CLINICAL STUDY

Cardiac resynchronization therapy Midterm follow-up of 128 patients

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Abstract

Objective: **Cardiac resynchronization therapy has been used in the treatment of advanced heart failure with inter- and intraventricular dyssynchrony for more than ten years.**
Aim of the study: **A retrospective study was conducted to assess midterm results of biventricular (BiV) pacing in cardiac resynchronization therapy.**
Methods: **128 consecutive patients (age 61.0±9.6, 98 males), with heart failure NYHA class 2.9±0.4 (2.5–3.5), with LBBB, QRS≥130 ms, with dilated cardiomyopathy – DCM (86), with coronary artery disease – CAD (36), with both these etiologies (4) and with valvular disease (2) had a BiV PM (82) or BiV ICD (46) implanted in 2000–2007. AV delay was optimized individually, using echocardiography. Before and 3 months after implantation, the following was established: NYHA class, LVEF (echocardiographically), maximum oxygen uptake (spiroergometrically), left ventricle diastolic diameter and mitral regurgitation. The average follow-up time was 25.8±20.8 months. Complications and 2-year survival (n=68) were also assessed.**
Results: **1) After 3 months of BiV pacing, NYHA class improved from 2.9±0.4 to 2.4±0.6 (n=99, p<0.001), LVEF increased from 20.2±4.9 to 23.9±6.6 % (n=92, p<0.001). Left ventricle diastolic diameter decreased from 69.8±8 to 67.5±10.0 mm (n=88, p=0.001) and mitral regurgitation was reduced from 2.2±0.9 to 1.9±0.9 (n=87, p=0.001) and maximum oxygen uptake during spiroergometry increased from 14.5±2.7 to 15.5±2.6 ml/min/kg (n=52, p=0.005). 2) Coronary sinus lead reposition was done in 2.3 %, epicardial lead implantation in 4.7 %, atrial lead reposition in 2.3 %, and right ventricular lead reposition in 2.3 % of patients. Contralateral reimplantation due to inflammatory complications in 1.6 % of patients. 3) Heart transplantation was performed on 9 patients. 4) Two-year survival was recorded in 77.9 % of 68 followed patients (72.2 % in CAD, 79.6 % in DCM).**
Conclusion: **In the retrospective study of patients with BiV pacing a decline in heart failure, an increase in cardiac pump efficiency, reverse remodelling of left ventricle and acceptable occurrence of complications were confirmed *(Tab. 4, Fig. 7, Ref. 18)*. Full Text (Free, PDF) www.bmj.sk**
Key words: cardiac resynchronization therapy, biventricular pacing, heart failure.

Abbreviations: AF – atrial fibrillation, AVD – atrioventricular delay, BiV – biventricular, CAD – coronary artery disease, ICD – implantable cardioverter-defibrillator, LBBB – left bundle branch block, LV – left ventricle, LV Dd – left ventricular diastolic diameter , LV EF – ejection fraction of left ventricle, MR – mitral regurgitation, NYHA – New York Heart Association classification, PM – pacemaker, PM DDD – dual chamber pacemaker, SR – sinus rhythm.

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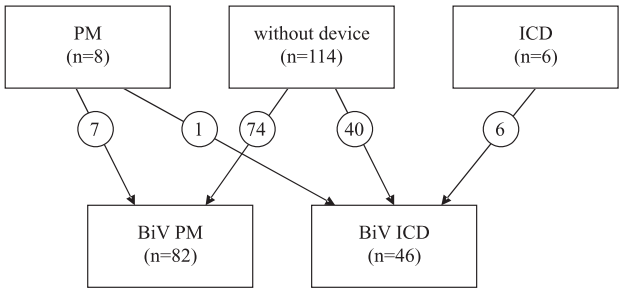

Fig. 1. BiV PM or BiV ICD 1st implantation and PM or ICD upgrade to BiV PM or BiV ICD (n=128).

In the evaluation of the results of biventricular pacing, randomized prospective multi-centre comparative studies are of fundamental significance, which was proved by both subjective and objective improvements in patients' condition (1–5).

The aim of the present study was to evaluate, in a group of consecutive patients with biventricular pacemakers (BiV PM) or biventricular implantable cardioverter-defibrillators (BiV ICD) implanted in our clinic, the technique and success rate of implantations, complications leading to reoperations, to assess both the subjective and the objective state of patients, their prognosis and two year survival.

