Medium-term prognosis of survival and hospitalization of patients after permanent pacemaker implantation based on BNP, high-sensitivity troponin T, and left atrium volume index

Średnioterminowe rokowanie dotyczące przeżycia oraz hospitalizacji u pacjentów po wszczepieniu stymulatora serca na stałe na podstawie badania BNP, troponiny T o wysokiej czułości oraz indeksu objętości lewego przedsionka

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Key words: cardiac pacing, B-type natriuretic peptide, left atrial volume index.

Słowa kluczowe: stymulacja serca, peptyd natriuretyczny typu B, indeks objętości lewego przedsionka.

Abstract

Introduction: Determination of predictors of survival and hospitalization can optimise a medical care of patient with permanent pacemaker.
Aim of the research: Use of the B-type natriuretic peptide (BNP), high-sensitivity troponin T (TnT hs), and left atrial volume index (LAVI) to control survival and hospitalizations due to cardiovascular causes in patients after pacemaker implantation.
Material and methods: The study covered a sample of 123 patients qualified for pacemaker implantation. During 23-month observation, cyclic BNP, TnT hs and LAVI examinations were performed. Mortality and hospitalization rate in groups with normal and elevated values were assesed using Kaplan-Meier curves.
Results: A statistical relationship was observed between survival and increased initial BNP plasma level (log-rank test = 2.11, $p < 0.05$). Significantly higher frequency of hospitalizations was observed with a higher initial BNP plasma level (log-rank test = 2.01, $p < 0.05$). No statistically significant relationships were found between the TnT hs concentration and the duration of survival and hospitalizations. A strong tendency was confirmed ($p < 0.10$) towards a higher probability of the survival of patients with low values of LAVI, compared to patients with high values of LAVI.
Conclusions: Results of the study conducted in regional centre (over 1000 implantations per year) confirmed that BNP peptide is an important indicator of survival and hospitalization due to cardiovascular causes after permanent pacemaker implantation. From among the 3 parameters examined: BNP, TnT hs LAVI, only BNP peptide and LAVI may be justified in the evaluation of patients after pacemaker implantation. Determination of BNP for evaluation medium-term prognosis of survival and hospitalization may be considered during routine pacemaker control visit.

Streszczenie

Wprowadzenie: Znalezienie predyktorów zgonu i hospitalizacji może pomóc w optymalizacji opieki nad pacjentem z kardiostymulatorem.
Cel pracy: Ocena rokowania co do przeżycia oraz hospitalizacji z przyczyn sercowo-naczyniowych u chorych po implantacji kardiostymulatora na podstawie peptydu natriuretycznego typu B (BNP), troponiny T o wysokiej czułości (TnT hs) oraz indeksu objętości lewego przedsionka (LAVI).
Materiał i metody: Badanie wykonano w grupie 123 chorych kwalifikowanych do implantacji stymulatora serca. W trakcie 23-miesięcznej obserwacji wykonano cykliczne badania BNP, TnT hs oraz LAVI. Określono śmiertelność i częstość hospitalizacji w grupach z prawidłowymi i podwyższonymi wartościami badanych parametrów na podstawie krzywych Kaplana-Meiera.
Wyniki: Stwierdzono zależność statystyczną między przeżyciem a stężeniem BNP przy przyjęciu (test log-rank = 2,11, $p <$ 0,05). Wykazano również znamiennie większą częstość hospitalizacji przy wyższym BNP przy przyjęciu (test log-rank = 2,01,

$p < 0,05$). Nie stwierdzono istotnych statystycznie związków między wartością TnT hs a czasem przeżycia i hospitalizacjami. Wykazano silną tendencję ($p < 0,10$) do większego prawdopodobieństwa przeżycia chorych z niskimi wartościami LAVI w stosunku do chorych z wysokimi wartościami LAVI przed wszczepieniem stymulatora serca na stałe.
Wnioski: Wyniki badania przeprowadzonego w ośrodku regionalnym (ponad 1000 implantacji rocznie) potwierdziły, że BNP jest istotnym wskaźnikiem przeżycia oraz hospitalizacji z przyczyn sercowo-naczyniowych po implantacji stymulatora serca na stałe. Z trzech badanych parametrów (BNP, TnT hs, LAVI) tylko BNP i LAVI mogą mieć zastosowanie w ocenie chorych po wszczepieniu stymulatora. Oznaczanie BNP w celu oceny średnioterminowego rokowania co do przeżycia i hospitalizacji może być rozważone podczas rutynowej kontroli kardiostymulatora.

