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First experience of treating patients with atrial fibrillation using thoracoscopic isolation with left atrial appendage excision in the North-Western State Medical University named after I.I. Mechnikov

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ABSTRACT

The given article describes the first experience of a thoracoscopic isolation of pulmonary veins and left atrial appendage excision in the North-Western State Medical University named after I.I. Mechnikov. The clinical case features a woman with a long history of paroxysmal atrial fibrillation, severe left atrium dilation, failure in a pace control drug therapy and no effect of radiofrequency catheter isolation of pulmonary veins.

Additionally, there outlined the advantages and the significance of employing the method of thoracoscopic ablation in patients with symptomatic paroxysmal and long-term persistent atrial fibrillation, — in case if antiarrythmic drugs and radiofrequency catheter ablation proved ineffective, as well as in patients with a long-term persistent atrial fibrillation along with a severe left atrium dilation.

Keywords: paroxysmal form of atrial fibrillation; thoracoscopic ablation; radiofrequency isolation of the pulmonary veins; excision of the left atrial appendage.

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Первый опыт лечения пациентов с фибрилляцией предсердий методом торакоскопической деструкции аритмогенных зон сердца с резекцией ушка левого предсердия в ФГБОУ ВО СЗГМУ И.И. Мечникова

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АННОТАЦИЯ

Описан первый опыт применения в СЗГМУ им. И.И. Мечникова торакоскопической изоляции коллекторов легочных вен с резекцией ушка левого предсердия, на клиническом примере пациентки с длительным анамнезом пароксизмальной фибрилляции предсердий, выраженной дилатации левого предсердия, неэффекивностью медикаментозной терапии для контроля ритма и отсутствием эффекта от радиочастотной катетерной изоляции устьев легочных вен.

Обсуждается преимущества и важность использования методики торакоскопической абляции у пациентов с симптомной пароксизмальной фибрилляцией предсердий при неэффективности консервативной стратегии и радиочастотной катетерной абляции, а также у пациентов с длительноперсистирующей фибрилляцией предсердий, в том числе со значимой дилатацией левого предсердия.

Ключевые слова: пароксизмальная фибрилляция предсердий; торакоскопическая деструкция аритмогенных зон сердца; радиочастотная изоляция устьев легочных вен; резекция ушка левого предсердия.

Как цитировать

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BACKGROUND

Atrial fibrillation (AF) is currently one of the most frequently diagnosed forms of cardiac rhythm disorders, and the number of newly diagnosed AF cases is continuously increasing worldwide [1, 2]. The most significant complications of this arrhythmia include ischemic stroke, often incapacitating patients, and/or left ventricular dysfunction, which causes severe heart failure.

Basic approaches to AF treatment, aimed at attempting to restore sinus rhythm (SR), include drug therapy, which involves the control of heart rhythm or rate, or an endovascular strategy, which consists mainly of transvenous catheter isolation of the pulmonary vein ostia (IPVO), as the main AF triggers using exposure to high-frequency current, that is, radiofrequency isolation (RFA) of the IPVO. The latter method is a proven and very effective treatment of paroxysmal AF (PAF), making it the first-line treatment for PAF. The absence of PAF within 1 year after the procedure is reported in 80% of patients with PAF [3].

Unfortunately, catheter isolation of the PVs is not always able to eliminate arrhythmia, and if it returns, catheter procedures required repeatedly. In addition, the probability of SR restoration and the effectiveness of its maintenance are also reduced in patients with chronic PAF. One of the modern methods of treating these patients is minimally invasive surgical intervention, involving thoracoscopic epicardial destruction of the arrhythmogenic zones of the heart with resection (deactivation) of the left atrial appendage (LAA) or thoracoscopic radiofrequency ablation (TRFA) [4, 5]. This surgical method involves endoscopic bilateral antral isolation of the left and right PVs (RPVs) and drawing ablation lines along the roof and posterior wall of the left atrium to form a closed contour, a box lesion set. LAA amputation is performed to prevent potential cardioembolic complications, which is caused by the extremely high risk of blood clots (up to 90%) in this cardiac structure in AF and their subsequent migration into the vessels of the systemic circulation [6]. The LAA is resected using a special suturing device or removed from the bloodstream by clipping. According to the European Clinical Guidelines for the Diagnostics and Treatment of AF of 2020, thoracoscopic epicardial ablation has a class IIa indication in patients with failed previous catheter ablations and in symptomatic cases with chronic PAF refractory to drug therapy [7].

