Abstract

Introduction: The beginning of cardiac stimulation in the last century, changed the natural history of bradiarrhythmias as sinus node disease and advanced atrio-ventricular block, making available single chamber and, later, dual chamber stimulation. Furthermore, with the implementation of fairly physiological sensors, there was the attempt of reproducing the natural heart rate variability. In contrast to accelerometric or ventilation sensors, CLS (ClosedLoopStimulation) represents a new concept of integration in the patient’s circulatory system, able to convert the sympathetic tone into an appropriate chronotropic response. CLS was conceived to respond to variations of right ventricle impedance during systole; right ventricle impedance, indeed, seems to be closely related to myocardial contractility, which in turn is modified by autonomic system, changing in consequence of patient’s metabolic needs. However, CLS has never been applied to AAI mode in clinical experiences, nor it has been compared to AAIR pacing based on conventional sensors. The aim of this experience was to evaluate, in patient implanted with a PM with a single lead in atrium (AAI patients), the appropriate behavior of CLS respect to AAIR pacing mode, mainly in terms of heart rate adaptation during autonomic tests.

Methods: Starting from our records of patients implanted with AAIR pacemakers for sinus node disease, according to a protocol described elsewhere, we selected five patients with a pacemaker provided of CLS algorithm (BiotronikCylos™ or Entovis™). The patients, four males and a female, with mean age 71.4 years, underwent a functional non-invasive test including evaluation of heart rate, arterial pressure and stroke volume during a set of autonomic tests both with the pacemaker programmed in AAIR mode and in CLS mode. The autonomic tests consisted of three stages of 2 minutes each, with a 1-minute recovery period between stages, at the beginning and at the end: mental stress, handgrip (patient sitting) and postural changes. Data were obtained by means of a Nexfin HD monitor (BMEYE, Amsterdam, The Netherlands) and were later analyzed through a proprietary software. Only two patients resulted to be completely dependent on pace-maker rhythm throughout evaluation, without any sinus interference; therefore the results refer to these two patients.

Results: In both patient, a smooth and gradual increase of heart rate during physical and mental stress was observed with the pacemaker programmed in CLS mode and the same graduation was observed in the heart rate recovery phase (Fig 1 and Fig 2); on the contrary, physical activity just produced rapid and non appropriate changes of heart rate in AAIR mode, whereas no significant heart rate variation was observed during mental stress and handgrip.

Discussion: Several studies compared ClosedLoop Stimulation to rate responsive ventricular or dual chamber stimulation based on conventional sensors. In the PROVIDE study it was observed that arithmetic test performed in CLS mode was associated with a significantly higher heart rate when compared to rate response based on accelerometer, whereas no difference was found during the 6 minute walk test between the two stimulation modalities. In patients with chronotropic incompetent atrial fibrillation, it was found that CLS is effective in adapting heart rate to mental stress. However, CLS has always been applied to VVI and DDD modes, since the right ventricular chamber contractility has been used as a sensor for the CLS system. At our knowledge, this experience is the first one applying the CLS to AAI stimulation in the clinical practice. In contrast to the current opinion considering atrial chambers just as inactive reservoirs, assigned to the collection of venous blood, they seem to carry out an active function, as powerful aspirators producing the venous blood return during the diastolic phase of cardiac cycle; the presence of valves in the venous system makes the flow continuous. Atrial wall stretch represents an active movement, probably directly or indirectly controlled by sympathetic tone, and for these reasonable to evoke the response of CLS system.

Conclusions: In patients who underwent a functional poliparametric evaluation by the Nexfin HD system, the AAI CLS mode produced a fairly physiological response of heart rate to physical and mental stress, whereas AAIR mode based on accelerometer obtained just a rough heart rate increase during non isometric physical activity.