Intravascular ultrasound for valve frame expansion and orifice area measurement as well as paravalvular leak assessment during transcatheter aortic valve replacement

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Introduction: Valve frame expansion (measured outer valve frame area/nominal valve dimension), but not oversizing (nominal valve dimension/annulus area, %) determines pattern of restored blood flow after transcatheter aortic valve replacement (TAVR). There is no online measure of frame expansion, and error in current echocardiographic assessment of effective orifice area (EOA) and paravalvular leak (PVL) are common.

Purpose: To evaluate large imaging field intravascular ultrasound (IVUS) during TAVR for measuring valve geometry [frame expansion, minimal geometric orifice area (min GOA), and mechanism of PVL] with transthoracic echo and angio-CT serving for comparative measures, along with the nominal EOA as established by Hahn et al.

Methods: After successful TAVR either a 10MHz Vision PV 0.035" (60mm imaging field) or 20MHz Vision PV 0.018" (24mm imaging field plus ChromaFlo) IVUS catheter (Philips) was slowly pulled from the left ventricle outflow (LVOT) to the aorta with continuous imaging of the aortic root.

Results: There were 16 pts (80.8±7.1 yrs, 8 female) treated for de novo aortic stenosis (n=15) or failed bioprosthesis (n=1), 7 of whom were treated with balloon-expandable TAVR. PV 0.35" catheters were used in 8 pts (including valve-in-valve) and allowed complete geometry assessment of 26.6±2.7mm nominal prosthesis Ø (Figure 1A) whereas PV 0.018" allowed complete geometry assessment in only 4 of 8 pts with nominal prosthesis Ø of 26.1±2.8mm (Figure 1B). Actual % valve inflow expansion (IVUS outer frame/valve nominal dimension) was significantly smaller than % valve oversizing (80%±19% vs 125±19%, p=0.005). Min GOA was substantially bigger than corresponding nominal EOA and EOA calculated using the post-procedural LVOT diameter (272±84mm^2 vs 174±25mm^2 vs 181±59mm^2, p=0.001 correspondingly). However, min GOA was similar to EOA calculated using baseline LVOT area (272±84mm^2 vs 230±90mm^2; r=0.713, p=0.009). IVUS and angio-CT measurements of outer prosthesis frame area were similar for inflow, coaptation site, and outflow (460±143mm^2 vs 454±134mm^2 and 455±134mm^2 vs 447±114mm^2 and 722±174mm^2 vs 725±180; p≤0.001 for all paired correlations). Inflow expansion (IVUS outer frame/baseline CT annulus area) tended to be smaller among valves with ≥mild vs no PVL (95±14% vs 107±11%, p=0.156), with clear ChromaFlo signal seen in the space between the aortic annulus wall and outer-valve frame surface (Figure 1C).

Conclusions: Large imaging field IVUS during TAVR allows for periprocedural assessment of actual valve geometry that differs substantially from nominal. IVUS offers online tomographic perspective and highest accuracy in anatomy evaluation corresponding with valve function.

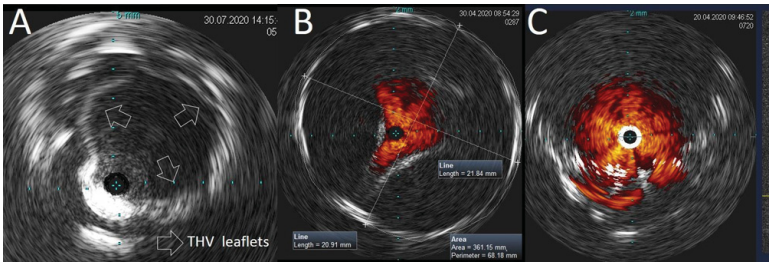

Figure 1