EXCLUSION OF ADVERSE HEMODYNAMIC PROGRAMMING IN CARDIAC RESYNCHRONIZATION THERAPY

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Abstract: Decrease of non-responder rate is the main challenge in cardiac resynchronization therapy. The problem could be solved, partly, in the follow-up by consequent individualization of hemodynamic pacing parameters. The esophageal electrogram feature of the Biotronik ICS 3000 programmer was used in the follow-up of 20 heart failure patients carrying implants for cardiac resynchronization therapy. Adverse hemodynamic programming of the sensed and paced AV delay could be easily observed and replaced by the individual optimal duration in 3 patients (15%) VDD and DDD operation. This result proves the value of esophageal electrogram recording CRT follow-up.

Keywords: heart failure, cardiac resynchronization, AV delay individualization

Introduction

Patients with chronic heart failure and left ventricular dysfunction can be treated with implantable biventricular pacing systems mostly in combination with automatic defibrillation. Unfortunately, leaving pacing parameters in empirical or factory settings, up to 30% of the patients although fulfilling guideline criterias for this therapy result in non-responders /1/. Responder rate in cardiac resynchronization therapy (CRT) of heart failure patients with sinus rhythm or atrial fibrillation could be increased by accurate selection, optimal position of the left ventricular electrode and individualization of the hemodynamic pacing parameters during follow-up /2/. AV delay is the most important parameter influencing the patients hemodynamic. It can be individualized by time-consuming echocardiographic measurements. In contrast, an esophageal electrogram offers a new approach to individualize AV delay and to exclude hemodynamic adverse programming of the AV delay. This method requires less equipment and can be performed quickly and easily.

Aims

To establish a new method in order to detect and to prevent hemodynamic adverse programming of the AV delay in CRT patients.

Methods

Based on results of our previously reported investigations /3/, esophageal left atrial electrogram (LAE) feature was implemented into the standard ICS3000 programmer (Biotronik, Berlin, Germany). Thus, the LAE can be recorded and measured simultaneously with 3 channel surface ECG. By perorally applying a TOslim electrode (Osypka AG, Rheinfelden-Herten, Germany) in 20 patients (5 females, 15 males, mean age 69±10 years old) carrying CRT systems of different companies, this feature was utilized to quantify implant-related interatrial conduction intervals (IACT) in VDD and DDD operation. The latter were determined by measuring the duration LA-Vp between onset of left atrial deflection (LA) in the esophageal left atrial electrogram and the ventricular stimulus (Vp) and calculating \( IACT = AVD - LA-Vp \). The optimal AV delay (SAV in VDD, PAV in DDD operation) is the sum of independent determinants separated by the left atrial deflection. It consists of the intraoperatively fixed implant-related interatrial conduction interval (As-LA in VDD, Ap-LA in DDD operation) that can not be changed by programming and an individually optimized duration of the LA-Vp interval (figures 1 and 2). Measuring in CRT patients As-LA and Ap-LA, individually, in previous studies by echo have shown that optimal LA-Vp can be approximated by mean value of 50ms. Thus, optimal AV delay for VDD and DDD pacing can be calculated using the formula: \( AVD = IACT + 50ms /4/ \).

Figure 1: Definition of the optimal sensed AV delay (SAV) as the sum of interatrial conduction interval As-LA and the individually optimized electromechanical interval LA-Vp.
Generally, in order to prevent truncation of the atrial activity and to enable an atrial kick to the left ventricular filling, the duration of the optimal AV delay must have always longer duration than As-LA and Ap-LA, respectively. Based on that, the presence of a hemodynamic adverse programming of the AV delay characterized by truncation of the left atrial action was defined by: $\text{SAV} \leq \text{As-LA}$ in VDD and $\text{PAV} \leq \text{Ap-LA}$ in DDD operation.

Figure 2: Definition of the optimal paced AV delay (PAV) as the sum of interatrial conduction time Ap-LA and the individually optimized electromechanical interval LA-Vp.

Results

Transesophageal measurements of the IACTs in the 20 CRT patients in sinus rhythm with SAV and PAV in factory settings resulted in As-LA of $30\pm26$ ms and Ap-LA of $97\pm33$ ms, at mean. In VDD and DDD operation, As-LA and Ap-LA exceeded SAV and PAV, respectively, in 3 patients (15%). In these patients, the “negative” duration of LA-Vp of $-21\pm7$ ms in VDD and $-27\pm11$ ms in DDD operation characterized a hemodynamic adverse programming of the AV delays (figures 3 and 4). In all of these patients, AV delays in both modes were individualized using the formula:

$$\text{optimal AVD} = \text{actual AVD} + 50\text{ms} - \text{actual LA-Vp}$$

Figure 3: Example of hemodynamic adverse programming of SAV by “negative” LA-Vp interval of -18 ms in VDD operation in CRT patient using the Biotronik ICS3000 programmers left heart electrogram feature.

Figure 4: Example of hemodynamic adverse programming of PAV by measuring “negative” LA-Vp interval of -28 ms in DDD operation in the same CRT patient as figure 3 using the Biotronik ICS3000 programmers left heart electrogram feature.

Conclusions

Our results demonstrate the importance of AV delay optimization in cardiac resynchronization therapy. It shows that adverse hemodynamical programming can be expected in a certain percentage of CRT patients if the AV delay in VDD and DDD operation is left in factory settings. Esophageal electrogram can easily solve this problem. This approach enables information about the position of left atrial deflection in relation to the ventricular stimulus. Truncation of the atrial contribution to the ventricular filling resulting in hemodynamic disadvantages can be consequently excluded if the ventricular stimulation will be delivered after the left atrial deflection has finished. For this purpose, the study proves the value of esophageal electrogram recording CRT follow-up.

Bibliography