Methods

Patients

The group consisted of 128 consecutive patients (96 men and 32 women, average age 61.0±9.6, ranging from 24–81 years) who in the period between Sept 1, 2000 and May 1, 2007 had a BiV PM (n=82) or BiV ICD (n=46) implanted at our clinic, with biventricular pacing being applied. They all suffered from chronic heart failure, NYHA functional class average value was 2.9±0.4 (2.5–3.5) in spite of intensive pharmacological therapy (ACE inhibitors, diuretics, spironolactone, digoxine, and beta-blockers). At the time of implantation, 106 patients exhibited sinus rhythm while 22 patients exhibited atrial fibrillation. Left bundle branch block (QRS complex width ≥130 ms) was present in all of them. Aetiologically this was a case of dilated cardiomyopathy (DCM) in 86 patients, coronary artery disease (CAD) in 36 patients (70 % angiographically proved stenosis of a least one large coronary artery or documented myocardial infarction), a combination of the two diseases in 4 patients, and valvular disease in 2 patients. Prior to implantation, the echocardiographically established LV EF was 20.2±4.9 (ranging from 8–39) %, left ventricle diastolic diameter (LV Dd) 69.8±9.8 (ranging from 50–99) mm and mitral regurgitation (MR) 2.29±0.9 (ranging from 0–4). The spiroergometrically established maximum oxygen uptake was 14.5±2.7 (ranging from 6.7–22.8) ml/min/kg.

BiV ICD implantation was applied in 46 patients (Fig. 1). All of them satisfied the currently valid guidelines of the Czech Society of Cardiology for ICD indication. Ventricular fibrillation and/or ventricular tachycardia were documented in 20 patients, while syncope and induced malignant tachyarrhythmia were proved in 10 patients. Runs of non-sustained ventricular tachycardia and induced malignant tachyarrhythmia during programmed ventricular pacing or in sense of Madit II Study indicated ICD in 16 patients.

In the first stage we were concerned with perfecting the technique of positioning the lead in coronary sinus and with programming individually the atriventricular delay (AVD). In the second stage devices with programmable interventricular (V–V) interval were implanted. We focused on establishing optimum V–V intervals (possibly together with AV delay) and assessing their effect on the patient's hemodynamics.

Implantation techniques

First implantation of BiV PM or BiV ICD was performed in 114 patients. To introduce the right ventricular pacing or defibrillation lead the Seldinger puncture technique was used in 104 patients while in 10 patients the lead was introduced subsequent to cephalic vein preparation. The atrial lead was always (n=106) introduced via puncture. Simultaneously, we introduced via punc-

Tab. 1. BiV PM or BiV ICD in patients with sinus rhythm (n=106).

Model	BiV PM/ICD	Manufacturer	Number
Contak TR, Contak Renewal TR	PM	Guidant	24
CRT 8000	PM	Vitatron	12
Frontier, Frontier II	PM	St. Jude Med.	7
InSync III	PM	Medtronic	5
Stratos LV, LV-T	PM	Biotronik	18
Atlas + HF, Epic HF	ICD	St. Jude Med.	15
Epic HF, Epic + HF, Epic H+	ICD	St. Jude Med.	10
Contak Renewal	ICD	Guidant	9
InSync ICD, InSync Marquis	ICD	Medtronic	4
Kronos LV-T	ICD	Biotronik	1
Lumax 340 HF-T	ICD	Biotronik	1

BiV – biventricular, PM – pacemaker, ICD – implantable cardioverter-defibrillator

Tab. 2. PM DDD(R) and BiV PM and BiV ICD in patients with atrial fibrilation (n=22).

Model	PM/ICD	Manufacturer	Number
Kairos D*	PM DDD	Biotronik	1
Axios DR*	PM DDDR	Biotronik	2
Philos DR*	PM DDDR	Biotronik	1
Kappa 701*	PM DDDR	Medtronic	1
Insignia Entra DR*	PM DDDR	Guidant	2
Meridian DR*	PM DDDR	Guidant	4
Contak TR**	PM BiV	Guidant	3
Contak Renewal TR 2 CRT-P**	PM BiV	Guidant	1
Frontier II**	PM BiV	St. Jude Med.	1
Atlas + HF**	ICD BiV	St. Jude Med.	3
Epic HF**	ICD BiV	St. Jude Med.	1
Kronos LV-T**	ICD BiV	Biotronik	1
Contak Renewal 4RF**	ICD BiV	Guidant	1

* – left ventricle lead inserted into atrial portion and right ventricle lead into ventricular portion of PM connector, ** – BiV PM or BiV ICD were implanted in patients with persistent atrial fibrillation and expected return of sinus rhythm after cardioversion, BiV – biventricular, PM – pacemaker, ICD – implantable cardioverter-defibrillator

Tab. 3. Coronary sinus and epicardial leads for left ventricle pacing (n=128).

