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NEW PERSPECTIVES

Persistent left superior vena cava in a patient with an implanted dual-chamber pacing system in atrial fibrillation with tachycardia-bradycardia syndrome

Kenzhebek BIZHANOV[1,2], Adil BAIMBETOV[2], Akmoldir SARSENBAYEVA[2], Evgeny LYAN[3], Kuat ABZALIYEV[4]

Department of Health Policy and Organization, Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan. **ke.bizhanov@gmail.com**

ABSTRACT

The relevance of the study is conditioned by the problem of implantation of an artificial cardiac pacemaker in atrial fibrillation in patients with tachy-brady syndrome according to the standard scheme related to the presence of a congenital anomaly, such as persistent left superior vena cava. The purpose of the study is to develop an operative method of implantation of a permanent two-chamber pacemaker in patients with tachy-brady syndrome with concomitant pathology of the persistent left superior vena cava. Research methods are the generally accepted clinical and instrumental examination of the patient, including taking anamnesis and a standard cardiological examination, electrocardiography, transthoracic echocardiography, plain radiography, angiocardiographic examination, and multispiral computed tomography, which, along with a general analysis, confirm the presence of tachy-brady syndrome with atrial fibrillation and congenital anomaly in the form of persistent left superior vena cava in patients. The study presents a developed model of surgical implantation of a permanent two-chamber pacemaker to stabilise the condition of patients with atrial fibrillation related to tachy-brady syndrome with concomitant persistent left superior vena cava; the standard implantation mechanism included the introduction of a radiopaque agent to clarify the anatomical structure of the vascular bed, further, its entry from the subclavian veins into the persistent left superior vena cava and into the cavity of the right atrium through the venous coronary sinus was detected, and then a gradual introduction of an endocardial right ventricular electrode was performed into the subclavian vein through the tricuspid valve along with its further positioning in the apex of the right ventricle; therefore, a permanent two-chamber pacemaker can be successfully installed, creating conditions for restoring sinus rhythm in this group of patients, which is of practical importance for the field of medicine *(Tab. 3, Fig. 4, Ref. 22)*. Text in PDF *www.elis.sk*

KEY WORDS: atrial fibrillation, persistent left superior vena cava, sick sinus syndrome, pacemaker implantation, cardiac surgery.

Introduction

There is a large percentage of diseases related to the cardiovascular system, where, despite progress in medical developments, a large percentage of patients with disabilities and pathological conditions incompatible with life remains. One of the conditions that threaten the life of patients is the tachy-brady syndrome, which combines periods of bradycardia and tachyarrhythmia, dramatically reduces motor activity and aerobic endurance, and does not allow leading a healthy lifestyle, even from the position of maintaining a regular working capacity (1). This condition is associated with the weakness of the sinus node and the slowing of the sinus rhythm in a sharply presenting bradycardia, which carries the threat of cardiac arrest in the patient. This syndrome is most often acquired, and middle-aged and elderly patients begin to feel changes from a decrease in endurance and heart rate, which do not allow them to perform their usual activities at a normal pace. This condition requires surgical treatment, so that, with the implantation of a pacemaker, the necessary heart rate is artificially maintained in patients (2).

There are many causes for tachy-brady syndrome, and during the diagnosis, it is necessary to pay due attention to the etiological signs of the development of the disease, which include various degenerative changes that occur with age in the sinoatrial node. These processes can be stimulated by arterial hypertension, coronary heart disease, various cardiomyopathies, after infectious diseases that carry damaging elements in the structure of the heart or strong toxic effects on the body, tumours, or the development

[1]Department of Health Policy and Organization, Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan, [2]Department of Interventional Cardiology and Arrhythmology, National Scientific Center of Surgery named after A.N. Syzganov, Almaty, Republic of Kazakhstan, [3]Cardiovascular Center, University Clinic Schleswig-Holstein, Kiel, Germany, and [4]Consultative and Diagnostic Center, Research Institute of Cardiology and Internal Disease, Almaty, Republic of Kazakhstan

Address for correspondence: Kenzhebek BIZHANOV, Department of Health Policy and Organization, Al-Farabi Kazakh National University, 050040, 71 Al-Farabi Ave, Almaty, Republic of Kazakhstan.

of various collagenoses (3). Thus, at the first stage of treatment, supportive drug therapy is used, which simultaneously affects the correction of bradycardia and tachyarrhythmia, but as the clinical practice of this group has shown, patients acquire a status close to a stable sinus rhythm after the implantation of a permanent pacemaker, which, with the necessary selection of a special programme, maintains the necessary rhythm of the cardiac muscle. Timely implantation also allows patients to take the necessary antiarrhythmic drugs and anticoagulants at a safer level, which together will restore the quality of life of these patients and prolong their optimal activity (4).