DESCRIPTION OF A CLINICAL CASE

Patient D (female, aged 63 years) presented for the surgical treatment of complex cardiac arrhythmias and electrical stimulation to the Department of Cardiac Surgery, Peter the Great Clinic of the Mechnikov North Western State Medical University, because of frequent episodes of "heart failure", shortness of breath, and associated general weakness, which significantly reduced her quality of life. The medical history revealed PAF for approximately 10 years, for which she received protective antiarrhythmic therapy with one or another antiarrhythmic drug for 7 years, including metoprolol, bisoprolol, and sotahexal. However, because of the ineffectiveness and an increase in the number of attacks up to 4–6 times a week, in 2018, she was referred to the Peter the Great Clinic for catheter RFA of the PVO. In 2018, RFA of the PVO was performed using the CARTO 3 non-fluoroscopic navigation system (Biosense Webster, Inc., USA). Anatomical mapping of the left atrium was performed, according to which the LA volume significantly exceeded the echocardiography values (250 vs 178 mL). Using a THERMOCOOL SMARTTOUCH SF ablation catheter (Biosense Webster) with contact force measurement, ablation effects were applied to isolate the right and left PV collectors. PV isolation was monitored using a LASSO catheter (Biosense Webster). An acute effect was obtained in the form of PV isolation. The patient was discharged with β-blocker therapy, angiotensin-converting-enzyme inhibitors, and new oral anticoagulants. However, a year after the surgery, AF began to recur initially no more than once every few months and by the time of re-application up to several attacks weekly. During the examination, according to 24-h Holter ECG monitoring (Fig. 1), PAFs were recorded with a total duration of approximately 5 h, with a heart rate of 48–169 beats per minute. After discussion with arrhythmologists, due to the presence of clinical symptoms, taking into account the disease duration (10 years of PAF), and significant dilatation of the LA, hospitalization was recommended for thoracoscopic destruction of the arrhythmogenic zones of the heart and LAA resection.

The principal diagnosis was made preoperatively (hypertension II, risk of cardiovascular complications 3, PAF, EHRA IIb, condition post-catheter RF IPVO (2018)). Complications were NYHA grade II heart failure with preserved ejection fraction, CHA2DS2-VASc of 3, and HAS-BLED of 2. Concomitant diseases were type II diabetes mellitus, which was managed by oral antihyperglycemic therapy and grade I obesity.

In addition to the routine preoperative examination, which included laboratory and clinical instrumental methods, to rule out anomalies in the entry of the PVs into the LA, assess the size and volume of the left atrium and LAA, and exclude the presence of a thrombus in the LAA, in the preoperative period (48 h before intervention), the patient underwent multislice contrast computed tomography (MSCT)

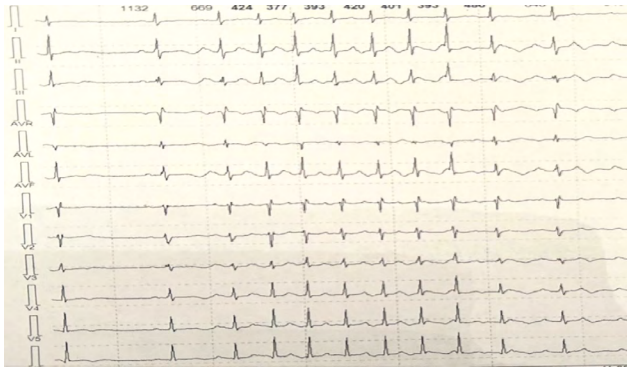

Fig. 1. 24-hour ECG monitor (50 mm/s) of patient D in the presence of paroxysmal atrial fibrillation
Рис. 1. Суточное электрокардиографическое мониторирование (50 мм/с) пациентки Д. на фоне пароксизма фибрилляции предсердий

