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Title: Tissue Doppler and speckle tracking strain echocardiography: from evaluation in healthy children to follow-up after surgery for a congenital heart defect
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General introduction
Background
In the past decades survival into adulthood of patients with a congenital heart defect (CHD) has increased.\(^1\) This increase in survival has shifted the focus of research in CHD patients from mortality to morbidity. Problems arising during long-term follow-up include arrhythmia, endocarditis and heart failure.\(^2\) A varying degree of impairment of ventricular performance, which may ultimately lead to heart failure, was observed in several subgroups of asymptomatic CHD patients long-term postoperatively.\(^3\)-\(^6\) Yet, when and why ventricular performance deteriorates is largely unidentified thus far. Impairment of ventricular performance may develop over time, as a consequence of residua, sequelae, and complications of the CHD itself or the surgical procedure. However, preoperative and perioperative factors may also induce impaired ventricular performance immediately after surgery,\(^6\) which may persist and/or worsen over time.

In previous studies, ventricular performance is described to decline immediately after surgery for a CHD if cardiopulmonary bypass is used.\(^7\),\(^8\) Furthermore, a few years postoperatively, cross-sectional studies in pediatric CHD patients have described a variable impairment of ventricular performance.\(^9\)-\(^12\) However, there is a paucity of longitudinal follow-up studies in CHD patients starting at surgery and continuing for a few years thereafter. Longitudinal follow-up studies could provide knowledge regarding the reversibility of the changes observed in ventricular performance immediately after surgery. If the impairment of ventricular performance persists during more long-term postoperative follow-up, this will further encourage careful follow-up of ventricular performance in CHD patients. Furthermore this may contribute to earlier start of therapeutic strategies.

Echocardiography is most often used to describe biventricular systolic and/or diastolic performance in CHD patients following surgery. Developments in echocardiographic techniques and introduction of new parameters, have boosted the ability of echocardiography to assess both regional and global ventricular performance.\(^13\),\(^14\) However, extensive study of the characteristics of newly introduced parameters in both healthy subjects and patients remains necessary before use of these techniques in clinical practice in children. Assessment of echocardiographic measurements in healthy children is important to augment the understanding of ventricular mechanics in children. Furthermore, knowledge of the characteristics of new measurements in healthy pediatric subjects, including their reproducibility and range of reference values, is important to allow correct interpretation of echocardiographic measurements in pediatric CHD patients.
Aim
The aim of this thesis was to assess changes in ventricular performance after surgery for a CHD. With echocardiographic assessment starting preoperatively and continuing to over one year after surgery, and using both tissue Doppler imaging (TDI) and speckle tracking strain imaging, a comprehensive insight of these changes will be provided. Furthermore, to improve correct interpretation of (our) findings in CHD patients, the characteristics of TDI and speckle tracking strain imaging derived parameters in healthy pediatric subjects were thoroughly assessed.

Outline thesis
Chapter 2 of this thesis reviews echocardiographic techniques currently applied in children and young adults to assess ventricular performance. Furthermore, studies using these echocardiographic techniques to assess ventricular performance after surgery for a CHD are described. In chapter 3.1 and 3.2 characteristics and reference values of several newly introduced echocardiographic parameters in healthy children are studied. Chapter 3.1 focuses on global peak strain and TDI peak velocity parameters in neonatal subjects. The significant changes in growth in the neonatal period may influence echocardiographic parameters, which renders evaluation in this period particularly interesting. Chapter 3.2 provides insight in characteristics and reference values of speckle tracking strain derived global peak strain parameters and parameters describing intraventricular time-differences in children aged 0 to 19 years.

Part 4 of this thesis (chapters 4.1-4.4) describes follow-up of ventricular performance after surgery for a CHD in several subgroups of CHD patients. Chapter 4.1 addresses follow-up of biventricular performance until hospital discharge in a mixed group of CHD patients undergoing surgery with cardiopulmonary bypass. In chapter 4.2 a prolonged echocardiographic follow-up of biventricular systolic performance, up to 20 months postoperatively, is assessed in patients with a ventricular septum defect undergoing correction. A similar follow-up duration is described in chapter 4.3 for a second subgroup of CHD patients undergoing surgical correction using cardiopulmonary bypass; patients with transposition of the great arteries undergoing an arterial switch operation. In these patients both left ventricular and right ventricular systolic and diastolic performance are assessed. Finally, chapter 4.4 describes changes in biventricular systolic and diastolic performance following correction of an aortic coarctation in two subgroups of coarctation patients. Subgroups included patients undergoing coarctectomy at younger than 1 month of age (neonatal) and at older than 1 month of age (nonneonatal).

Chapter 5 summarizes the main findings of our studies, discusses these in view of present literature and provides future perspectives. Finally, in chapter 6 a Dutch summary of our work is provided.
REFERENCES