Notably, atrial fibrillation often accompanies tachy-brady syndrome, and in the presence of this condition, it is necessary to correct it in such a way as to avoid its permanent form. According to the study, atrial fibrillation is observed in half of the patients with tachy-brady syndrome. Therewith, several such patients also have congenital anomalies, which, in detecting persistent left superior vena cava, aggravates the hemodynamics of the patient. This congenital pathology is detected in about 5% of patients, and in this regard, the operation to implant a permanent pacemaker, which is necessary to improve the quality of life and prolong it, requires a special approach to the diagnosis of the anatomical structure of the vessels and the technical implementation of the surgical treatment (5).

Thus, the development of features of implantation of an artificial cardiac pacemaker in patients with atrial fibrillation related to tachy-brady syndrome and with concomitant congenital anomaly of the left superior vena cava is an urgent task in the framework of providing the necessary medical care.

Materials and methods

This study uses medical examination methods, including clinical and instrumental examinations recommended in the official healthcare protocols of Kazakhstan with the necessary examination of cardiac patients. Thus, the methods used were taking anamnesis, complaints, physical examination of selected patients, standard general clinical examinations at the level of hospitalisation in the framework of identifying the necessary laboratory parameters (6). The instrumental research methods included the registration of 12-lead electrocardiography, transthoracic echocardiography, chest X-ray, angiocardiographic examination of blood vessels, multispiral computed tomography, which allowed confirming all available aspects of the clinical diagnosis in patients before implanting a permanent pacemaker, during a re-examination of the effectiveness of the implantation according to the standard scheme, which was supplemented at the level of the developed elements for attaching pacemaker electrodes, based on comorbidity in patients in the form of a congenital anomaly of the left upper vena cava, which also allowed determining the effectiveness.

The results obtained were statistically processed using the STATISTICA 8.0 programme, and the Kruskal-Wallis criterion was used to statistically assess the level of reliability. The results are also displayed using a graphic image in figures and tables. The study was conducted based on the National Scientific Center for Surgery named after A.N. Syzganov in Almaty, Republic of Kazakhstan. 38 patients with atrial fibrillation related to tachy-brady syndrome and concomitant congenital anomaly of the persistent left superior vena cava were examined. The age of the subjects ranged from 46 to 57 years, among whom there were 22 women and 16 men. Before the examination, all patients had their written consent to take part in it. Moreover, the study considered other basic principles at the level of general clinical epidemiology in selecting patients based on the data obtained, processing and monitoring of the results. The study consists of three stages. At the first stage, analytical and theoretical analysis of scientific and methodological literature on the treatment of tachy-brady syndrome with concomitant atrial fibrillation by means of surgical implantation of an artificial cardiac pacemaker, in particular in patients with congenital pathology in the form of persistent left superior vena cava, was conducted, during which the problem, purpose, research methods were determined, and a work plan was drawn up. At the second stage, clinical and instrumental examinations of patients with tachy-brady syndrome were conducted, the results were analysed, and conclusions were formulated. At the third stage, the obtained results and conclusions were clarified and systematised.

Results and discussion

Within the framework of the system-activity approach, a detailed analysis of the data obtained from clinical and instrumental examinations was conducted, reflecting factors in the field of medical care for patients with tachy-brady syndrome along with identified atrial fibrillation factor and the concomitant presence of a congenital anomaly of vascular structure in the persistent left superior vena cava. Nowadays, based on long-term practice in treating the weakness of the sinus node, reflected to a large extent in the reduction of vitality and the ability to perform various physical activities, where the physical performance of the heart along with the main household load which becomes unbearable very fast, the generally accepted treatment regimens are implantation of an artificial cardiac pacemaker and drug therapy (7). Atrial fibrillation mainly affects the able-bodied part of the population, which necessitates the investigation of the necessary therapy for these patients according to the degree of recovery of the cardiorespiratory system endurance as an important and priority part of medicine. At the first stage, atrial fibrillation may pass unnoticed for the patients themselves, but in the occurrence of tachy-brady syndrome, this pathological syndrome can create conditions for the premature death of patients.

