Impact of Closed Loop Stimulation System on the Physiological Heart Rate in Patients with Pacemakers in Daily Life

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Introduction: Chronotropic incompetence (CI) is one of serious issues for patients with cardiac implant devices and rate responsive pacemakers have been widely used. CI is commonly defined and diagnosed by the heart rate (HR) response to exercise such as peak exercise HR and HR reserve which is the difference between maximal predicted HR and resting HR. In their daily life, however, there is few conditions in which they have peak exercise HR and repeat exercise tests are not popular, so it is difficult to assess how the pacemakers optimize pacing rate of stimulation pulses. Closed Loop Stimulation (CLS) system developed by BIOTRONIK have the potential of the automatic optimization as physiological responses following monitoring changes of the intracardiac impedance compared to the conventional accelerometer sensor. The aim of this study is to evaluate the rate response function in sick sinus syndrome (SSS) patients with rate responsive pacemakers by comparing with non-SSS patients with pacemaker implantation as the control group in their daily life.

Methods: We investigated the HR histograms of the patients with pacemakers for atrioventricular block as control group, and analyzed the differences of daily HR variation between SSS patients with CLS-pacemakers (CLS group) and accelerometer sensor responsive pacemakers made by Medtronic (Med-R group) compared to control group retrospectively. The lower rate and upper rate setting were 60 and 130 in all patients, respectively. The patients with any tachycardia episodes were excluded from this study.

Result: One hundred and six in control group, 35 in CLS group and 52 in Med-R group were enrolled. Of control group, 28 patients had the low percentage of atrial sensing (%As<70%) were excluded, and 6 and 4 patients had the low percentage of atrial pacing (%Ap<70%) were also excluded of CLS group and Med-R group, respectively. Finally, we analyzed 29 in CLS group and 48 in Med-R group compared with 78 in control group. There were no significant differences in average age (75.3±8.3 vs. 79.0±9.0 vs. 78.0±6.5), male ratio (44.3% vs. 41.0% vs. 55.6%) and the average duration of physical activity (4.0±1.9hr/day vs. 3.2±1.4hr/day vs. 4.3±1.8hr/day) among control, CLS and Med-R group, respectively. Although average HR of both CLS and Med-R group did not reach that of control group, Med-R group had much lower average HR (control:74.9±3.6 min-1, CLS: 72.0±3.1 min-1, Med-R: 64.9±1.2 min-1). In addition, the difference in the average HR for the control group was significantly different between 2 groups (control-CLS:2.9 min-1 vs. control-Med-R:10.0 min-1 , p<0.001). Interestingly, the variance of the average HR of Med-R group ($\sigma^2=2.99$) tended to converge, while that of CLS group ($\sigma^2=16.37$) were likely to same as control group ($\sigma^2=22.51$).
Conclusion: CLS system had the possibility of more physiological HR response in each patient.