Severe aortic stenosis: measurement of energy loss index using 3d echocardiography without geometrical assumptions ... is the stenosis really severe?

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Background
It is known that in the evaluation of aortic stenosis (AS) through 2D transthoracic echocardiogram (2D TTE) the effective valve area (eAVA) tends to underestimate the real area (AVA) because it does not take into account the pressure recovery phenomena and it assumes the left ventricular outflow tract (LVOT) as circular. The Energy Loss Index (ELI) by 2D TTE is the eAVA that involves the pressure's recovery. However, it also assumes it as circular. In patients with AS, measurement of the LVOT area and STJ by 3D transesophageal echo (3D TEE) with planimetry should be a more accurate measurement of ELI.

Objectives
1.To evaluate the size and geometry of the STJ by 3D TEE,compare it with 2D TEE measurement and with 3D LVOT geometry.
2. To compare the measurement of the eAVA and ELI by 2D TTE and ELI by 2D TTE replacing the LVOT (LVOTa) and STJ areas (STJa) by the areas measured with 3D TEE (fusion 2D/3D ELI) versus an Anatomical 3D ELI using anatomical 3D AVA (aAVA) and the 3D aSTJ.

Methods
We studied 41 patients with severe AS (AVA <1 cm²) with 2D TTE and 3D TEE,prospectively. The 2D TTE eAVA was estimated by Continuity Equation. In the 3D TEE, 3 captures were done and analyzed off line (QLAB). The areas of the LVOT, STJ and AVA (aAVA) were measured in midsystole, same frame by planimetry; also the anteroposterior (AP) and lateral (L) diameters of the LVOT and the STJ were measured. The sphericity index (AP/L diameter) was performed. To calculate ELI, we used the formula = eAVA*STJa/STJa-eAVA. When replacing the 2D LVOTa with 3D in the eAVA, fusion 2D/3D eAVA was obtained. When replacing 2D LVOTa and STJa by the values obtained with 3D TEE in the ELI formula, the fusion 2D/3D ELI was obtained. The Anatomical 3D ELI was obtained using the 3D aAVA and 3D STJa. Data are reported as mean±SD.

Results
Average age was 74.9 (±9),25% male.Ejection Fraction was 55.5% (±11).Peak and mean aortic valve gradients: 61(±18) and 37 (±13)mmHg,respectively. 2D TTE LVOTa was 3.19 (±0.8)cm² vs 3D LVOTa 3.9 (±0.9)cm² (p=0.0001). 2D STJa was 5.4(±1.6)cm² vs 3D STJa 4.66(±1.3)cm² (p<0001). The sphericity index of the LVOT was 0.79(±0.09) and STJ 1.07(±0.08), p <0001. LVOT and STJ AP diameter: 1.9(±0.2)cm and 2.5(±0.3)cm; respectively (p<00001). LVOT and STJ L diameter: 2.5(±0.3)cm and 2.3(±0.3)cm;respectively (p<00001). Comparing the 2D eAVA, difference with fusion 2D/3D eAVA was 19% (p<0.001), 3D aAVA 16% (p<0.001), 2D TTE ELI 14% (p<0.001), fusion 2D/3D ELI 35% (p<0.001) and Anatomical 3D ELI 32% (p<0.001). When comparing 2D/3D fusion eAVA with fusion 2D/3D ELI and 3D aAVA with Anatomical 3D ELI, the difference was 19%.

Conclusions
With 3D echo the STJ geometry tends to be more spherical than the LVOT, but the larger diameter of the LVOT turns out to be the inverse of the STJ. With 2D echo the size of the LVOT is

underestimated while the STJ is overestimated. If any geometrical assumptions are not taking into consideration with 3D echo there will be implications in the calculation of the eAVA and ELI: the smaller STJ size and the larger LVOT size reflect less AS severity in regard to classical 2D methods.