

The Influence of Left Ventricular Outflow Tract Eccentricity on Differences in LVOT area, Aortic Valve Area, and Stroke Volume Index from Cardiac CT, Transthoracic Echo and Catheterization in Patients with Senile Calcific Aortic Stenosis

Background

Senile Calcific Aortic Stenosis is the most common cause of Aortic stenosis in older patients, and is characterized by calcium deposition on the aortic valve leaflets leading to restriction of the aortic valve orifice. Due to this restriction, reductions in stroke volume and increases in cardiac workload generally follow, which can eventually lead to more serious cardiac issues, including heart failure and death. Aortic valve area (AVA) is thus a necessary calculation when assessing the severity of aortic stenosis, and is typically measured by transthoracic echocardiography (TTE) using the continuity equation. However, calculation of AVA using the continuity equation (and, similarly, the measurement of stroke volume index (SVI)) by TTE assumes circular geometry of the Left Ventricular Outflow Tract (LVOT), and does not account for LVOT eccentricity. We sought to determine the effect of LVOT eccentricity on discrepancies in LVOT area, AVA, and SVI as measured by CTA, TTE, and/or catheterization. We hypothesized that LVOT eccentricity plays a role with differences in these measurements.

Methods

We performed a retrospective analysis of 36 consecutive patients with senile calcific aortic stenosis referred for Transcatheter Aortic Valve Replacement (TAVR) at our institution. The patient data was collected between July 2012 and May 2017. Data collected from these 36

patients came from measurements made by CTA, TTE, and catheterization. From CTA, LVOT area was measured by planimetry of CTA images. Eccentricity was then calculated using measurements of the short (a) and long (b) axes as shown by the CTA images (eccentricity = $1 - (a/b)$).

TTE data allowed for implication of the Continuity Equation in order to determine the Aortic Valve Area (AVA). Through use of the Gorlin Equation, AVA could be calculated through catheterization. Comparisons of data measured by CTA, TTE, and catheterization were made using the paired Student's t-Test, and statistical analyses of the data were conducted. Finally, the Pearson correlation coefficient (r) was calculated to determine the correlations between LVOT eccentricity and LVOT area, AVA, and SVI.

Results

The mean age of the patients was 83.25 (median 84 ; range of 66 —95). 20 were male and 16 were female. Information about some preexisting and possible confounding medical conditions were noted. 20 patients presented with coronary artery disease (CAD), 20 patients presented with hypertension, and 6 patients presented with Diabetes Mellitus.

The average LVOT eccentricity as presented by cardiac CTA was 0.28 cm² (range of 0.13 cm² — 0.46 cm²). LVOT area measured by CTA was significantly larger than LVOT area measured by TTE, with an average difference of 1.14 cm² (32%, $p < 0.001$). The average difference in AVA between TTE and Catheterization, however, was *not* significantly different (0.06 cm²; 7%, $p=0.15$). The average SVI was significantly different between TTE and Catheterization (9.77 ml/BSA; 22%, $p<0.001$).

Statistical analysis showed that there was a small correlation between LVOT eccentricity and the differences in Aortic Valve Area measurements ($r = 0.12$). There were moderate correlations ($r = 0.41$ and $r = 0.39$) between LVOT eccentricity and the differences in mean LVOT area measurements, and mean Stroke Volume Indexes, respectively.

Conclusion

In patients with senile calcific aortic stenosis, there is a significant difference in LVOT area as measured by TTE and cardiac CTA. There is also a significant difference in SVI measured by TTE versus heart catheterization. Despite these differences, AVA is not significantly different when calculated by TTE compared to catheterization. LVOT eccentricity has moderate statistical correlation with these differences in LVOT area and SVI measurements.

Historically and in clinical practice, LVOT eccentricity is not primarily accounted for when assessing senile calcific aortic stenosis. The results of this study suggest that LVOT eccentricity plays a role in the differences in heart measurements from different techniques.