Thus, even at the stage of timely diagnosis, there is a need to monitor patients at risk, since cardiac arrhythmias can occur due to, for example, a sharp increase in workload. A person's life depends on maintaining the tone and endurance of the cardiac muscle, since throughout it there may situations that will, at different levels, including the ideomotor one, increase the load in the aspect of aerobic mechanism, so improper breathing or a decrease in endurance, a waste of personal cardiac reserve in performing a high-intensity load can disrupt the functioning of the body, acting as the starting point in the disease progression in the form of a violation of the sinus rhythm of the heart (8). Often, the accompanying criteria

and parameters of life circumstances in performing the necessary physical activity, sports activities, psycho-emotional stress, or other causes of anxiety and overload do not allow the patient to stabilise the disturbed somatic state, while the physical and emotional work create conditions for aggravating the rhythm disturbance, which becomes chronic. Thus, based on an increase in the performance of a threshold physical or long-lasting psychoemotional load for the body, a functional disorder occurs, which manifests itself in a failure of the sinus rhythm of the heart (9).

Over time, while maintaining external negative circumstances, the failure aggravates and acquires a chronic form, which, against the background of drug therapy and various factors, accompanied by the development of degenerative processes, and influenced by many physiological and age-related aspects, causes the emergence of various diseases that in the modern world have become common for people of a certain age. These include arterial hypertension, coronary heart disease, and other cardiopathies, which, based on current trends, spread due to the introduction of large, intense physical exertion into the life of the population in fitness halls, gyms, or other places where training and reaching of qualifying standards take place, causing the excessive physical, aerobic, or emotional load on the human body (10). Further, the considered and other pathologies are reflected in the structural changes in the morphology, which has a short-term effect within the framework of any, even minor functional disorder, and carries pathologically changeable structural parameters in determining human anatomy, based on the lengthening of the time interval in the order of functional impairment, in which morphology always has a concomitant element. Thus, the functional circle of pathology development forms the persistent pathological morphology, which will be reflected in the work of the whole organ, in particular the heart, and further carry pathology at the level of the cardiovascular system. In this case, the cardiac muscle, like any muscle in the body, acquires a persistent pathological stereotype in the work with the ongoing development of tachyarrhythmia, where fatigue factors in reducing its performance will manifest themselves as periods of bradycardia (11).

Thus, at the phase of functional impairment, the tachy-brady syndrome affects the general activity of patients, who will have a sharp decrease in endurance, not be able to perform their usual work, which will generally affect their quality of life, including lack of strength to perform the work and movement necessary to maintain a healthy life. The developed weakness of the sinus node will be reflected in a condition that is life-threatening. At this stage of the disease in the form of atrial fibrillation, it becomes necessary to use treatment methods that will maintain the sinus rhythm of the cardiac muscle at a stable level, both at rest and when performing optimal physical activity (12). As clinical experience shows, this condition cannot be achieved in a stable, compensated form at the phase of drug therapy. Therefore, various clinicians proved that to maintain the sinus rhythm, a technically developed means are used in its stability factor, such as an artificial cardiac pacemaker, which allows the heart to beat at a programmed level (13). Currently, the implantation of an artificial cardiac pacemaker is an ordinary surgery that can be performed by any certified cardiac surgeon, but the clinical practice also shows factors that an incorrectly selected programme for heart contraction, with an increase in load on it, can lead to the development of premature heart failure or atrial fibrillation, which increases the likelihood of the patient's death. In many ways, these parameters depend on the criteria, such as setting the mode of cardiac performance on the line of its stimulation by this device, the place of implantation of the electrode or its introduction, which will then give electrical signals at the level of cardiac muscle contraction. In connection with the aspects under consideration, various studies are regularly conducted in this area, and cardiac surgeons use different schemes of implantation and stimulation of the heart to find optimal criteria. Despite this, the treatment of tachy-brady syndrome in the form of implantation of a permanent pacemaker has become common, and according to statistical research in the field of healthcare, these surgeries occupy about a third of all heart surgeries performed (14).

