The effect of pressure afterload due to aortic coarctation on left ventricular function in children

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Akademisk avhandling

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Coarctation of the aorta (CoA) is a congenital heart disease which represents a narrowing of the proximal descending aorta, hence increasing pressure afterload to the left ventricle (LV). Conventional treatment of native CoA is surgical repair, however potential recurrence or other related complications e.g. aortic rupture, heart failure and cerebrovascular events are common. Thus, lifelong follow-up of these patients is required. Echocardiography is the most patient’s friendly method to evaluate CoA and in particular its effect on LV function. Moreover, the novel speckle tracking echocardiography (STE) is an important method to assess subclinical LV dysfunction, a technique that promises better evaluation of LV function in these patients.

The aims of this thesis were to review the literature on LV function in children with CoA using myocardial deformation imaging technologies, hence, to better understand the current knowledge and vagueness of the scientific evidence. We also aimed to study the effect of early CoA repair on the structure and function of LV and ascending aorta. In addition, we wished to establish in a meta-analysis format normal values of speckle tracking derived strain and strain rate values.

Methods:

Study 1. We have systematically searched the PubMed, and studies that fulfilled the inclusion criteria were critically analyzed and presented on a narrative form.

Study 2 and 3. In addition to conventional echocardiographic measures of LV and ascending aorta, we measured longitudinal strain and strain rate of the LV using a vendor independent software, TomTec. We have also measured the Aorto-Septal angle (AoSA). Data was compared with normal healthy controls.

Study 4. Electronic databases were systematically searched and suitable studies were meta analyzed using Comprehensive meta-analysis version 3 software.

Results:

Study 1. In 7/4945 included articles, 123 and 76 patients with congenital aortic stenosis (CAS) and CoA were reported, respectively. Normal conventional LV function, with subclinical myocardial dysfunction were reported in all studies before intervention. After intervention, a consistent improvement of myocardial deformation parameters was documented, even though not reaching normal values.

Study 2. In 21 patients with CoA, LV function significantly improved after intervention (p <0.001), however normal values were not reached even at medium-term follow-up (p = 0.002). Medium-term longitudinal strain correlated with pre intervention LV ejection fraction (EF) (r = 0.58, p = 0.006). Medium-term subnormal values were more frequently associated with Bicuspid aortic valve (BAV) (33.3% vs. 66.6%; p <0.05).

Study 3. AoSA was abnormally wide before intervention, in particular at peak ejection in the descending aorta (p <0.0001), and correlated with CoA pressure gradient. After intervention, AoSA normalized and significantly correlated with the increase of LV cavity function and overall LV deformation parameters.

Study 4. In a meta-analysis of 28/282 studies including 192 subjects, strain and strain rate values were established. Longitudinal strain normal mean values varied from -12.9 to -26.5 (mean, -20.5; 95 % CI, -20.0 to -21.0). Normal mean values of circumferential strain varied from -10.5 to -27.0 (mean, -22.06; 95 % CI, -21.5 to -22.5). Radial strain normal mean values varied from 24.9 to 62.1 (mean, 45.4; 95 % CI, 43.0 to 47.8). Meta-regression showed LV end-diastolic diameter as a significant determinant of variation of longitudinal strain. Longitudinal systolic strain rate was significantly determined by age and radial strain was influenced by the type of vendor used.

Conclusion: The systematic review showed subclinical LV dysfunction in children with CoA before and after correction. However, since most of the patients were operated at an older age and had preserved LV EF, the effect of early intervention on LV function was only speculated. Our children with CoA who were operated at an earlier age showed LV subclinical dysfunction even at medium-term after intervention while the AoSA returned to normal shortly after intervention. Lower longitudinal strain values were found in patients with LV dysfunction (LV EF <50%) before intervention and BAV. Finally, normal range values for strain and strain rate have been established and seem to be influenced by patients’ age, LV end-diastolic diameter and vendor used.

Keywords:
Coarctation of the aorta, congenital aortic stenosis, left ventricle, myocardial deformation imaging, speckle tracking echocardiography, longitudinal strain, aorto-septal angle, children.