

First Implantation Of Biventricular Pacemaker - Cardiac Resynchronization Therapy

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The article presents the first successful experience of electrophysiological treatment of CHF by the method of implantation of a biventricular pacemaker (ECS) of cardiac resynchronization therapy (CRT) in the Republic of Sakha (Yakutia). A clinical case, surgical technique of CRT implantation are described. A brief overview of this treatment method to date.

Keywords: pacemaker, cardiac resynchronization therapy, first experience, Yakutia

1. INTRODUCTION

Chronic heart failure of various etiologies is one of the most common pathologies among the adult population of developed countries. Its prevalence in the world is quite high (about 22 million patients), especially in the Russian Federation (it occurs in 7% of the population - about 7.9 million patients) [1, 2]. In North America and Europe, approximately 2.5% of adults have CHF. Thus, the treatment of CHF is one of the main tasks of public health in all economically developed countries.

Undoubtedly, the first publications on the dependence of the pumping function of the heart on the sequence and synchronicity of conduction of excitation through the atria and ventricles of the heart date back to the beginning of the 20th century. The very first work is the article of C. Wiggers, a famous American physiologist, dated 1925, in which the author reports on the non-physiological nature of stimulation of the apex of the right ventricle in mammals [5]. As a result, with the development of cardiology, several papers have been published on the alternative position of the right ventricular electrode in terms of the extension of excitation to myocardial contractility and cardiachemoedynamics [6-9]. Subsequently, the simplicity and safety of endocardial implantation of the electrode in the apex position of the right ventricle led to the fact that for a long period of time this technique, in fact, had no alternative, and the problem of its non-physiological nature faded into the background. Until the end of the 1980s, bundle branch blocks were not considered as factors affecting intracardiac hemodynamics, the pathogenesis of CHF and the life expectancy of patients. The development of echocardiography and widespread use made it possible to pay attention to cardiohemodynamic disorders in the presence of a wide QRS complex and especially in left

bundle branch block (LBBB). In any case, the fundamental work on this issue was published by C.L. Grines et al. (1989) [10]. Thus, the main prerequisite for the emergence and development of CRT was the understanding of the negative consequences of dyssynchrony.

Most authors admit that the first publication on CPT was the article by S. Cazeau et al. in 1994. The authors described a clinical case of using four-chamber continuous cardiac pacing in a patient with end-stage heart failure, NYHA FC IV, left bundle branch block with a QRS duration of more than 200 ms, and degree I atrioventricular block [3]. The patient was implanted with a DDD pacemaker with endocardial electrodes in the right heart, coronary sinus and thoracoscopically implanted with an epicardial electrode to stimulate the left ventricle. As a result of resynchronizing stimulation at the hospital stage, an increase in the ejection fraction (EF) of the left ventricle (LV) by 20–25% was noted, and the patient's condition began to correspond to FC II according to NYHA. J.C. Daubert et al. (1998) proposed to pass an electrode for LV stimulation through coronary veins [4]. This implantation technique is most widespread, and the manufacturing companies have created special electrodes and systems for delivering the electrode to the venous system of the heart.

The history of the development of electrophysiological methods of treatment in Yakutia began back in 1988, the first such operation was the implantation of a single-chamber pacemaker (ECS), on the basis of the Republican Hospital. In 2004, the first operations on the implantation of a two-chamber pacemaker were also performed. At present, once mastered operations have become routine, standard operations, which are currently being carried out up to two and a half hundred per year. On the 26 June 2019 in the Republic of Sakha (Yakutia), a new stage of development began, a relatively new method of electrophysiological surgical treatment of CHF was performed, the implantation of a three-chamber pacemaker of cardiac resynchronization therapy. A positive result of treatment was obtained, according to the instrumental studies carried out after 3 months after the operation.

So, the purpose of our article was to write about performing of the first in the Republic of Sakha (Yakutia) implantation of biventricular pacemaker of cardiac resynchronization therapy. The operation was performed at the Republican Hospital No. 1 - National Center of Medicine in June 26, 2019.

