0.001$). The resulting systolic-diastolic mean cross-sectional diameter difference averaged 0.71 ± 0.70 mm (range 0.1 to 2.1 mm), and the mean diameter difference averaged 0.91 ± 0.8 mm (range 0.2 to 1.9 mm). The circumference remained stable throughout the cardiac cycle as did the derived circumferential diameter (0.27 ± 0.5 mm; range 0 to 0.6 mm).

Conclusion: 4DCT imaging data suggest that aortic annular shape becomes more elliptical in diastole, but in patients with heavily calcified valves the resulting periodic time-variation of its area and mean diameter were relatively modest. Consequently, mean diameter and cross-sectional diameter are well suited for sizing in TAVI. However, since annular circumference and circumferential diameter remain perfectly constant throughout the cardiac cycle, they may represent the most robust parameters for sizing.