The ventricular evoked response for monitoring the cardiac state

**Purpose:** The determination of hemodynamically relevant information from intracardiac signals of modern pacemakers or ICDs offers the possibility to monitor the progression of cardiac diseases and the success of therapeutic measures, especially if combined with telemedicine capabilities. The ventricular evoked response (VER) - the unipolar recording of the ventricular excitation wave induced by an effective stimulation pulse - is one of the intracardiac signals potentially suited for hemodynamic monitoring. The aim of this study was to identify correlations between parameters of the VER and echocardiographic parameters such as the left ventricular end-diastolic diameter (LVEDD), the stroke volume (SV), and the left ventricular posterior wall thickness (LVPWT).

**Methods:** Nine patients with a mean age of 70 years were implanted with a dual chamber pacemaker capable of recording and transmitting broadband, high-resolution intracardiac electrograms (Logos, BIOTRONIK, Berlin, Germany). Pacemaker indication was sick sinus syndrome in 6 and AV-block in 3 patients. Hemodynamic changes were induced by increasing the pacing rate (80, 100, 120, 140 ppm). The VER was continuously recorded using custom-made software and analysed with the program MATLAB (The Math Works). Echocardiographic parameters were determined for each pacing rate.

**Results:** Mean LVEDD decreased with increasing pacing rate (57.4±12 mm at 80 ppm vs. 49.4±9 mm at 140 ppm; p<0.01, Wilcoxon test), whereas the mean amplitude of the VER’s R-wave increased significantly from 13.5±4.1 mV at 80 ppm to 16.1±5.3 mV at 140 ppm (p<0.01). There was a significant correlation between LVEDD and the R-wave amplitude (r=0.56; p<0.01). No correlation was found between VER parameters and SV or LVPWT.

**Conclusions:** VER R-amplitude reduction correlates with an increase in the LVEDD. It is assumed that with the LVEDD enlargement, the distance between the myocytes contributing to the summed VER potential and the recording electrode increases, thus reducing the R-wave amplitude. Repetitive VER recordings to determine the R-wave amplitude in pacemaker or ICD patients would thereby allow monitoring of the pro- and regression of the left ventricular size, e.g. as a sign of reverse-remodelling owing to cardiac resynchronisation therapy.

**Transvenous lead extraction from coronary sinus and cardiac veins**

**Purpose:** The transvenous techniques for the removal of chronically implanted pacing and defibrillating leads transvenous removal pacing (PL) and Defibrillating Leads (DL) have achieved an high success rate with low complication rate. However, the procedures are often complex and are associated with a small but significant risk. The experience of the operators and the availability of different approaches for difficult cases seems to affect both results and complications.

**Materials and methods:** Since January 1997, we managed 787 patients (592 men, mean age 65.0 years, range 6-95) with 1330 leads (mean pacing period 68 months, range 1-336). 1192 were PL and 138 were DL. 828 were ventricular leads, 465 were atrial leads and 12 Superior Vena Cava leads and 25 coronary sinus leads). The indications to removal were: 34.22% class I (455 leads), 65.78% class II (875 leads). We performed mechanical dilation using the Cook Vascular extraction kit and other intravascular tools, if necessary (Catchers and Lassos, Osypka). In case of free-floating leads or when the removal through the implant vein was not possible (difficult exposed leads), we use a personal technique developed using a new approach through the internal jugular vein (Jugular Approach-IA).

**Results:** Removal was attempted in 1330 leads; among these 1136 was successfully extracted with the standard mechanical approach (success rate 85.4%). In 12 leads was performed a partial extraction (0.9%) and 9 was unextracted (0.67%). In 1 case (0.07%) the transvenous mechanical extraction technique was inapplicable. The IA was performed in 180 leads (164 PL and 16 DL). Among these 39 were intravascular free-floating leads (38PL and 1 DL) and 141 were difficult exposed leads (126 PL and 15 DL) allowing the removal of 178/180 (98.8%). After this approach final results were: total extraction 98.35%, partial extraction 0.90% and unextracted 0.69%, not applicable 0.07%. Major complications in the overall experience occurred in 4 cases (0.3%)