Introduction

In 2009 in Poland, there were 113 functioning centres for implantation of permanent pacemakers. In that year, 27,194 pacemakers were implanted (including exchanges). Thus, 707 pacemakers were inserted per 1 million inhabitants, on average. On this background, the Kielce region occupied a very good position. In this region there were four centres implanting pacemakers. In 2009, 1013 pacemakers were implanted, including exchanges. Therefore, calculating per million inhabitants, the result obtained was 794 pacemakers implanted. This result was higher than the national average [1]. At present (2016), in Poland there are 145 cardiology centres where specialist procedures of implantation of a pacemaker are performed. These procedures are performed in highly specialist centres, as well as in smaller cardiology wards. In 2016, a total of 28,740 procedures were performed, which is 743 procedures per 1 million population [2]. In that year in the Kielce region there were five centres for permanent pacemaker insertion. These were: Kielce Region Cardiology Centre, Regional Polyclinical Hospital – 696 implantations, CARINT Ostrowiec Świętokrzyski – 147 implantations, PAKS Starachowice – 127 implantations, Kielce Province Health Unit Starachowice – 149 implantations, and Pińczów INTERCARD – 126 implantations. Thus, in 2016, a total of 1245 permanent pacemakers were implanted in the Kielce region [3].

At present, the determination of the natriuretic peptide plasma level plays an important role in clinical management. In this case, the determination of B-type natriuretic peptide (BNP) and NT-proBNP are the most important, and elevation of their plasma level is observed in cardiovascular, as well as in other diseases [4] (Table 1).

At present, the measurement of BNP plasma level plays an important role in the confirmation of the diagnosis of heart failure. B-type natriuretic peptide has a high diagnostic accuracy at a cutoff of 100 pg/ml (83.4%), and the negative predictive value of BNP at levels of less than 50 pg/ml is 96%. Added to other clinical information, rapid measurement of BNP is useful in establishing or excluding the diagnosis of congestive heart failure in patients with acute dyspnoea [5]. Testing of BNP is cost-effective in patients with acute dyspnoea – inducing several important changes in management of dyspnoea, including a reduction in the initial hospital admission rate, the use of intensive care, and total time in the hospital at 180 days [6].

The second very important marker, which in recent years has played a very important role in the diagnostics, is troponin, measured by high sensitivity assays. It is used mainly in the diagnostics of acute coronary syndromes. Elevated troponin levels occur also in conditions other than acute coronary syndromes – mainly heart failure, pulmonary embolism, states after cardiopulmonary resuscitation, electrotherapy, renal failure, and sepsis. Studies of the levels of high-sensitivity troponin in these states are still unequivocal. Based on the preliminary data, it may be presumed that the frequency of occurrence of elevated levels of troponin determined by a high sensitivity test will increase [7].

Also, echocardiographic examination has for a long time been very important in the diagnostics of heart failure. Classically, the size of the heart chamber and left ventricular ejection fraction have played the most important role. In recent years, in the analyses of available literature, an increasingly greater attention has been paid to the assessment of the left atrial volume, especially its value standardised with respect to the body surface area of the patient, i.e. left atrial volume index (LAVI). Such an evaluation of LAVI has been presented in recent years in studies concerning, among others, patients with atrial fibrillation, patients after cardiac surgery, and those after cerebral stroke events [8–10].

Aim of the research

Considering the constant and systematic increase in the number of permanent pacemaker implantations, patients with pacemakers constitute a considerably large group of cardiologic patients. Therefore, there is a need for working out objective methods of

Table 1. Causes of increased natriuretic peptide plasma level [4]

Cardiac causes	Non-cardiac causes
• Heart failure • Systolic dysfunction • Diastolic dysfunction • Ischaemic heart disease • Arterial hypertension with the features of left ventricular hypertrophy • Valvular heart disease • Atrial fibrillation	• Acutepulmonary embolism • Pulmonary hypertension • Ischaemia • Pulmonary heart disease • Renal failure • Septic shock • Hyperthyroidism

Table 2. Patient selection for pacemaker implantation

Group I AAI/R	Sick sinus dysfunction with normal AV node function: a. Sinus bradycardia b. Bradycardia-tachycardia syndrome
Group II DDD/R	1. Sick sinus dysfunction: a. Sinus bradycardia b. Bradycardia-tachycardia syndrome 2. Second-degree AV block with MAS episodes 3. Third-degree AV block
Group III VVI/R	1. Third-degree AV block 2. Atrial fibrillation with AV conduction disorders

the control of the implanted systems on the functioning of the cardiovascular system. Objective and cheap methods for the assessment of the cardiovascular system are still being sought, also after the procedure of pacemaker implantation. The presented study is an attempt to discuss the use of popular biomarkers and the selected parameters of echographic examination for the evaluation of medium-term prognosis in patients after permanent pacemaker implantation.

