554 **Supplementary Material**

555 *MRI acquisitions*

556 MRI exams were conducted on MAGNETOM 1.5T Aera or Avanto (n=94) and 3T Skyra (n=12)

557 scanners (Siemens Medical Systems, Erlangen, Germany), after injection of a gadolinium-based

558 contrast agent (0.03 mol/kg Ablavar, Lantheus Medical Imaging, N. Billerica, MA, USA; or 0.1-

559 0.2 mmol/kg Gadavist or Magnevist, Bayer, Leverkusen, Germany; or 0.1-0.2 mmol/kg

560 Multihance, Bracco Diagnostics Inc., Township, NJ, USA).

561 Prospectively ECG-gated 4D flow MRI data were acquired in a sagittal volume encompassing

562 the thoracic aorta. Respiration gating was achieved by means of a 16 mm-acceptance window

563 size navigator placed on the lung-liver interface. Parallel imaging (GRAPPA) along the phase

564 encoding direction (y) was used with a reduction factor R=2 (24 reference lines) to accelerate the

565 acquisition. Other sequence parameters were as follows: repetition time=4.8±0.1 ms; echo

566 time=2.4±0.1 ms; flip angle=15°; acquisition matrix=160x80-100; isotropic pixel in-plane

567 spacing=2.18±0.13 [2.125-2.6875] mm; slice thickness=2.88±0.32 [2.4-3.8] mm; 2 k-space

568 segments per cardiac time frame; temporal resolution=38.3±0.65 [36.8-40] ms; number of

569 slices=23-36; receiver bandwidth=445-460 Hz/pixel; encoding sensitivity Venc=150-300 cm/s

570 depending on the presence and severity of aortic valve stenosis.

571 *Assessment of left ventricular and aortic valve function as well as aortic dimensions*

572 Left ventricular (LV) end-systolic (ESV) and end-diastolic (EDV) volumes were measured with

573 conventional contouring of ECG-gated cine balanced steady state free precession (bSSFP) short-

574 axis images covering the left ventricle, while including the papillary muscles and chamber

575   trabecula using QMass v7.2 (Medis, Leiden, The Netherlands), to calculate stroke volume and

576   ejection fraction.

577   Aortic valve morphology and function were determined using cine bSSFP and 2D PC images

578   obtained at the level of the aortic valve. BAV morphology was classified according to Sievers

579   classification(1). Aortic valve stenosis and regurgitation severity was classified as none, trace,

580   mild, moderate or severe according to published guidelines(2).

581   Aortic diameter measurements were obtained from CE-MRA images at the sinuses of Valsalva

582   (SOV) and mid-ascending aorta (mid-AA) using the open-source, free DICOM medical image

583   viewer Horos™ (2015, http://www.horosproject.org/; based off of OsiriX). SOV diameter was

584   the maximal value among the 3 sinus-to-sinus measurements, including the external walls. Mid-

585   AA diameter was the maximal value over 2 orthogonal measurements in a reformatted plane

586   orthonormal to the aorta, including the external walls(3).

587   *4D flow MRI data analysis*

588   For each baseline and follow-up 4D flow dataset, preprocessing was first applied using a

589   previously described Matlab program (The Mathworks, Natick, MA, USA)(4), including eddy

590   current correction, background noise suppression and velocity aliasing unwrapping. A 3D

591   angiogram (PC-MRA) was computed by multiplying absolute velocity by magnitude images and

592   averaging over all cardiac phases(4), to segment the aortic volume (Mimics, Materialize, Leuven,

593   Belgium) and subsequently mask the flow velocities (Figure 1.a).

594

595

References

596 **References**

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611

612 **Supplementary figure legend.** Consort flow diagram for retrospective cohort identification
613 from an institutional database of aortic 4D flow MRI examinations.

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┌─────────────────┐
│ Aortic 4D flow  │
│   (n=1673)      │
└─────────────────┘
         │
         │      ┌──────────────────────────────────────────────────────────────┐
         │      │ Excluded (n=1640)                                            │
         ├─────→│ • No aortic or valve disease (n=545)                         │
         │      │ • No aortic or valve replacement (n=884)                     │
         │      │ • No 4D flow both before and after surgery (n=189)           │
         │      │ • History of aortic dissection / previous surgery (n=21)     │
         │      │ • Modified Ross pulmonary autograft procedure (n=1)          │
         │      └──────────────────────────────────────────────────────────────┘
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    ┌────┼──────────────────┐
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┌────────────────┐ ┌─────────────────────┐ ┌──────────────────────┐
│ AVR alone (n=5)│ │ ARR-HA⁻ (n=16)   │ │ ARR-HA⁺ (n=12)   │
└────────────────┘ └─────────────────────┘ └──────────────────────┘

AVR: aortic valve replacement; ARR-HA⁻: aortic root replacement with no hemi-arch repair; ARR-HA⁺: aortic root replacement and hemi-arch repair