Model	Manufacturer	Polarity	Number
Attain OTW	Medtronic	UP	31
Easytrak	Guidant	UP	19
Easytrak 2 a 3	Guidant	BP	18
QuickSite	St. Jude Med.	UP	13
QuickSite	St. Jude Med.	BP	25
LV 32	Vitatron	UP	7
Corox OTW	Biotronik	UP	7
Corox LV-H 75-BP	Biotronik	BP	1
CapSure Epi*	Medotronic	BP	7

UP – unipolar lead, BP – bipolar lead, * – epicardial lead

ture the introducer for left ventricular lead into the right atrium. Using a special performed introducing cannula and X-ray control we introduced a quadrupolar steerable 5F or 6F electrophysiological catheter into coronary sinus (most frequently a Medtronic catheter, less frequently a Cordis catheter) as the introducer. Its suitable position was confirmed by intracardial electrogram (signals from both atrium and ventricle) and X-ray examination (left and right oblique projections). Subsequently we moved the introducing cannula from the superior vena cava or the upper right atrium into coronary sinus via an electrophysiological catheter. The branches of coronary sinus were sprayed with a contrast substance (lomeron) and camera-recorded. The left ventricular lead was positioned in the lateral, posterolateral or anterolateral coronary sinus branch using the over-the-wire system (leads by Guidant Easytrak, Medtronic Attain OTW, St. Jude Medical Quicksite, Biotronik Corox OTW and Corox LV-H or Vitatron LV32) or the lead was introduced thoracotomically by the surgeon (Medtronic Capsure Epi). For details see Table 4. The suitability of the position was checked by measuring the pacing parameters (voltage pacing threshold, R-wave amplitude, and pacing circuit impedance) and by excluding diaphragma contractions. Using the earlier positioned introducers we inserted cannulae into the superior vena cava and through them we introduced the pacing leads (always with active fixation) into the right ventricle and the right atrium and then measured their pacing parameters. The intervention was completed by pulling out the introducing cannulae (great care and much experience are recquired to remove the cannula from coronary sinus) and by measuring the pacing parameters at the three leads again, connecting the generator, and creating and closing the pocket.

Leads, biventricular pacemakers and cardioverter-defribrillators

All atrial and right ventricular leads were bipolar, with active fixation. Unipolar lead to coronary sinus was used 74 times, bipolar lead 47 times, and epimyocardial bipolar leads 7 times.

In 114 patients it was a case of first implantation (74 times BiV PM and 40 times BiV ICD).

In 14 patients the earlier applied implant was “upgraded” (biventricular PM was concerned 8 times: the original PM VVIR was upgraded in 5 cases, the original PM VDD in 1 case, the

original PM DDD in 2 cases). In 6 cases the implantation of biventricular ICD was concerned: there was 1 upgrade from PM VVI, 1 upgrade from PM DDD, 3 upgrades from single-chamber ICD to BiV ICD, and 1 upgrade from dual-chamber ICD to BiV ICD (Fig. 1).

In patients with sinus rhythm (n=106) we introduced the atrial lead into the right atrium, the right ventricular lead into the right ventricle apex, the left ventricular lead into coronary sinus, and we connected the biventricular pacemaker or ICD (for PM and ICD models and manufacturers see Table 1).

In patients with chronic atrial fibrillation (n=17) the right ventricular and the left ventricular leads were implanted. In 11 patients the DDD(R) PM was used. The left ventricular lead was connected to the atrial portion of the connector while the right ventricular lead was connected to the ventricular portion of the connector of PM with the possibility of programming a short atrioventricular delay. In 6 patients the biventricular device (4x PM, 2x ICD) without atrial lead was implanted. In 5 patients with persistent atrial fibrillation and expected return of sinus rhythm after cardioversion we implanted BiV PM (once) or BiV ICD (4 times), including the atrial lead (Tab. 2).

In 46 patients the implantation of biventricular defibrillator was indicated according to the guidelines of the Czech Society of Cardiology. In these patients, we introduced the defibrillation lead into the right ventricle and, following a standard verification of its suitability we connected the BiV ICD.