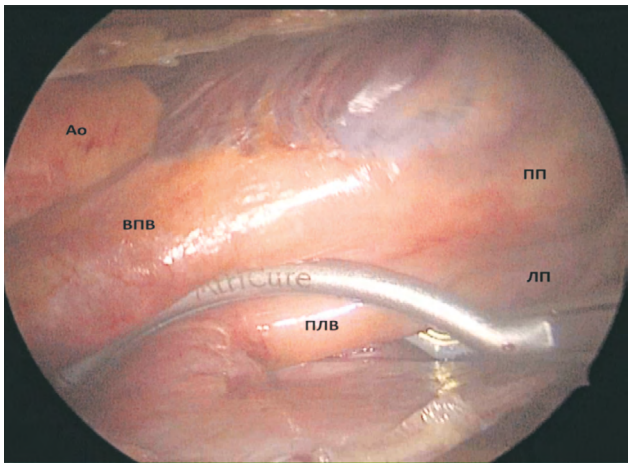

Fig. 2. Stage of the thoracoscopic isolation of the pulmonary veins with a bipolar clamp electrode. Ao — aorta; ЛП — left atrium; ПП — right atrium; ПЛВ — right pulmonary veins; ВПВ — superior vena cava
Рис. 2. Этап торакоскопической изоляции легочных вен биполярным зажимом — электродом. ПП — правое предсердие; Ao — аорта; ВПВ — верхняя полая вена; ЛП — левое предсердие; ПЛВ — правые легочные вены

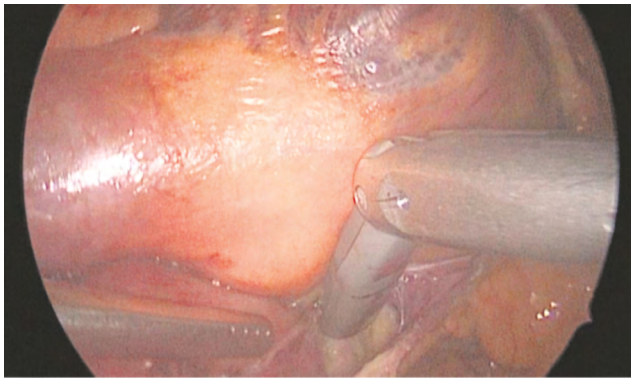

Fig. 3. Stage of ablation with a unidirectional bipolar electrode of the ganglion plexuses in the right pulmonary veins ostium
Рис. 3. Этап абляции однонаправленным биполярным электродом ганглионарных сплетений в области устьев правых легочных вен

of the heart. According to MSCT data, the LA volume was 189 mL, measuring 70 × 45 × 60 mm, the RPVs enter into the atrium as a single collector, whereas the left PVs have a common arrangement. The LAA measured 37 × 17 mm, and no blood clots were detected in the cavity. Transthoracic echocardiography and coronary angiography (performed to rule out significant stenoses of the coronary arteries) did not reveal any additional pathology. Two days before surgery, the patient discontinued taking indirect anticoagulants and started taking low-molecular-weight heparins in an adequate dosage.

The surgery was performed in May 2021. Under endotracheal anesthesia with selective one-lung ventilation, thoracoscopic approach to the right hemisphere was made through three separate punctures in the chest.

After opening the oblique and transverse sinuses of the pericardium, antral isolation of the RPVs was subsequently performed using a special bipolar Isolator Synerg Clamp (AtriCure Inc., USA) at 10 radiofrequency impacts, with transmural control (Fig. 2).

Moreover, using a bipolar unidirectional electrode, an Isolator RF pen (AtriCure Inc.) from the same access, continuous epicardial ablation lines were applied along the LA roof and base. The upper line was drawn to the LAA from the right superior PV, through the transverse sinus, and the lower line was drawn from the right inferior PV to the left inferior PV, along the LA inferior wall. The autonomic ganglion plexuses, as part of the cardiac autonomic nervous system, can be triggers of pathological excitation outside the PVs, triggering AF episodes [8]. They were also subjected to ablation effects, being located in the subepicardial fatty tissue, particularly in the area of the RPV confluence and Waterston's groove (Fig. 3).

Then, the surgery proceeded from the left-sided approach, with the same sequence of actions, namely, tenfold isolation of the antral segments of the left PVs with a bipolar clamp, with transmural control, and further revision, under visual control, of the lines of the epicardial ablation of the left atrium (posterior wall and roof), with the creation of a closed circuit along box lesion type (Fig. 4).