Material and methods

The study group consisted of 147 patients who qualified for permanent pacemaker implantation. Patients were recruited for prospective study during hospitalisation and qualified for pacemaker implantation according to the current guidelines, mainly the Recommendations for Cardiac Pacing and Resynchronisation of the Polish Cardiac Society, published in 2007 and revised in 2010. Table 2 summarises patient selection for implantation. The study was approved by the Local Bioethics Committee (the Swietokrzyska Chamber of Physicians, approval no. 8/2009 of 19 May 2009) and carried out between January 2010 and January 2012. During the period of observation, 13 patients withdrew their consent for further participation in the study. In the course of the observation, 11 patients were additionally excluded who did not satisfy the criteria of the prevalence of stimulation while checking the pacemaker. Based on telephone conversations, it was found that patients of these groups are alive and provided care by a family physician at their place of residence. Into the study were enrolled only those patients who during routine check-up of the pacemaker (3 months after implantation and 6 months after implantation) had more than 75% of pacing stimulations. Such a percentage of stimulations was considered as sufficient to confirm a significant prevalence of stimulations over the patient's own heart rate during the observation. Clinical characteristics of the patients are presented in Table 3.

Table 3. Clinical characteristics of patients in the study according to type of the implanted pacemaker

Patients groups	Group AAI/R (n = 22)	Group DDD/R (n = 61)	Group VVI/R (n = 40)	P-value
Age	72.4 ±7.7	73 ±7.94	74.11 ±7.14	
Sex, F/M	13/9	31/30	19/21	
Medical history				
Arterial hypertension	17	51	23	< 0.05
Coronary artery disease	14	36	20	> 0.05
Previous myocardial infarction	5	12	9	> 0.05
Compensated heart failure	8	17	22	< 0.05
Diabetes mellitus	9	17	10	> 0.05
Previous transient ischaemic attack	4	5	5	> 0.05
Medication:				> 0.05
ACE	15	40	30	> 0.05
ARB	4	12	5	> 0.05
B blocker	15	29	26	< 0.05
Ca blockers	3	12	7	> 0.05
Diuretics	5	18	5	> 0.05
Nitrates	5	4	1	> 0.05
Statins	13	23	23	> 0.05
Antidiabetic agents	9	10	9	> 0.05
Anticoagulants	4	29	29	> 0.05

Table 4. Selected clinical parameters measured before implantation

Parameter	Group AAI/R (n = 22)	Group DDD/R (n = 61)	Group VVI/R (n = 40)	P-value
BNP [pg/ml]	167.57 ±175.42	157.27 ±186.34	401.59 ±415.13	< 0.05
TnT hs [ng/l]	18.07 ±20.04	10.42 ±12.81	14.59 ±13.1	< 0.05
LAVI [ml/m^2]	26.20 ±5.43	30.56 ±9.45	44.16 ±12.12	< 0.05
LVEF (%)	60 ±3.87	55.42 ±6.45	48.92 ±8.18	< 0.05

Analysis of the hard outcomes, i.e. deaths due to general causes and hospitalisation due to cardiovascular causes (myocardial infarction, decompensation of heart failure, stroke), was performed in a total of 123 patients. Based on the direct interview and medical interview with patients' families, hospitalisation due to cardiovascular causes and deaths were determined. A total of 61 males and 62 females aged 53–85 years participated in the study.

Patients with acute coronary syndromes up to 6 months before the implantation of pacemakers, active inflammation, brain stroke up to 6 months before the implantation, heart defects, heart failure NYHA class III and IV, cancers, respiratory failure, connective tissue diseases, muscular dystrophy, anaemia with haemoglobin 10 g/dl and less, and thyroid diseases were excluded from the study. Additionally, those with rates of paced beats below 75% during pacemaker check-up were not taken into account, either.