We did not succeed in introducing the lead into coronary sinus in six (4.7 %) patients, which corresponds to the results reported in similar papers (6). Because of unfavorauble anatomic conditions in coronary sinus (2 cases) or perforation of coronary sinus (4 cases) epicardial lead was implanted thoracotomically and pulled into the subclavicular region and then introduced into the pacemaker or ICD connector (in the Centre for Cardiovascular and Transplant Surgery in Brno). These perforations occurred in the group of the first fifty patients.

In one patient with clear indication of resynchronization therapy and, simultaneously, surgical revascularization, the epimyocardial lead was sewn above the left ventricle during the operation for aorto-coronary bypass. The BiV pacing system was introduced as a later step. An overview of the leads used in coronary sinus and epicardial leads is given in Table 3.

Methods

Prior to implantation the degree of heart failure was determined (according to the NYHA functional classification), the left ventricle ejection fraction (LV EF), the left ventricle diastolic diameter (LV Dd) and the degree of mitral regurgitation (MR) echocardiographically, and performed spiroergometric examination and right-sided heart cathetrization. In addition to standard measurements, we recorded the position and pacing parameters of the left ventricle during implantation.

During implantation the AV delay was programmed in all patients to 130 ms at sequential pacing and 100 ms at P-wave triggered ventricular pacing.

V-V delay (if enabled by the PM or ICD model) was programmed to 0 ms or to the nominal value, and to 10 or 15 ms if dual-chamber PM was used (left ventricle lead was connected to the atrial portion and stimulated earlier). Additional optimization of AV and V–V delay was conducted during hospitalization, using the echocardiographic methods we have developed and published (7, 8).

Three months after implantation the same examinations as before the implantation of PM or ICD were performed in cooperating patients. During the whole follow-up any complications (in particular those leading to reoperation) were analysed and two-year survival or death was reported and causes were examined.

Results

The average pacing threshold of LV leads introduced into the branches of coronary sinus during implantation was 1.2±0.7 V at 0.5 ms pulse width (ranging from 0.3 V at 0.4 ms – 2.8 V at

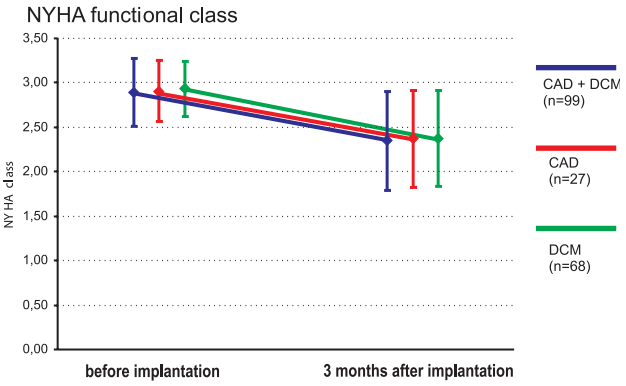

Fig. 2. NYHA functional class before and 3 months after BiV PM/ICD implantation (n=99). CAD – coronary artery disease, DCM – dilated cardiomyopathy (4 patients with CAD and DCM co-incidence was included in the CAD+DCM group only).

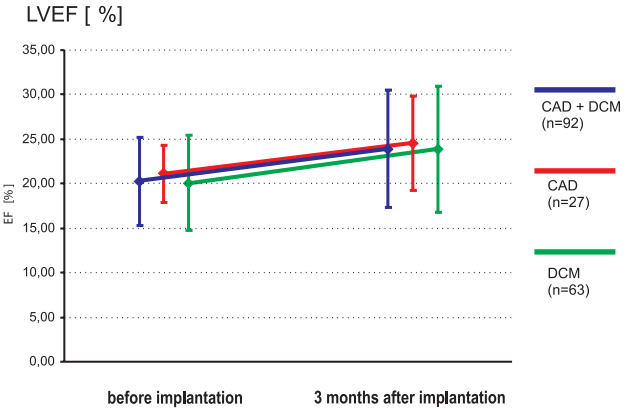

Fig. 3. Left ventricle ejection fraction before and 3 months after BiV PM/ICD implantation (n=92). CAD – coronary artery disease, DCM – dilated cardiomyopathy (2 patients with CAD and DCM co-incidence was included in the CAD+DCM group only).

