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Heart rate variability and pacemaker treatment in children with Fontan circulation

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Akademisk avhandling

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Title
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Abstract
Background: Fontan surgery is performed in children with univentricular heart defects. Arrhythmias are frequent complications, occasionally requiring pacemaker treatment. Previous data regarding indications and risk factors for pacemaker treatment in Fontan patients is limited and conflicting. Heart rate variability (HRV) reflects autonomous nervous activity controlling the sinus node and has been associated with tachyarrhythmias in both adults and children, as well as in adults with sinus node dysfunction (SND).

Aim: To study HRV, arrhythmia and pacemaker treatment in children with Fontan circulation— with the purpose of contributing to the reduction of long term complications in this patient group.

Methods: We have retrospectively reviewed pacemaker therapy in all Swedish patients who underwent Fontan surgery from 1982 to 2017 (n=599). We have also analysed HRV from 24-hour Holter ECG recordings in 112 children with Fontan circulation and in children with univentricular heart defects before bidirectional Glenn (BDG) procedure (n=47), before and on completion of Fontan surgery (n=47 and 45 respectively). Analysis was performed by power spectral analysis and Poincaré method, and results compared with healthy controls. Furthermore, HRV was analysed in Fontan patients who later required a pacemaker due to severe SND. Results were compared with Fontan patients who had SND, without indication for pacemaker treatment, with patients with Fontan circulation without SND and healthy controls. In addition we evaluated the possibility to analyse arrhythmias and HRV in 27 Fontan children using intermittent ECG recordings with a handheld devices at home during a 14-day period.

Results: After a mean follow-up of 12 years, 13% (78/599) of patients with Fontan circulation had received a pacemaker. Patients operated with the extracardiac conduit (EC) had a significantly lower prevalence of pacemaker implantation (6%) than patients with a lateral tunnel (LT) (17%). The most common pacemaker indication in patients with Fontan circulation was SND (64%). Children with Fontan circulation showed significant reductions in several HRV parameters, compared with controls. No significant differences were found between patients operated with LT versus EC (paper I). After BDG the RR interval and SD2 (representing changes in heart rate over 24-hours) significantly increased compared to pre-BDG. Compared with healthy controls, patients post-BDG, had significantly longer RR intervals and reduced overall HRV. PHF (reflecting parasympathetic control of the heart) was significantly reduced after TCPC as compared to before (paper II). Fontan patients with SND showed significantly elevated SD2 (representing changes in heart rate over 24-hours), somewhat reduced in patients that later required a pacemaker (Paper V). Handheld ECG analysis revealed frequent ventricular extra systoles in one patient and episodes of supraventricular tachycardia in another. Seven Fontan patients showed reduced HRV recorded with the handheld device over a 14-day period (paper III).

Conclusions: Overall HRV was reduced in patients with univentricular heart defects during the different surgical stages of Fontan surgery, compared to healthy controls. HRV was reduced in both patients with LT and EC with no significant difference between them. After BDG heart rate was significantly reduced as compared to before. PHF, reflecting the parasympathetic innervation of the heart was reduced after as compared to before TCPC. Pacemaker treatment is commonly needed in patients with Fontan circulation, and SND was the most prevalent indication for implantation. The prevalence of Fontan patients requiring pacemaker treatment was significantly lower in patients with EC. HRV analysis can contribute to management when following-up patients with Fontan circulation.

Keywords
Fontan circulation, sinus node dysfunction, heart rate variability

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