The level of high-sensitivity troponin T in blood was measured using the Elecsys 2010 analyser, where the troponin value was automatically determined in ng/l. Roche specific reagents were applied for the determinations. The results were read based on the calibration curve. The cutoff of troponin measured with high-sensitivity assays was 3 ng/l.

B-type natriuretic peptide was determined from venous blood sample collected by the EDTA method and centrifuged for 10 min at 2000 G in order to obtain plasma. The determination was performed using Triage reagents by means of the Beckman Coulter UniCel Dxl 600 Immunoassay System. Concentration of BNP was determined based on the recorded multi-point calibration curve. All blood samples were collected in supine position in the morning. The cutoff of B-type natriuretic peptide plasma level was 100 pg/ml.

Echocardiographic examination was performed in all patients in the morning hours between 9.00 and 12.00, by means of Acuson Sequoia ultrasound system, using an echocardiography probe of a frequency of 3.5 MHz. Left atrial volume was evaluated by Simpson's method (SIM). In Simpson's method, the left atrium is divided into many disc-shaped segments on several levels, and the atrial volume is obtained by summing-up the volumes of these discs. The measurements are performed from the apical four-chamber view (A4C) and two-chamber view (A2C). The echocardiographic system possesses special automated software for the calculation of the volume by this method. The left atrial volume correlated best with the body surface area; therefore, for the standardisation of measurements it was proposed that LAVI be used. The examinations were performed in accordance with the ECG curve. The echocardiographic evaluation of the left atrium included such parameters as left atrial maximum volume – V max, left atrial minimum volume – V min, and left atrial volume index – LAVI. The cutoff of LAVI was 28 ml/m^2.

Statistical analysis

The descriptive statistics of the total population according to the type of implanted pacemaker are presented in Tables 3 and 4. The differences between groups were evaluated with ANOVA test and χ^2 test. Differences in values of measured parameters were evaluated with U Mann-Whitney test. The survival and hospitalisation probability was evaluated using the Kaplan-Meier survival curve based on a 23-month observation of a group of 123 patients. The criteria of division into two groups were: initial concentrations of BNP and high-sensitivity troponin, as well as the LAVI value.

Results

During 23-month observation 28 patients was hospitalised due to cardiovascular causes and 9 patients died. Differences in hospitality and mortality rates in groups divided by initial BNP plasma level (normal vs. elevated) were statistically significant ($p < 0.05$). Differences in hospitality and mortality rates in groups divided by initial high-sensitivity troponin plasma level as well initial LAVI value (normal vs. elevated) were statistically insignificant ($p > 0.05$). Differences in mean plasma level of BNP and TnT hs and mean value of LAVI were statistically significant, but they are assumpted preliminary. Characteristics of the patients who reached the endpoints are presented in Table 5. While analysing the survival and hospitalisations of patients considering the BNP levels prior to the permanent pacemaker implantation, it was found that the probability of survival and hospitalisation of patients with low values of the BNP peptide was significantly higher,

Table 5. BNP, TnT hs, and LAVI (measured before implantation) in patients who reached the endpoints

Parameter (norm)		Endpoint					
		Hospitalisation (n = 28)			Death (n = 9)		
		Group with normal values	Group with elevated values	*P*-value	Group with normal values	Group with elevated values	*P*-value
BNP (< 100 pg/ml)	*n* (%)	6 (12.24)	22 (29.73)	< 0.05	1 (2.04)	9 (12.16)	< 0.05
	Mean plasma level	62.8 ±15.6	380.2 ±298.3	< 0.05	50	475 ±269.4	< 0.05
TnT hs (< 3 ng/l)	*n* (%)	5 (14.71)	23 (25.84)	> 0.05	0	10 (10.87)	> 0.05
	Mean plasma level	3 ±0	14.7 ±8.9	< 0.05	3 ±0	28.3 ±20.1	< 0.05
LAVI (< 28 ml/m²)	*n* (%)	5 (12.5)	23 (27.71)	> 0.05	1 (2.44)	9 (10.98)	> 0.05
	Mean value	21.5 ±3.4	44.6 ±12.3	< 0.05	25.4	53.1 ±15.8	< 0.05