The ligament of Marshall, located in the epicardial fat fold between the left PVs and the LAA, is also easily accessible from this approach, which is also a potential arrhythmogenic substrate. In our case, it was also subjected to ablation.

The final stage of surgical treatment was LAA resection, which was performed using a special endoscopic cutting and suturing device, the ENDO GIA stapler (Tyco Healthcare Group, North Haven, USA). After installing drains in both pleural cavities and completing the surgery, the patient was

transported to the resuscitation and intensive care unit for further case follow-up.

The patient was discharged on day 7 after surgery in satisfactory condition. For the first 3 months, antiarrhythmic therapy for such patients involves the intake of amiodarone (100 mg/day), followed by 24-h monitoring and discontinuing the drug if SR persists.

For 2.5 years after the surgery, the patient subjectively feels well, no PAFs were noted either clinically or according to 24-h ECG monitoring while taking bisoprolol 5 mg/day, fosinopril 20 mg/day, and xarelto 20 mg/day.

DISCUSSION

TRFA, supplemented by LAA resection, has been known since 2005, after R.K. Wolf et al. [9] published their results of bilateral epicardial PV ablation for AF with LAA removal through a minimally invasive approach with video-assisted support. The undoubted advantage of thoracoscopic RFA in comparison with the maze surgery introduced into clinical practice by J.L. Cox is significantly associated with less surgical aggression and absence of the need to use cardiopulmonary bypass with cardiac arrest, which can have a decisive influence on the results of treatment in patients with severe comorbid pathology [10, 11]. Compared with open surgery, thoracoscopic ablation is less traumatic and has fewer perioperative complications and shorter hospitalization periods. Compared with endovascular PV isolation, according to recent studies, TRFA is more traumatic but demonstrates more optimistic results in maintaining SR in patients with PAF and those referred for repeated catheter intervention who are resistant to drug therapy [12, 13].

The presented clinical case of the treatment of a patient with chronic PAF and a previous history of catheter-based IPVO is one of the first cases of surgical treatment of such patients at the Mechnikov North Western State Medical University by thoracoscopic destruction of arrhythmogenic zones. To date, with surgical treatment of complex cardiac arrhythmias and electrical stimulation in the Department of Cardiac Surgery, a total of 23 such surgeries have been performed over 2.5 years. The main results are still subject to serious analysis; howeve, the first findings can already be shared.

All cases referred for TRFA were previously discussed by a team of doctors, including an arrhythmologist, an anesthesiologist, and a cardiac surgeon. The indications considered the absolute lack of prospects for drug antiarrhythmic therapy and catheter intervention. Only 3 out of 23 patients had not previously undergone endovascular ablation. These were symptomatic patients with chronic PAF

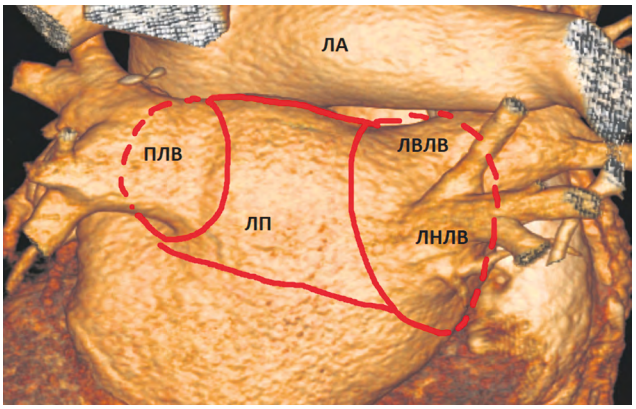

Fig. 4. Formation of ablation lines during thoracoscopic RFA: ПЛВ — right pulmonary veins (single collector); ЛВЛВ — left superior pulmonary vein; ЛНЛВ — left inferior pulmonary vein; ЛП — left atrium; ЛА — pulmonary artery Ablation lines are indicated in red

Рис. 4. Формирование линий абляции при выполнении торакоскопической радиочастотной абляции: ПЛВ — правые легочные вены (единым коллектором); ЛВЛВ — левая верхняя легочная вена; ЛНЛВ — левая нижняя легочная вена; ЛП — левое предсердие; ЛА — легочная артерия. Красным цветом обозначены линии абляции

and increased LA sizes, whose treatment with catheter RFA was considered inappropriate. The maximum duration of AF noted in patients who underwent surgery was 15 years, with a maximum of 4 catheter ablations in the history.