2. CLINICAL OBSERVATION

Patient S., 62 years old, was observed in the Republican Cardiological Dispensary "RH # 1-National Center of Medicine" with complaints of shortness of breath with moderate physical exertion, pain in the heart, decreased exercise tolerance, periodically general weakness, dizziness.

From the anamnesis it is known that on 12/08/2016 he had a Q-positive MI of the anteroposterior LV region. According to emergency indications, SCAG was performed from 08.12.2016 with further TBCA with stenting d / 3, s / 3 OA LCA DES-stent Merlbimime 4.0x24, TBCA VTK2 dated 08.12.16. TBCA with stenting p / s DV1 from 24.12.16. LAD stenosis in the proximal segment 50-70%, distal LAD stenosis 80%. Critical stenosis of the

mouth of the VTK1. Since 2017, he has noted the appearance of shortness of breath and periodic pressing pain in the heart area with moderate physical exertion. He was examined at the Republican Cardiological Dispensary - according to the results of HMECG, a violation of the heart rhythm in the form of AV blockade was revealed, there were no indications for implantation of a pacemaker. Conservative therapy with follow-up was recommended. In 2018, according to echocardiography, a decrease in the pumping function of the heart, EF-52%, the appearance of hypokinesia of the basal, antero-septal, mid-anterior-septal, apical and lateral segments, confirmed by an ECG with a complete blockade of LPH. Insufficiency of 1 degree MK, 1 degree TC were observed. In 2019, the survey showed negative dynamics. According to the results of echocardiography, end-diastolic size 5.7 cm, end-systolic size 4.3 cm, end-diastolic volume 131 ml, end-systolic volume 76 ml, ejection fraction (according to Teichholz - 49%, Simpson's formula - 42%), hypokinesia of the mid-anterior septal, lateral and posterior segments of the LV. Lack of AK, MK and 1 degree TC 1 degree pulmonary hypertension. ECG showed sinus bradycardia with a heart rate of 50 per minute, complete blockade of the left bundle branch with a wide ventricular complex, QRS-168 msec, EOS to the left was revealed.

Complete examination showed progression of heart failure, diagnosis I42.8. Ischemic cardiomyopathy. I25.2 ischemic heart disease. Angina pectoris 2 FC. PEAKS (Q positive MI, anterior disseminated from 08.12.2016). Coronary sclerosis. TBCA with stenting OA LCA, TBCA VTK2 from 08.12.16. TBKA with stenting DV1 were made on 24.12.16. I44.7 LDC: Complete blockade of LBG. Transient AV block of the 2nd degree. Ryan grade 5 ventricular premature beats. I35.1 1 degree Insufficiency of AC, 1 degree, MC 1 degree TC. Background: I11 Hypertensive disease of stage 3, achieved degree of AH 2, risk of CVC 4. Taking into account the progression of heart failure, on the basis of the instrumental studies and anamnesis, the patient was offered the operation of implantation of a pacemaker cardiac resynchronization therapy. The patient's consent was obtained.

On 26.06.2019, the operation of implantation of the pacemaker of cardiac resynchronization therapy was performed.

Pacemaker implantation of cardiac resynchronization therapy is a continuation of the operation of implantation of a two-chamber pacemaker. After appropriate preparation of the patient, antibiotic prophylaxis, treatment of the surgical site and adequate local anesthesia, an incision was made in the left pectoral region, followed by the creation of a subcutaneous pacemaker bed. Using the Seldinger technique, the subclavian vein was cannulated in three separate sites, one for each pacemaker electrode: the right atrium (RP), right ventricle (RV), and left ventricle (LV). Then the RV electrode is directed through the tricuspid valve and positioned in the interventricular septum of the RV and screwed into the myocardium, the right atrial electrode is installed in the appendage of the RV and also screwed in. After receiving the acceptable parameters from the electrodes (impedance, stimulation threshold and sensitivity), the next stage of the operation, the transition to the positioning of the LV electrode. Photo №1.