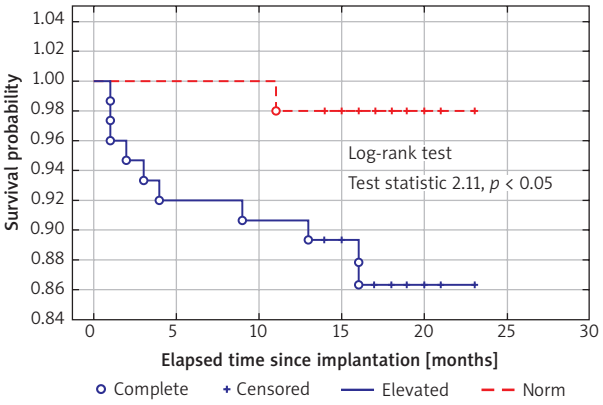

Figure 1. Probability of survival of patients after permanent pacemaker implantation with respect to BNP plasma level prior to implantation

compared to those who had elevated BNP levels ($p < 0.05$) (Figures 1, 2). While analysing the survival and hospitalisations of patients according to the level of high-sensitivity troponin T prior to the permanent pacemaker implantation, no statistically significantly higher probability of the survival and hospitalisation of patients with low level of high-sensitivity troponin T was observed, compared to patients with elevated values of high-sensitivity troponin T ($p > 0.05$) (Figures 3, 4). While analysing the survival and hospitalisations of patients, considering the values of the left atrial volume index prior to the permanent pacemaker implantation, no statistically significantly higher probability of survival and hospitalisation of patients with LAVI values was observed, compared to those who had high LAVI values ($p > 0.05$) (Figures 5, 6).

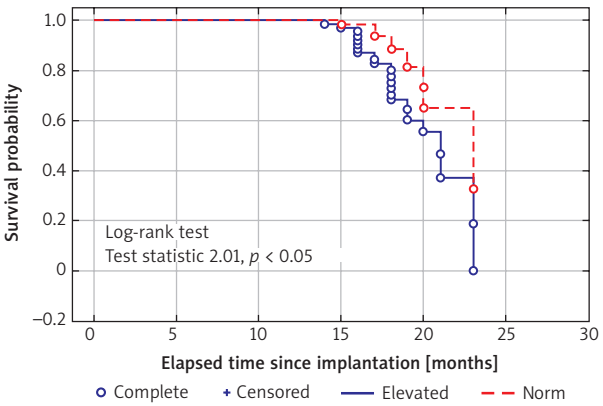

Figure 2. Probability of hospitalisation due to cardiovascular causes after permanent pacemaker implantation with respect to BNP plasma level prior to implantation

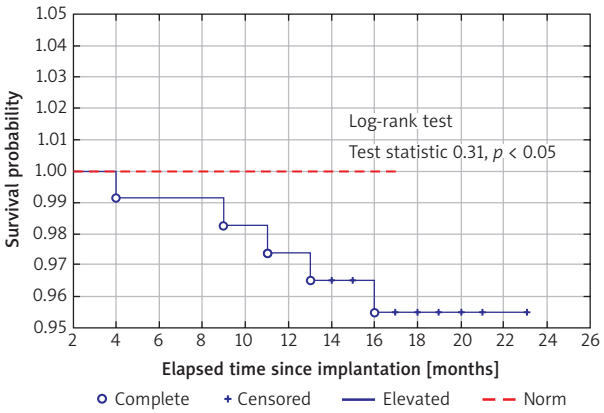

Figure 3. Probability of survival of patients after permanent pacemaker implantation with respect to high-sensitivity troponin T plasma level prior to implantation

Discussion

For more than 50 years, permanent pacemaker implantation has been an established method for the treatment of patients with disorders of the electrical activity of the heart. During this time, the directions in the development of electrotherapy have significantly changed. At present, pacemakers and stimulation systems have become complex systems of therapy for patients, and not always for those with disorders concerning the cardiac conduction system [11–14].