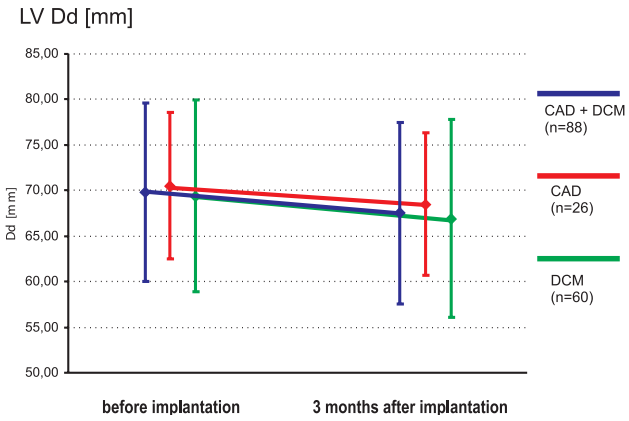

Fig. 4. Left ventricle diastolic diameter (LV Dd) assessed by echocardiography before and 3 months after BiV PM/ICD implantation (n=88). CAD – coronary artery disease, DCM – dilated cardiomyopathy (2 patients with CAD and DCM co-incidence was included in the CAD+DCM group only).

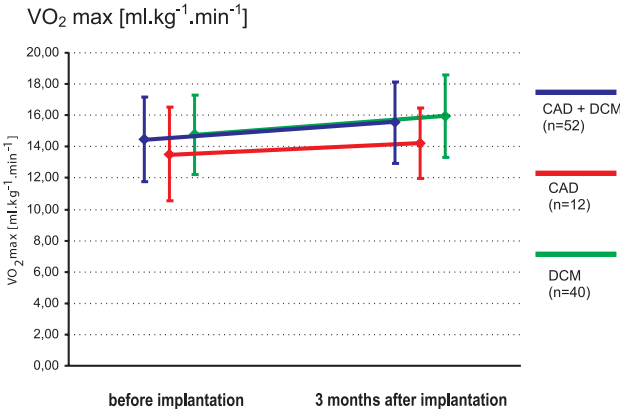

Fig. 6. Maximum oxygen uptake (VO_2 max) assessed by spiroergometry before and 3 months after BiV PM/ICD implantation (n=52). CAD – coronary artery disease, DCM – dilated cardiomyopathy.

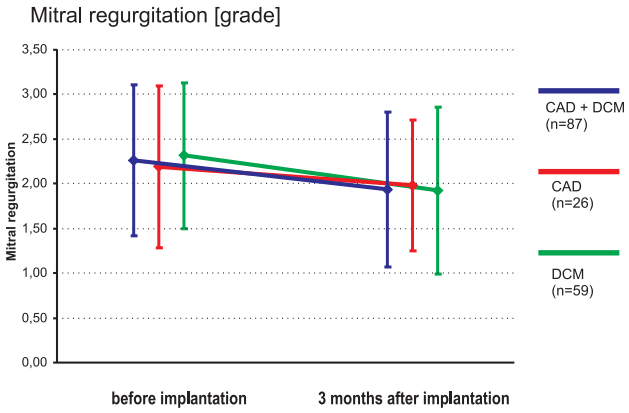

Fig. 5. Mitral regurgitation (MR) assessed by echocardiography before and 3 months after BiV PM/ICD implantation (n=87). CAD – coronary artery disease, DCM – dilated cardiomyopathy (2 patients with CAD and DCM co-incidence was included in the CAD+DCM group only).

1.0 ms). Exceptionally we had to accept a high acute pacing threshold of 2.8 V at 1.0 ms. The average R wave amplitude was 17.8±9.8 (ranged 1.5–54.5) mV.

The repositioning of LV lead in coronary sinus had to be performed due to lead dislocation in 2 patients and diaphragma contractions in one patient. The repositioning of atrial leads was necessary in 3 cases and the RV lead had to be repositioned in 3 patients. Epicardial lead implantation was performed in 7 patients.

Because of local inflammatory changes that could not be suppressed by antibiotics, contralateral reimplantation of the whole system, inclusive the three leads, was necessary in 2 patients.

