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Aortic WSS distribution in TGA patients after arterial switch in rest and during dobutamine-stress

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Introduction (or Basis or Objectives):
Aortic root dilatation is an important complication in patients with transposition of the great arteries (TGA) after arterial switch operation (ASO). The interaction between altered geometry (Figure 1A) after ASO and aortic hemodynamics in rest and stress state is unknown. 4D flow enables investigation blood flow and related hemodynamic parameters, including wall shear stress (WSS), known to be associated with vascular remodelling and aortic dilatation. The aim of this study was to assess WSS distribution along the thoracic aorta at rest and stress using 4D flow MRI.

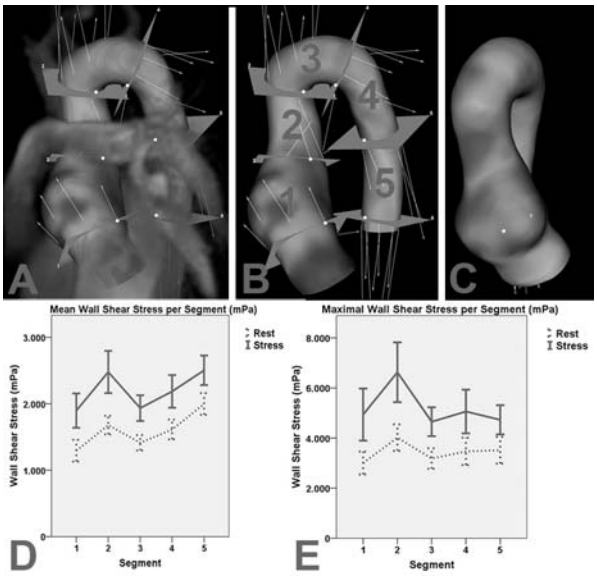

Figure 1. **A.** Anatomy after Lecompte. **B.** Aorta segmentation **C.** WSSmax distribution along the thoracic aorta with WSS-hotspot in distal AAo. **D.** WSSmean per aortic segment at rest and dobutamine-stress. **E.** WSSmax per aortic segment at rest and dobutamine-stress.

Methods:
Sixteen patients (mean age: 15.9±3.0 years) after ASO for simple TGA underwent cardiac MRI including 4D flow at rest and during dobutamine-induced stress (dosage 7.5 ug/kg/min) and non-contrast enhanced 3D MR angiography (NCE-MRA) at rest on a Tesla 3.0 scanner (Philips Healthcare). Post-processing of 4D flow data was done with CAAS MR 4Dflow_v1.1 software (Pie Medical Imaging BV)(Figure 1B). Peak systolic phase was identified for 5 thoracic aortic segments along the cardiac cycle and peak systolic 3D aortic volume was formed and manually adapted where necessary. Mean WSS (WSSmean) and maximal WSS (WSSmax) were calculated for all segments. Furthermore, correlation between aortic diameter differences (ratios) at standardized landmarks and alterations in WSS (∆WSS) were investigated.

Results:
A relatively large diameter difference was found between de dilated root and the mid-ascending aorta (AAo) (ratio root/mid-AAo=1.62±0.22). Segmental WSSmean and WSSmax was lowest in the dilated proximal AAo and highest in the distal AAo (Figure 1C) and distal descending aorta in rest and during stress. WSS increased significantly during dobutamine-stress for all aortic segments (WSSmean:506-800 mPa, P<0.001; WSSmax:1215-2610 mPa, P<0.000-0.002), the most for the distal AAo segment (Figure 1D & 1E). Moderate correlation was found between ∆WSSmax in the distal AAo segment and the diameter difference between the root and mid-AAo (ratio)(r=0.51, P=0.044).

Conclusions:
TGA-specific geometry related to the arterial switch operation, evidenced by neo-aortic root dilation and a sudden change in vessel diameter at mid-ascending aorta level, leads to specific wall shear stress distribution along the ascending aorta in TGA patients which aggravates during dobutamine stress.