Nevertheless, there are several reasons why performing implantation of an artificial cardiac pacemaker may be difficult and even not feasible, since technically, the schemes for performing these surgeries, due to certain anatomical reasons, must be supplemented with stages that will be performed based on individual developments. One of such reasons is the congenital persistent left superior vena cava. It occurs in the intrauterine development of the foetus, where the anomaly in question develops as a result of the pathology of obliteration of the left anterior cardiac vein, so its drainage is observed in the right atrium, which will affect the coronary sinus to a greater extent. Alternatively, its drainage is observed in the left atrium in its isolated position, which is detected in a small percentage compared to the previous one. Sometimes, from the position of abnormal development, the right superior vena cava will be absent under the influence of various factors of intrauterine development. In this case, the main drainage of the upper extremities and head in a person with this pathology will be carried out only thanks to the left superior vena cava. Thus, the concomitant pathology at the level of the persistent left superior vena cava, based on various causes occurring during foetal development, may also affect the pathological development of the posterior defect of the atrial septum, which is located in the area of the coronary sinus. The above is accompanied by an atrioventricular canal defect and a possible absence of inferior vena cava (15). The described data are important when the need for surgical implantation of a permanent pacemaker is identified due to tachy-brady syndrome, where concomitant persistent left superior vena cava is considered as an enhancement of the clinical picture in patients, and so jugular and subclavian veins may be used in this surgical treatment (16).

Due to the difficult diagnosis of this pathology, for many patients, even in the presence of the anomaly under study, information about collecting an anamnesis or the history of the disease may not be available, and only during the surgery or during additional examinations, it can be detected. Therewith, if a persistent left superior vena cava is detected during usual and generally accepted surgery, several conditions that cause technical difficulties can occur, and even in its absence, it is a risk factor during the surgery in any case. Thus, any cardiac surgeon should be ready to change tactics during the regular surgery and, based on deep

Tab. 1. Clinical characteristics of patients.

Criteria	Number of patients (n=38)
Age	51 (46; 57)
Arterial hypertension	26; 68.4%
Coronary heart disease	31; 81.5%
Infective cardiomyopathy	8; 21%

Table 2. Patient complaints.

Complaints	Number of patients (n=38)
Pre-syncope states	33; 86.8%
Dizziness	38; 100%
General weakness	38; 100%
Shortness of breath during exercise	38; 100%
Rapid fatigue	38; 100%
Chest pain	29; 76.3%

anatomical knowledge of the cardio-vascular system, to find new approaches at the level of electrode insertion or its necessary implantation in the patient to ensure high-quality electrical control by the pacemaker in the future, which ensures the success of this surgical implantation and treatment in general (17). Moreover, before or during this surgery, there are aspects for conducting the necessary diagnostics to the extent of detecting various anomalies in the vascular bed. Considering the above, all the identified criteria and parameters were analysed in detail, both individually and in their effective components, which initiates the development of a method of surgical implantation of a permanent two-chamber pacemaker in patients with tachy-brady syndrome and persistent left superior vena cava so it can be further applied in the field of practical medicine to improve the quality of cardiological care in Kazakhstan. The result of the study is the degree of development of the model in question regarding its implementation in the field of practical medicine.

Thus, this study, in developing the parameters of implantation of a permanent pacemaker from the standpoint of the effectiveness of such surgical treatment, allows creating clinical compensation for the disease; it can be introduced into the field of practical medicine in several stages since it included the investigation of aspects regarding the treatment of tachy-brady syndrome and various aspects during the implantation of an artificial cardiac pacemaker. Further, the data obtained were statistically processed, subsequently, at the next stage, the implantation model was developed and tested in the form of identifying vascular anomaly for its subsequent introduction into the field of practical medicine, which will improve the cardiological care, thus solving an important task in the field of healthcare. This examination covered 38 patients diagnosed with tachy-brady syndrome with atrial fibrillation, sick sinus syndrome, and persistent left superior vena cava. The cardiological diagnosis was made to all patients at the polyclinic stage based on daily monitoring of the Holter electrocardiogram. The parameters of the congenital vascular anomaly were disclosed during the surgical treatment later. Based on the clinical examination data, the patients suffered from arterial hypertension (68.4 %), coronary heart disease (81.5 %), cardiomyopathy of infectious genesis (21 %), which is presented in Table 1.

Table 2 presents the average values of the main complaints made by patients, which collectively reflect cardiovascular pathology.