Three months after the implantation, heart failure according to the NYHA functional classification (n=99) was on average assessed to be in the class 2.4±0.6 (1.0–4.0), in contrast to the input values 2.9±0.4 (ranged 2.5–3.5): p<0.001 (Fig. 2). LV EF after three months (n=92) amounted to 23.9±6.6 (ranged 10–45), in contrast to 20.2±4.9 (ranging from 8–39) %: p<0.001 (Fig. 3). Left ventricle diastolic diameter (n=88) decreased from 69.8±9.8 (ranging from 50–99) to 67.6±10.0 (ranging from 48–102) mm: p=0.001 (Fig. 4) and mitral regurgitation (n=87) decreased from 2.2±0.9 to 1.9±0.9 (ranging from 0–4): p=0.001 (Fig. 5).

Spiroergometrically established maximum oxygen uptake related to kilogram of mass (n=52) was 15.5±2.6 (ranging from 9.5–21.2) ml/min/kg, compared to the input values 14.5±2.7 (ranging from 6.7–22.8) ml/min/kg: p=0.005 (Fig. 6). Three months after implantation, the average cardiac index CI (n=63) was 2.1±0.4 (ranging from 1.4–3.2) l/m^2, in contrast to the input values 2.1±0.5 (ranging from 1.2–3.3) l/m^2 it did not change: p=0.39 : p=NS.

Three months after implantation, the average pacing threshold on the LV lead (n=128) exhibited favourable values, they increased from 1.2±0.7 to 1.6±1.0 (ranging from 0.2–5.0) V at 0.5 ms.

In ten patients with BiV ICD (n=46) ventricular tachyarrhythmias were detected during follow-up. The problem was solved by antitachycardia pacing and discharges in eight patients, in two patients by discharges alone.

After the introduction of biventricular pacing, pharmacotherapy remained roughly the same. More frequent application was recorded for digoxine (68.1 against 60.9 %, p=0.24, NS), beta-blockers (94.1 against 88.3 %, p=0.11), diuretics (98.3 against 95.3 %, p=0.18, NS), potassium saving diuretics (85.5 against 75.0 %, p=0.03), ACE inhibitors and/or sartans (97.5 against 95.3, p=0.36, NS) and amiodarone (47.9 against 28.9 %, p=0.002) (Tab. 4).

Heart transplant was indicated and realized in nine patients, 14.1±6.9 (6–24) months after implantation, specifically 6, 8, 10, 10, 10, 17, 20, 23, and 24 months after PM implantation.

Tab. 4. Pharmacotherapy before and 3 months after BiV PM or BiV ICD implantation.

	I	II	Statistical significance
Digoxine	78	81	NS
ACEI/sartans/both together	100/21/1	98/18/0	NS
Carvedilol/another beta-blocker	83/30	81/31	NS
Furosemide/other diuretics/both	111/10/1	109/8/0	NS
Spironolactone/amiclarane	95/1	100/2	p=0.03
Amiodarone	37	57	p=0.02
ASA/indobufen/warfarin	40/1/30	47/2/33	NS
Statin/fibrate/both together	66/3/1	62/2/1	NS

Column I – medication before implantation (number of patients treated with), column II – medication 3 months after implantation (number of patients treated with)

The average follow-up time for patients living with BiV PM/ICD (excluding patients who died or underwent heart transplant) until May 1, 2007, was 25.84±20.8 (ranging from 0–75, median 22.4) months.

Two-year survival was established for a group of patients who had BiV PM or BiV ICD implanted before May 1, 2005: patients who underwent heart transplantation were excluded. Out of 68 patients 53 (77.9 %) are surviving. The average time between implantation and death (in 15 patients: 22.1 %) was 10.6±6.6 (ranging from 0.5–23.6, median 11.5) months (Fig. 7a).

From the group of 128 patients a total of 23 (18 %) patients had died by May 1, 2007. The average time between implantation and death was 18.3±12.5 (0.5–45.8, median 14.1) months. The most frequent cause of death was severe heart failure. Two patients with BiV PM died suddenly, one died of acute myocardial infarction, two of malignant tumour growth while in two patients the cause of death could not be established.

Statistical analysis

For statistical analysis StatSoft Statistica 6.0 software was used. Descriptive statistics (average, standard deviation, mean) were computed using standard formulas.

Paired quantitative parameters before and after implantation were compared by nonparametric Mann-Whitney U test.

For statistical evaluation of medication before and after implantation the chi-quadrate test was used.

Survival rates are displayed as Kaplan-Meier curves.

Discussion

In the evaluation of the results of biventricular pacing, the randomized prospective multi-centre comparative studies (MIRACLE (1, 2), CARE-HF (3, 4), COMPANION (5)), which have proved both subjective and objective improvement in patients condition, are of fundamental significance.