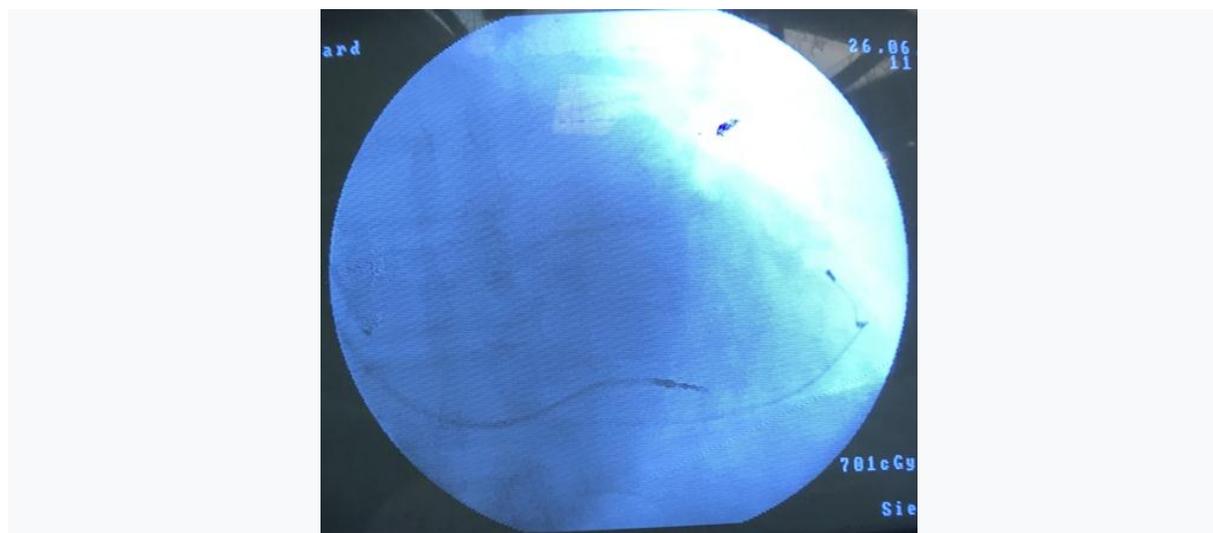
Photo №1 Electrodes in the right atrium and right ventricle



The guide catheter is inserted through the introducer into the PN cavity and the catheter tip is inserted into the orifice of the coronary sinus. A catheter with a balloon for obturation of the CS was passed through the guide catheter into the coronary sinus. Next, the balloon and coronary sinus were filled with a contrast agent. The inflated balloon prevents the contrast medium from returning to the atrium, which allows the necessary contrasting of the coronary veins. Based on the images obtained, a large vein of the heart was selected, the LV electrode was positioned in a large vein of the heart using a guiding catheter. Stimulation threshold 1.0 B, at the time of trial LV stimulation, there is a twitching of the diaphragm muscles. Taking into account the effect on the diaphragmatic muscles, the LV electrode is positioned in the posterior vein of the left ventricle according to the method described above. The stimulation threshold is 0.5 V; during trial stimulation, the LV lateral wall is excited. After removal of the catheter, the LV electrode is guided into the posterior LV vein using a guide catheter. During control measurements of parameters from the LV, adequate parameters of the stimulation threshold, sensitivity and resistance were obtained. After connecting the resynchronization therapy stimulator, a synchronous contraction of the RV and LV is determined.

Most of the electrodes with passive fixation available in the arsenal of modern medicine are installed in the lateral or posterolateral branches. Most authors agree that the choice of vein for LV electrode implantation is a decisive factor in the outcome of CRT. It is important that the LV electrode is located in the lateral wall of the LV, since in most cases the depolarization wave reaches this part of the myocardium later [11]. Photo №2.

Photo №2. Electrodes in the right heart and left ventricle



The duration of the operation was 2 hours 10 minutes. The patient was transferred from the operating unit to the general ward. The postoperative period was uneventful, the healing of the postoperative wound was by primary intention. The patient was discharged in satisfactory condition on 6-7 days.