Based on the analysis of the cardiogram data, heart rate indicators were identified, which were determined in the parameter 48±2 at rest, and its minimum value was 35±1. The analysis of the obtained clinical data confirms the need for patients to stabilise their somatic state in the phase of increasing contractility of the heart in the sinus rhythm restoration for surgical implantation of a system of permanent two-chamber pacing. Notably, all patients were admitted for implantation of a permanent pacemaker to the National Scientific Center of Surgery named after A.N. Syzganov after unsuccessful attempts to do this in hospitals at the place of residence, therefore, these patients were initially considered to be at a possible risk during the surgical intervention (18). This criterion can be considered further based on the described clinical experience, as the presence of a concomitant parameter must be excluded by involving an additional research method. Thus, upon using the chosen tactics, the congenital anomaly in the form of a persistent left superior vena cava was detected. At the level of generally accepted preoperative preparation, as part of the identification of diagnostic criteria necessary for the successful operation, patients underwent a chest X-ray and transthoracic echocardiography, but within the framework of these diagnostic methods, no abnormalities of the development of the vascular bed of the heart were detected. This fact shows that in several problems in the field of the condition of the major vessels, the methods used cannot be considered reliable.

Thus, the above-described parameters and facts dictate the need to develop a model for implantation of a permanent two-chamber pacemaker in patients with atrial fibrillation with tachy-brady syndrome and persistent left superior vena cava when their satisfactory state and sinus rhythm of the heart are restored. The study required methodological analysis and identified its main parameters, which, based on a generalised approach to ensuring the effectiveness of treatment and the establishment of an optimal state in patients, allows introducing the developed elements of surgical treatment into the field of practical medicine. Therefore,

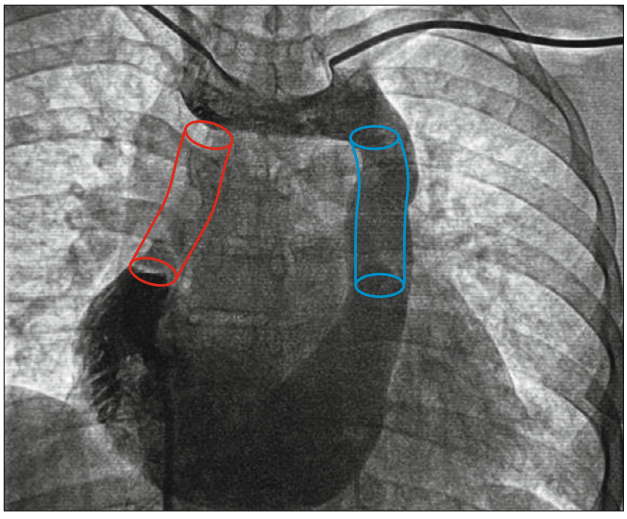

Fig. 1. The detected anomaly of the major vessels of the heart.

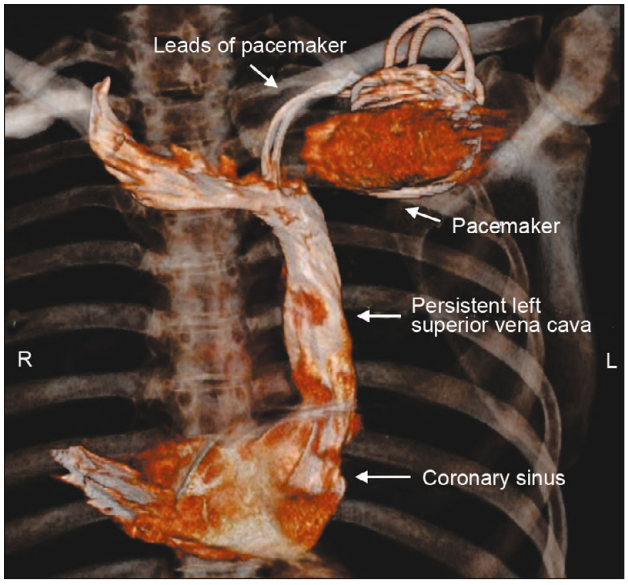

Fig. 2. Anomaly of the major vessels of the heart.

given the above, the model for implantation of a permanent dual-chamber pacemaker was developed, within which, during surgical treatment, the left and right subclavian vein and the right femoral vein were punctured, which allowed clarifying the anatomy of the heart and large veins. Then, through the introducer and catheter, the selected radiopaque agent was introduced into the left and right subclavian veins and into the right atrium through the femoral catheter, which showed the flow of the agent from the subclavian veins into the persistent left superior vena cave and into the cavity of the right atrium through the venous coronary sinus; then, the endocardial right ventricular electrode was inserted into the subclavian vein through the tricuspid valve and further positioning of the corresponding electrode in the apex of the right ventricle was performed, which allowed successfully installing a permanent two-chamber pacemaker.