During this period, many methods have been examined and developed for the evaluation of the cardiovascular system in patients after permanent pacemaker implantation. Both small and large groups of patients have been examined, and the duration of examinations has varied. Also, the length of the survival period of patients after implantation has differed. In studies concerning large groups of patients, Udo *et al.* presented a study of 1517 patients and their observation within the period 2003–2007. In this study, the survival rate was between 81% and 69 % [15]. In many studies, the researchers attempted to determine the factors that decide about the survival of a patient after permanent pacemaker implantation. Pyatt *et al.* determined survival and the factors deciding about survival. In a study of 803 patients who had undergone pacemaker implantation, with a mean age of 77.3 years, it was found that age, ventricular stimulation, cardiomyopathy and heart failure in medical history, male gender, and valvular heart diseases exert a negative effect on survival [16]. In a large Polish study, Krzemień-Wolska *et al.* observed patients with permanent pacemakers for more than 4 years. The patients enrolled into the study were aged 18–80 years and had typical indications for permanent pacemaker implantation. Among the group of 450 patients, 35.9% of patients attained a 4-year survival rate, which is 79.7 %. In the group of patients who were characterised by a longer survival, those with permanently implemented DDD pacemaker dominated, and those who were younger at the moment of qualification. However, in the group of patients with shorter survival, those with higher creatinine levels at qualification for the implantation prevailed [17]. Shen *et al.* examined a group of 154 patients aged 80 ±7 years, observed from 0.1–19.8 years, mean: 4.2 ±2.8 years. Multivariate analysis of this group showed a relationship between the deterioration of survival and such factors as: congestive heart failure, chronic obstructive pulmonary disease, age, insulin-dependent diabetes, and male gender [18]. Also, according to large studies by Brevik *et al.* and Skagen *et al.*, medical history taken before implantation concerning ischaemic heart disease and heart failure is of the greatest importance for the prognosis of patients after permanent pacemaker implantation [19, 20].

In our own study, conducted in a group of 123 patients who were observed for a period of 23 months,

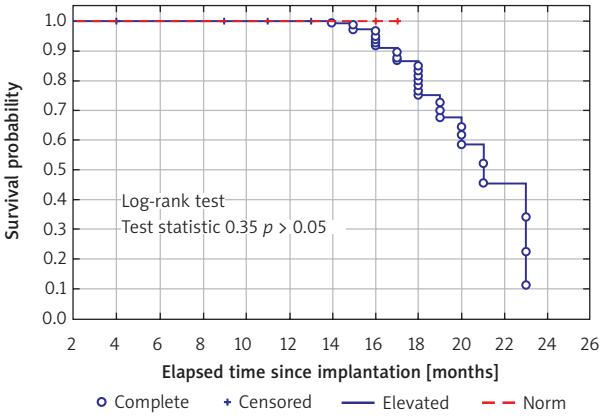

Figure 4. Probability of hospitalisation due to cardiovascular causes after permanent pacemaker implantation with respect to high-sensitivity troponin T plasma level prior to implantation

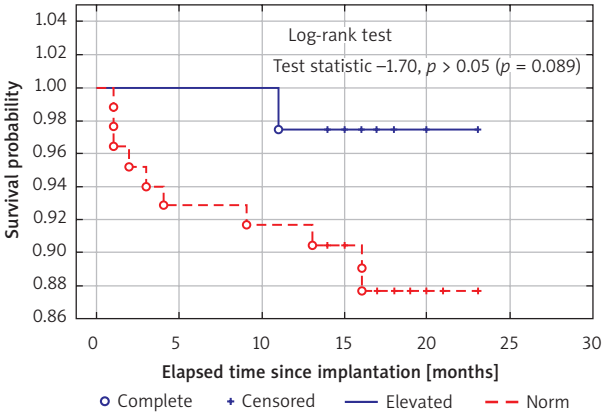

Figure 5. Probability of survival of patients after permanent pacemaker implantation with respect to the value of left atrial volume index (LAVI) prior to implantation

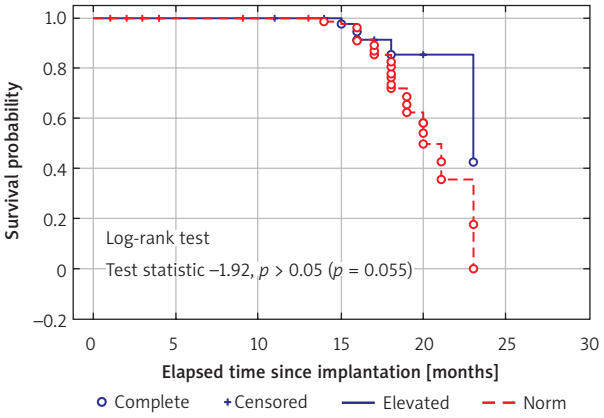

Figure 6. Probability of hospitalisation due to cardiovascular causes after permanent pacemaker implantation with respect to the value of left atrial volume index

6 patients died. Thus, the survival rate obtained was 95%. A significantly higher probability of survival was observed in patients with low values of BNP prior to the implantation, compared to patients with elevated levels of BNP peptide. Nevertheless, no significantly higher statistically probability of survival was found among patients with low values of high-sensitivity troponin T, with respect to patients with elevated values of high-sensitivity troponin T. While performing echocardiographic examination in the examined group, a strong tendency was noted towards a higher survival probability in patients with low values of the LAVI, compared to those with high values of the LAVI.