Control instrumental studies were carried out at 3,6,9 months after the operation, the patient's well-being is satisfactory, notes an increase in exercise tolerance, an increase in walking distance, a decrease in shortness of breath during exercise. EchoCG results are presented in Table №1, ECG results are presented in Table №2.

Table №1. Echocardiography (EchoCG) data before and after surgery

	Before surgery	After surgery (in 3 months)	After surgery (in 6 months)	After surgery (in 9 months)
End-diastolic dimension(EDD)	5,9 cm	5,4 cm	5,1 cm	5,3 cm
End-systolicdimension (ESD)	4,5 cm	3,9 cm	3,6 cm	3,6 cm
End-diastolicvolume (EDV)	131 ml	97 ml	86 ml	105 ml
End-systolicvolume (ESV)	76 ml	44 ml	39 ml	49 ml
LV ejection fraction (EF) according to the	49	53	58%	60%

Teichholz formula%				
LV ejection fraction (EF) according to Simpson's formula%	42	56	55%	60%
Violation of LV contractility	Hypokinesia of the mid-septal, antero-septal, lateral and posterior segments	No clear zones of hypokinesia were identified.	Areas of hypokinesia of the lower LV segments.	Hypokinesia of the basal and middle segments of the LV.
Other data	Insufficiency of AV 1 degree, MV 1-2 degree, TV 1 degree LAV 1 degree The estimated pressure in RV is 31 mm Hg.. in LA 23 mm Hg.	Insufficiency of MV 0-1 degree, insufficiency of TV 1 degree	Insufficiency of MV 0-1 degree, insufficiency of TV 1 degree	Insufficiency of MV 0-1 degree, insufficiency of TV 1 degree

Table №1 Electrocardiographic (ECG) data before and after surgery

	Before surgery	After surgery (in 3 months)	After surgery (in 6 months)	After surgery (in 9 months)
Rhythm	Sinus bradycardia with 50 bpm	The rhythm of biventricular stimulation with 55 bpm	The rhythm of P-synchronized biventricular stimulation with 52 bpm	The rhythm of P-synchronized biventricular stimulation with 53 bpm
Electrical axis of the heart	To the left	To the left	Closer to vertical	Closer to vertical
Violation of conduction	Complete left His bundle branch block	no	no	no
QRS	168 msec	154 msec	144 msec	144 msec
PQ	180 msec	154 msec	134 msec	136 msec

ProngP	64 msec	118msec	58 msec	42msec
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3. DISCUSSION

Cardiac resynchronization therapy (CRT) is a clinically proven treatment for chronic heart failure (CHF) accompanied by cardiac dyssynchrony. The results of randomized controlled trials have demonstrated a significant improvement in cardiac functions and cardiac efficiency in patients with CHF with severe left ventricular (LV) systolic dysfunction with a decrease in EF of less than 35% and the presence of inter- and intraventricular myocardial dyssynchrony [12,13,14], decreased symptoms, improving the quality of life, increasing life expectancy, reducing the frequency of hospitalizations for CHF, mortality from CHF and overall mortality [15,16,17]. It should be noted that until recently, patients with severe CHF (NYHA (New York Heart Association) III – IV functional class (FC)) and widening of the QRS complex on the surface ECG up to 120 ms or more were referred to CRT.

Also, natural and socio-economic extreme conditions of human life in the North play an important role in the development and aggravation of cardiovascular diseases. Residents of the North are more likely than southerners to suffer not only from colds, but also from cardiovascular diseases (CVD) [18].

During follow-up, in the long-term period after the CRT implantation operation, a positive effect of treatment is observed. Clinical condition, hemodynamic parameters, exercise tolerance are improving. Patients with congestive heart failure, when signs of interventricular dyssynchrony are detected, are promising candidates for CRT.

Based on the foregoing, the development of a new method of treating CHF in the Republic of Sakha (Yakutia) showed that there is a possibility of performing this operation not only in Federal centers. Which, in turn, is more convenient for patients to receive high-quality medical care in the field of cardiovascular surgery in the region of residence.

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