At the control stage, the developed model of implantation of a permanent pacemaker was tested in practice. Notably, all surgical treatments performed in 38 patients were performed successfully. However, in several cases (39.4 %), when the endocardial right ventricular electrode was inserted through the subclavian vein, technical difficulties were observed in conducting it through the tricuspid valve and positioning it in the apex of the right ventricle. In addition, technical difficulties (55.2 %) were in the factor of passing the endocardial electrode through the persistent left superior vena cava in the fact of passing it from the coronary sinus into the cavity of the right ventricle through the tricuspid valve. This led to the conclusion that it is necessary to train this process on the appropriate training dummies, so that at the level of practical application these actions are successful, clear, and exclude the delay in the field of surgical intervention and the factors of possible complications when performing fuzzy actions. Figure 1 presents an angiographic X-ray of a congenital persistent left superior vena cava that flows into the right atrium cavity through the coronary sinus and reflects the complete absence of a normal superior vena cava on the right.

The results of the multispiral computed tomography of the chest organs with contrast to confirm the anomaly of the large vessels of the heart are demonstrated in Figure 2.

Figure 3 shows the anteroposterior projection after the implantation of endocardial electrodes and a permanent two-chamber pacemaker.

Figure 4 is the right-lateral projection which shows two implanted endocardial electrodes and an artificial cardiac pacemaker after its implantation.

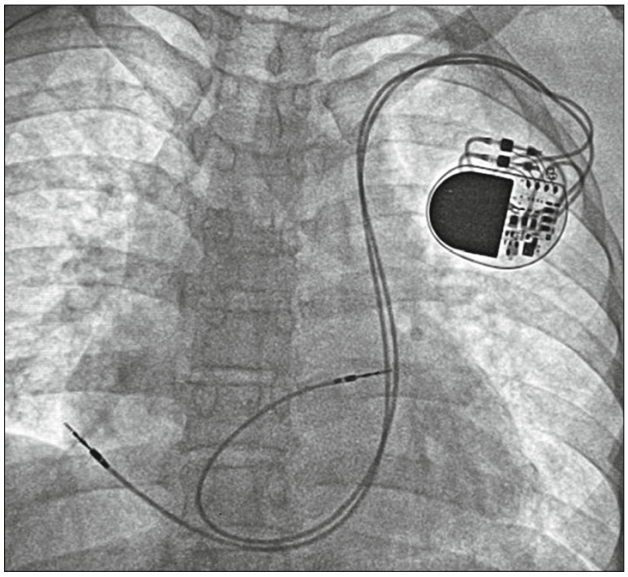

Fig. 3. Anteroposterior projection of an implanted permanent two-chamber pacemaker and endocardial electrodes.

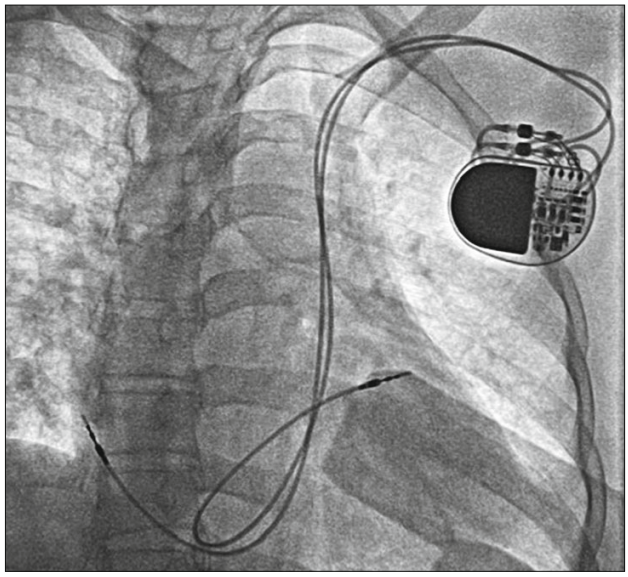

Fig. 4. Right-side projection of an implanted permanent two-chamber pacemaker and endocardial electrodes.