In contrast to the above exact publications we are presenting a report on a retrospective study as encountered in clinical practice. In the present study we have evaluated both patients with first implantation of BiV PM and patients with first implantation of BiV ICD, as well as patients with earlier implanted PM or ICD upgraded to BiV PM or BiV ICD, respectively. Even in this heterogeneous group improvement in patients condition after three months of biventricular pacing was proved. All the patients claimed reduced breathlessness. The average drop in NYHA functional classification from 2.9±0.4 to 2.4±0.6 (n=99, p<0.001) was statistically significant even if the placebo-effect cannot be excluded. The echocardiographically established LV EF increased significantly in agreement with other authors (9) from 20.2±4.9 to 23.8±6.6 % (n=92, p<0.001). We found also the signs of left ventricle reverse remodelling – left ventricle diastolic diameter decreased from 69.9±9.8 to 67.5±10.0 mm (n=88, p=0.001) and mitral regurgitation decreased from 2.2±0.9 to 1.9±0.9 (n=87, p=0.001). The average maximum oxygen uptake established via spiroergometric examination also increased significantly from 14.5±2.7 to 15.5±2.6 ml/min/kg (n=52, p=0.005). The examination of cardiac output and the determination of cardiac index did not show any difference in the values before and 3 months after implantation.

Pharmacotherapy after implantation was roughly the same as in first implantation. One week hospitalization after implantation enabled us to add or increase the dose of beta-blocker and add digoxine (mostly to patients with atrial fibrillation) without any fear of potential bradycardia. Thanks to bedside monitoring of ECG during the one-week post-implantation hospitalization, non-sustained ventricular tachycardia or paroxysmal atrial fibrillation was captured in twenty patients and amiodarone was added to their therapy. Diuretics therapy slightly increased in the end of follow-up (Tab. 4).

In comparison with the input values (1.2±0.7 V at 0.5 ms, n=128) the pacing threshold established on the LV lead after 3 months (1.6±1.0 V at 0.5 ms, n=117) showed favourable values that allowed optimizing the pacing impulse amplitude and thus extending the service life of BiV PM or BiV ICD in most patients.

We positioned the right ventricle lead mainly in the right ventricle apex (such that the distance between the tip of the RV lead and the tip of the LV lead was as large as possible). This problem has not been solved yet and some authors prefer positioning the RV lead in the midseptum (10).