Basically, surgery is performed on patients who had undergone one or more transvenous catheter RFA, and the pericardium tissues damaged by inflammation were intraoperatively revealed, which somewhat complicates the main stage and lengthens the surgery, particularly in the initial stages. This may have occurred because two patients required conversion to sternotomy (in one case with the use of cardiopulmonary bypass) due to bleeding. In case 1, it could be caused by damage to the right superior PV, and in case 2 (in an older man) it could be caused by LA damage. In both cases, bleeding was stopped, and the rhythm was restored intraoperatively.

In two patients, TRFA was abandoned during the surgical intervention because at the initial stage dense adhesions were noted in the pericardial cavity. Their presence is a contraindication for thoracoscopic surgery because of the critical risk of fatal bleeding. Unfortunately, neither MSCT of the heart with contrast nor preoperative transthoracic echocardiography could predict the presence of adhesive process in the pericardium. Among other contraindications to TRFA, the following should be noted: (a) a history of open heart surgery (for the same reason, the formation of adhesions in the pericardium), (b) a thrombus in the LAA (due to the high risk of its dislocation during the intervention), and (c) the patient's inability to tolerate one-lung ventilation

(concomitant pulmonary pathology causing severe respiratory failure).

According to the primary analysis, the majority of the patients who underwent surgery maintained SR during the first 6 months after TRFA, which corresponds to the main data published in the literature [14]. Despite the first optimistic results, patient follow-up will allow for a more objective study. Recently, an increasing number of studies have indicated the need for a combined hybrid approach (catheter and thoracoscopic) in the treatment of complex groups of patients with chronic PAF resistant to drug and endovascular treatment [15, 16]. Some of the patients from our group who underwent surgery will also require this method.

CONCLUSIONS

This study presents a clinical case of the successful thoracoscopic destruction of the arrhythmogenic zones of the heart with LAA resection and ablation of the ligament of Marshall in a patient with chronic AF (paroxysmal AF for 10 years) and severe LA dilatation that was unresponsive to drug therapy and catheter IPVO first performed at the Mechnikov North Western State Medical University. This case demonstrates the consistency of the method and good prospects for its practical application in the treatment of this category of patients.

ADDITIONAL INFORMATION

Ethics approval. Written consent was obtained from the patient's legal representatives for the publication of medical information and images.

Author contribution. All of the authors have made significant contributions to the concept development and the article preparation. All authors were directly involved in the clinical case presented and the treatment method discussed; the final article version was read and approved before publication.

Each author's contribution. D.A. Yakovlev — direct surgical interventions, data gathering and its analysis, article conception and text writing; A.I. Lenkyn — Anaesthetic support of surgical interventions, analysis of the received data, text writing; V.V. Stepanova — direct performance of catheter ablation for atrial fibrillation presented as a clinical example, development of the article concept, text writing, gathering of statistical material; V.A. Marinin — participation in the treatment process, development of the article concept, final editing; N.V. Petrov — practical participation in the treatment process, materials processing and design research; V.K. Verendeev — design research, literature review, gathering and processing of the material.

Competing interests. The authors declare that they have no competing interests.

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ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Заключение этического комитета. Получено письменное согласие законных представителей пациента на публикацию медицинских данных и фотографий.

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, и подготовку статьи, принимали непосредственное участие в представленном в качестве клинического случая и обсуждаемом методе лечения, прочли и одобрили финальную версию перед публикацией.

Вклад каждого автора. Д.А. Яковлев — непосредственное исполнение хирургических вмешательств, сбор и анализ полученных данных, разработка концепции статьи и написание текста; А.И. Ленькин — анестезиологическое обеспечение вмешательств, анализ полученных данных, написание текста; В.В. Степанова — непосредственное выполнение операции катетерной радиочастотной абляции, представленной в качестве клинического примера, разработка концепции статьи, написание текста, сбор статистического материала; В.А. Маринин — участие в лечебном процессе, разработка концепции, внесение окончательной правки; Н.В. Петров — практическое участие в лечебном процессе, обработка материалов и дизайн исследования; В.К. Верендеев — дизайн исследования, обзор литературы, сбор и обработка материалов.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

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