Abnormal Biophysical Properties of the Aorta in Post Surgical Patients with Congenital heart diseases: a Non-Invasive Study

BACKGROUND
Children with congenital heart disease (CHD) represent a growing population: The incidence of congenital heart defects is almost 1 in 100 live births and due to major improvements in medical and surgical care, most of them will reach adulthood.

Some specific diagnoses might be associated with an increased risk for adult cardiovascular disease compared with the general population. To date, relatively few data exist regarding which CHD is associated with a significant increased risk and their role in early development of atherosclerosis.

Tetralogy of Fallot (TET), coarctation of the aorta (COA) and transposition of the great arteries (TGA) are three of the most common-life-threatening forms of CHD. However, the overall perioperative mortality in the recent era is less than 5%. Most of the children with this condition will survive until adulthood.

These CHDs are associated with congenital and/or post-surgical vascular anomalies. Both macroscopic (dilation, surgical scarring) and microscopic vascular alterations (aortic cystic medial necrosis) have been described and might contribute to vascular and myocardial function impairment.

OBJECTIVE AND HYPOTHESIS
Objective
Using non-invasive techniques, we sought to assess the aortic biophysical properties, total arterial compliance, hydraulic power and efficiency in post-operative children with TET, COA and TGA.

Hypothesis
We hypothesized that children born with these forms of CHD would have abnormal vascular function, increasing their risk of acquiring early-onset cardiovascular disease.

PATIENTS AND METHODS

Patients
• 55 patients with TOF (n=24), COA (n=20) and TGA (n=11) were enrolled in the study during their regular follow-up
• 55 controls were recruited from volunteers
• All subjects were between the ages of 8 to 19 years, mean age was 15.2y, 13.4y, 14.3y and 14.1y respectively for TET, COA, TGA and CTRL
• CHD patients had no additional disease, especially no hypertension or renal disease
• CTRL patients had no chronic illness

Methods
• A full cardiovascular physical examination was performed. Height and weight were recorded and body mass index (BMI) calculated. Resting systolic and diastolic blood pressures (BPs and BDPs) were recorded simultaneously with echocardiography via sphygmomanometry.
• A full echocardiographic assessment was performed. M-mode, and Doppler echocardiographic imaging, and carotid artery application tonometry were used to measure aortic flows and dimensions. Pulse-wave velocity (PWVv), input (Zi) and characteristic (Zc) impedance, arterial stiffness (Ep) and β-index were calculated. Total arterial compliance (TAC), mean (Wt) and total (Wt) hydraulic power, and efficiency (HE) were calculated from carotid pulse tracings and flows using standard fluid dynamics equations.

The calculation of these indexes is presented on the lower left panel and the technique in the lower right panel.

• Statistical analysis: Univariate analyses were performed on all continuous variables. Summary statistics are expressed as median (range). The statistical significance was determined using a Kruskal–Wallis ANOVA followed by Mann–Whitney U test. P values <0.05 were considered statistically significant. All statistical analyses were performed using SAS software version 9.1.3 (SAS Institute Inc., Cary, NC).

CONCLUSION
Children with post-operative TET, COA and TGA have stiffer aortas, increased work and higher total arterial compliance than CTRL. It is unclear if this is related to intrinsic lesions of the aorta, alterations of the aorta due to surgical repair or other factors. Further studies and follow-up are needed to determine if these abnormalities predispose these patients to long-term cardiac dysfunction and cardiovascular risk.