The second important outcome on which the determination of prognoses of patients with cardiovascular disorders is based concerned hospitalisations due to cardiovascular causes. Brandt *et al.* distinguished from a large examination, DANPACE, a randomised group of 696 patients for AAIR pacing and 688 for DDDR pacing. The observation period was 8.9 years. No differences in hospitalisations for cardiovascular causes were observed in these groups due to atrial fibrillation, heart failure, or ischaemic cerebral stroke [21]. Gierula *et al*. collected data concerning 491 patients after pacemaker implantation. The mean period of observation was 668 days. From this group, 56 patients were hospitalised and died due to the aggravation of heart failure. Multifactor analysis confirmed that a past myocardial infarction and a higher percentage of ventricular pacing during the observation were independent factors favouring these events [22]. In a large retrospective study, Kafara *et al.* analysed the records of patients who had undergone pacemaker implantation. The fate of 274 patients was analysed, with mean age 74 ±7 years. The patients received both VVI and DDD pacemakers [23].

A higher percentage of hospitalisations was observed in patients who received right ventricular apical pacing, compared to those who received stimulation from other right ventricular pacing sites, and these hospitalisations were longer. In addition, while analysing complications in this study, a greater exposure was observed among patients with a history of ischaemic heart disease and past myocardial infarction [23]. As well as single-centre studies conducted in small groups of patients, many multi-centre studies in large groups of patients who had undergone permanent pacemaker implantation deserve attention. During the period 2009–2013, Nichols *et al.* examined large groups of patients with implanted devices. The observation lasted for 1 year after the implantation of the device. These were 22,557 with a pacemaker, 20,632 patients with implantable cardioverter defibrillator, and 2063 patients who received cardiac resynchronisation therapy. In the study, damage to the electrodes was found, which was the cause of the exchange of the device in 0.46% of cases after pacemaker implantation, in 1.27% of cases after cardioverter implantation, and in 1.94 % of cases after implantation of the resynchronisation device. In each case, the complications were associated with costly hospitalisation [24]. Regional single-centre studies also confirmed the usefulness of the determination of BNP peptide, high-sensitivity troponin T, and LAVI in the evaluation of patients who had undergone permanent pacemaker implantation [25]. While analysing the available literature, data may be quoted from many studies conducted in large groups of patients concerning hospitalisations due to electronic device infections and related complications [26, 27].

The results of our own study conducted in a group of 123 patients and 23-month observation showed a significantly higher probability of survival of patients with initially lower (before the examination) values of the BNP peptide. However, no significant relationship was found between the levels of high-sensitivity troponin T in patients prior to the implantation. Also, the values of the left atrial volume index before the implantation were not significantly related with hospitalisation due to cardiovascular causes.

Throughout all these years, from the beginning of cardiac pacing, many studies have been conducted aimed at optimum selection of the type of cardiac pacing, and optimum control of the patient after permanent pacemaker implantation. The discussed problem of the functioning of the cardiovascular system after permanent pacemaker implantation seems to be important for contemporary cardiology. Considering the importance of the problem, it seems necessary to cover larger groups of patients by studies, and introduce long-term observation in patients who have undergone pacemaker implantation.

Limitations of the study

Considering the fact that the study was conducted in a population group of older age, this resulted in some important limitations: 1) Difficulties with communication with patients (hearing loss; difficulties with understanding, memorising, and performing the tasks ordered – previous neurological events). 2) Patients' difficulties with locomotion: (lack of possibility for the patient to come for a visit, especially during the winter season; difficulties with correct performance of echocardiographic examination due to motor organ dysfunction).

Conclusions

The results of the study conducted in a regional centre (over 1000 implantations per year) confirmed that BNP peptide is an important indicator of survival and hospitalisation due to cardiovascular causes after permanent pacemaker implantation. From the three parameters examined (BNP, TnT hs, and LAVI) only BNP peptide and LAVI may be justified in the evaluation of patients after pacemaker implantation. De-

termination of BNP for evaluation of medium-term prognosis of survival and hospitalisation may be considered during routine pacemaker control visit.

Conflict of interest

The authors declare no conflict of interest.

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