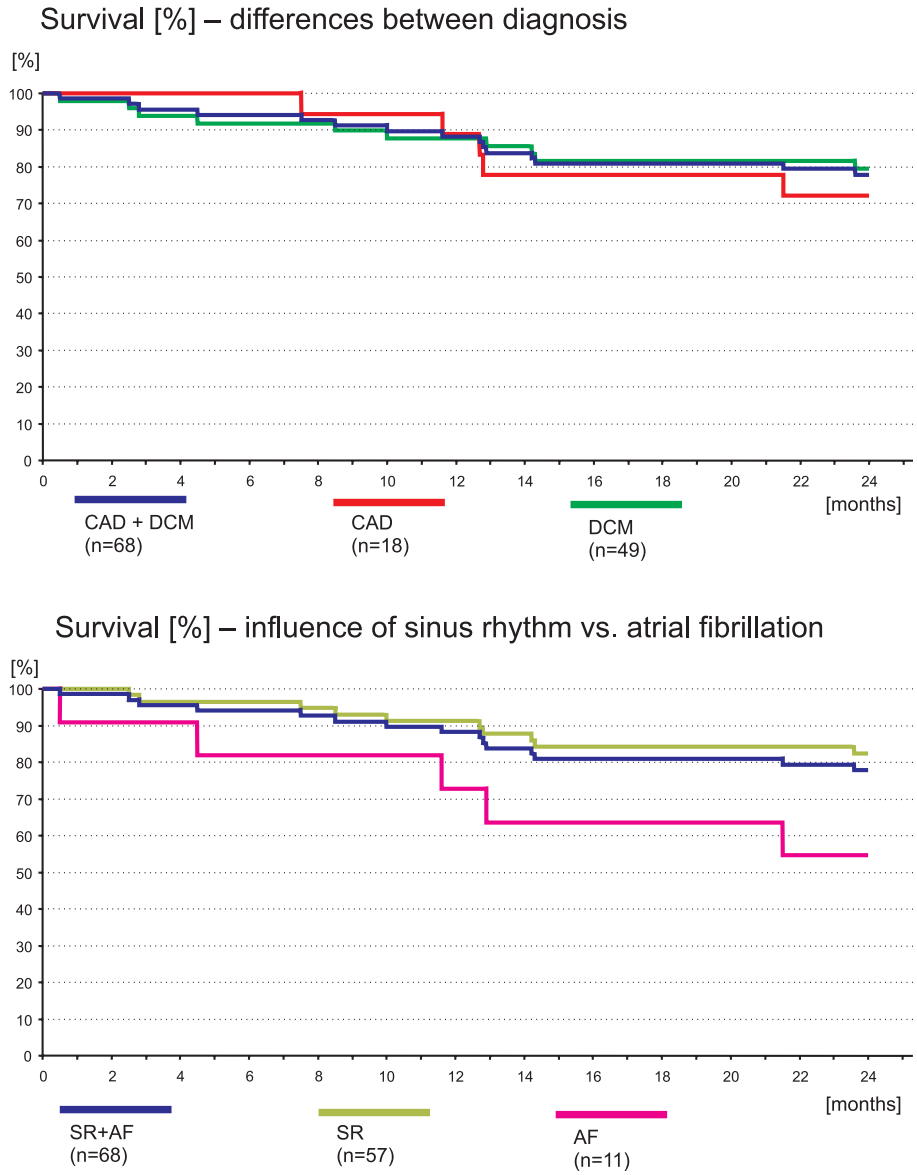

Fig. 7 a, b. Two-year survival of patients with BiV pacing (n=68).
***patients with implantation till 1. 5. 2005. Percentage of surviving patients on axis Y, survival in months on axis X. DCM – dilated cardiomyopathy, SR – sinus rhythm, AF – atrial fibrillation.**

AV delay and V-V delay were optimized in accordance with the procedures we developed and published (7, 8). The problem of optimizing these parameters remains open worldwide. For this purpose several echocardiographic methods are used (11–17).

Nine patients underwent orthotopic heart transplantation. After the implantation of BiV PM/ICD in five of them there was, in spite of temporary improvement, progression in their heart failure, in four patients there was no improvement at all after the implantation of the BiV system, and their further worsened condition made hospitalization, pharmacological stabilization of their condition and subsequent heart transplant absolutely necessary. They were performed 6, 8, 10, 10, 10, 17, 20, 23, and 24 months after implantation.

Two-year survival of patients (established for a group of 68 patients, irrespective of whether they had a BiV PM or BiV ICD implanted) was 77.9 %. In patients with DCM the survival was 79.6 % while in patients with CAD it was 72.2 %. This is in agreement with data in the literature (5). In patients with coronary artery disease there were more non-responders to resynchronization therapy, which is probably due to post-infarction scarring of myocardium (18). In our group NYHA improved in 72.1 % patients with DCM in contrast to 70.4 % patients with

CAD. The survival was influenced by the presence of atrial fibrillation – the prognosis in these patients was worse (Fig. 7b).

Conclusions

In a group of 128 consecutive patients with biventricular pacing (with BiV PM or BiV ICD):

1) After three months of biventricular pacing a significant decline in breathlessness was recorded – a drop in the average NYHA functional classification value from 2.9±0.4 to 2.4±0.6 ($p<0.001$), an increase in the average LV EF from 20.2±4.9 to 23.9±6.6 % ($p<0.001$). We also found the signs of left ventricle reverse remodeling – left ventricle diastolic diameter decreased from 69.8±9.8 to 67.5±10.0 mm ($p=0.001$), mitral regurgitation decreased from 2.2±0.9 to 1.9±0.9 ($p=0.001$ and maximum oxygen uptake during exercise grew from 14.5±2.7 to 15.5±2.6 ml/min/kg ($p=0.005$).
2) The following reoperations had to be preformed: reposition of the coronary sinus lead in 3 patients (2.3 %), implantation of epicardial lead in 6 patients (4.7 %), reposition of the atrial lead in 3 patients (2.3 %), reposition of the RV lead in 3 patients (2.3 %), and contralateral reimplantation of the whole system due to inflammatory complications in 2 patients (1.6 %).
3) Heart transplantation was performed in nine patients.
4) The two-year survival ($n=68$) was 77.9 %: in patients with DCM it was 79.6 % and in patients with CAD it was 72.7 %. The survival was influenced by the presence of atrial fibrillation – the prognosis in these patients was worse.

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