Aortic Stiffness following treatment of Severe Aortic Stenosis

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Background: Arterial stiffness is an independent predictor of cardiovascular mortality and can be assessed by CMR measurement of aortic distensibility (AD) and pulse wave velocity (PWV).

Aim: To determine AD and PWV in patients with severe symptomatic aortic stenosis and identify changes following TAVI compared to SAVR.

Methods: Forty-eight patients underwent identical paired 1.5T CMR scans (Intera, Philips or Avanto, Siemens). Brachial artery blood pressure was recorded by Dinamap (Critikon, Tampa, Fl, USA). Multi-phase steady state free precession (SSFP) cine imaging (50 phases) was acquired in a axial plane to the thoracic aorta at the level of the pulmonary artery bifurcation (Ascending aorta (AA) and proximal descending aorta (PDA)).

AD ($mmHg^{-1}$) was calculated following the contouring of the aortic region of interest, Figure 1A (QMass V7.5, Medis, The Netherlands), using the equation; (Aortic $_{\text{max lumen area}}$-Aortic $_{\text{min lumen area}}$) / (Aortic $_{\text{min lumen area}}$ x [Systolic BP – Diastolic BP]).

Aortic PWV was assessed using identical planning with retrospectively gated, through plane, phase-contrast velocity encoded images (breath-hold, single slice, 10mm thick, 40 phases, typical FOV 350, RFOV 85, VENC 200cm/s). Offline analysis was performed using previously published algorithims implemented in the in-house software PMI 0.4. The velocity encoded images of the AA and PDA were manually contoured to derive velocity-time curves. The distance (mm) between AA and PDA was measured manually from in-plane saggital-oblique SSFP images of the aortc arch. PWV (m/s) was calculated using the transit-time method (foot-foot delay, Figure 1B).

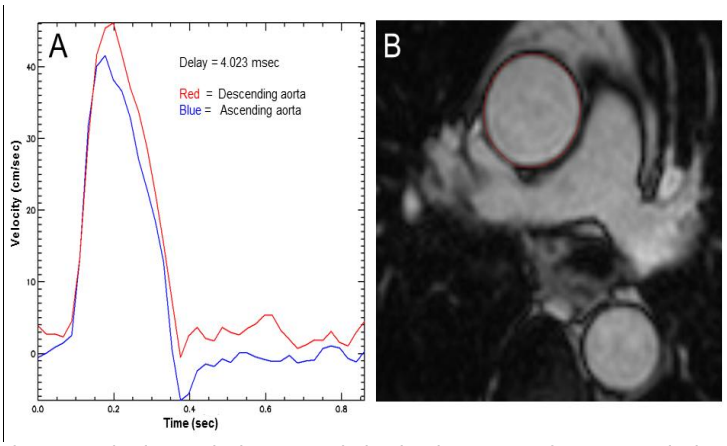

Figure 1: A) Time-Velocity curve derived using PMI software to calculate foot-foot delay (curves are automatically adjusted to accommodate time delay).

B) Aortic cross sectional measurements made by manual planimetry of the ascending aortic endovascular-blood pool interface at minimal and maximal distention.

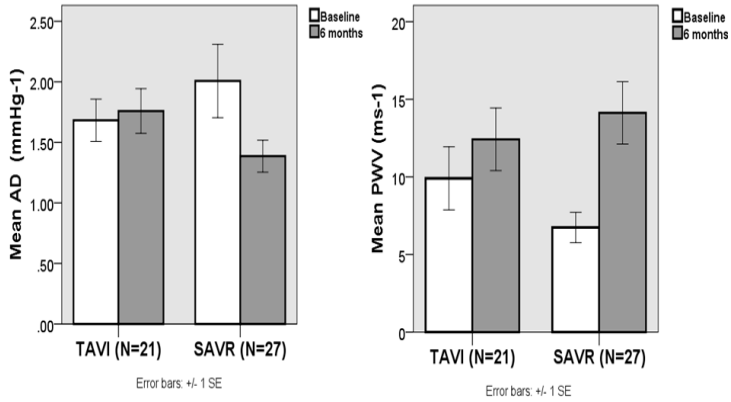

Figure 2: Change in aortic distensibility and pulse wave velocity pre- and post-TAVI/SAVR.

Results: 27 SAVR patients (age 71.8±7.0 years, 75% male, EuroSCORE II 1.43±0.44%) and 21 TAVI patients (age 81.7±6.3 years, 52% male, EuroSCORE II 6.32±5.99%) were studied before and 6 months following valve replacement. Arterial pulse pressure significantly increased following SAVR (57±19.6 vs. 63±14.6mmHg, $p<0.05$) but not after TAVI (68±24.0 vs. 67±21.6mmHg, $p=0.91$). AD significantly decreased post SAVR (2.00±1.57 vs. 1.39±0.69x$10^{-3}$$mmHg^{-1}$, $p<0.05$) whereas there was no change observed in the TAVI group (1.68±0.80 vs. 1.76±0.85x$10^{-3}$$mmHg^{-1}$, $p=0.74$).

PWV significantly increased post-SAVR (6.69±5.12 vs. 12.13±6.22ms^{-1}, $p=0.01$) whereas there was no change observed in the TAVI group (9.91±9.32 vs. 12.42±9.24ms^{-1}, $p=0.23$).

Conclusions: In patients with severe aortic stenosis, SAVR but not TAVI is associated with a significant increase in PWV and decrease in AD at 6 months. This increase in aortic stiffness may be a consequence of the different techniques of valve replacement and has potential long-term implications on cardiovascular mortality.