Table 3. Complaints of patients after surgery.

Complaints	Number of patients (n=38)
Pre-syncope states	–
Dizziness	11; 28.9%
General weakness	14; 36.8%
Shortness of breath during exercise	14; 36.8%
Rapid fatigue	14; 36.8%

The success of the surgical treatment was also confirmed in the early postoperative period, which proceeded without complications. As part of the dynamics, Table 3 presents the complaint of patients after surgery, which allows identifying positive clinical dynamics in the operated patients.

In addition, the indicators of heart rate in the postoperative period identified during the dynamics allowed obtaining data in the parameter 81±4 at rest, and its minimum value was 76±2. After discharge, the patients were registered with a cardiologist under dynamic observation against the background of anticoagulant therapy. In addition, a follow-up examination a month after the operation disclosed satisfactory hemodynamic parameters in them. The parameters of the implanted pacemaker were within the normal range. Thus, the analysis of the data obtained proved the success of the developed model of surgical implantation of a permanent pacemaker, which, when introduced into the practical field of medicine, will allow providing professional cardiac surgical care to patients within the framework of planned treatment. The correctness of this study is ensured, since the characteristics and parameters of clinical and instrumental research methods, the data obtained, and the developed model are consistent.

This study showed that among the standard cases of the implantation of an artificial cardiac pacemaker, there are patients who require an individual approach to treatment, so the cardiac surgeons need the necessary skills to timely adapt to the newly identified parameters and perform surgery. Thus, the possible manifestations in the patient will be reflected as the parameters and individual structure of the anatomical structures, first detected congenital anomalies. Since in the general practice developmental anomalies in patients are extremely rare, including in the practice of a cardiac surgeon, the investigation of the field of medical research centres, where patients from different parts of the country and regions come to receive highly qualified medical care, showed that there is a seemingly rare congenital pathology, which becomes more common within one specialised medical centre (19). In this context, the professional training of specialists based on an individual approach and the search for ways of surgical treatment that would allow the cardiac surgeon to perform the necessary anatomical and functional restoration, and, as in the case under study, the implantation at a competent level becomes relevant. Since successful heart surgery creates conditions for further stabilisation of the cardio-respiratory system to restore optimal heart performance, increase endurance and quality of life in patients, including those with tachy-brady syndrome and aggravated anamnesis at the level of existing congenital pathology in cardiac patients (20-22). Thus, the developed model allows for timely professional cardiac surgical care for patients with sick sinus syndrome and concomitant congenital anomaly of the major vessels of the heart, which is of practical importance for the healthcare sector.

Conclusions

In the practice of cardiac surgeons, there may be cases when special professional knowledge and skills are required to timely solve emerging issues within the framework of providing professional cardiac surgical care to the population. Along with the frequently encountered tasks in the treatment of patients based on their diagnosis, there are patients who need an individual approach, including when performing the necessary surgical treatment to restore their functional performance to an optimal degree, based on the available capabilities. Thus, a small percentage of patients with tachy-brady syndrome has a concomitant congenital pathology in the form of a persistent left superior vena cava, and as part of the necessary implantation of a permanent two-chamber pacemaker, a scheme for changing the usual surgical implantation will be necessary. Congenital anomalies cause various difficulties, from the standpoint of diagnosing these conditions and performing surgery.

Therefore, a model of complementary elements to the implantation of a permanent two-chamber pacemaker was developed, which allows stabilising the patient's condition having atrial fibrillation with tachy-brady syndrome and concomitant congenital pathology in the persistent left superior vena cava; the model, along with the standard approach to implantation, includes diagnostic administration of a radiopaque agent that clarifies the anatomical structure of the vascular bed with the subsequent gradual introduction of an endocardial right ventricular electrode through the subclavian vein, and then through the tricuspid valve with its stable positioning in the apex of the right ventricle, which allows successfully implanting a pacemaker in patients with anatomical anomalies of the major vessels of the heart to restore their sinus rhythm, increasing the endurance and quality of life. The materials of this study are useful for cardiac surgeons and other healthcare professionals, and can be applied in practice, which will improve the quality of cardiac surgical care and solve problems in the field of practical medicine.

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