

# RESULTS OF THE THORACOSCOPIC RADIOFREQUENCY EPICARDIAL ABLATION WITH A BIPOLAR ELECTRODE DURING LONGSTANDING PERSISTENT FORM OF ATRIAL FIBRILLATION

*Rustem Tuleutaev<sup>1</sup>, Alibek Oshakbayev<sup>1</sup>, Kuat Abzaliyev<sup>2, 3</sup>, Baurzhan Rakishev<sup>1</sup>, Symbat Abzaliyeva<sup>3,\*</sup>*

<sup>1</sup>A.N. Syzgyrov National scientific Center of Surgery, 62, Zheltoksan, Almaty, Kazakhstan

<sup>2</sup>Research Institute of Cardiology and Internal Diseases, 120, Aiteke bi, Almaty, Kazakhstan

<sup>3</sup>al-Farabi Kazakh National University, 71 al-Farabi Ave., 050040 Almaty, Republic of Kazakhstan,

**Annotation** Thoracoscopic ablation using the ‘box lesion’ technique was performed using a bipolar radio frequency clamp. A total of 48 patients, including 38 men and 10 women, mean age 58 years (range 33 - 74). The mean duration of AF was 4 yrs (range 1.5 months - 21), the mean size of the atrium  $4.15 \pm 0.9$  cm (2.9-8.8 cm), mean LVEF was 57.7% (39 -73%). Mitral regurgitation of 1-2 degrees was present in 14 patients, EDV LV 147.7 ml (81-224). Primary catheter ablation was performed in 22 patients, where 5 of them (22.7%) were performed repeatedly. Resection of the left atrial appendage (LAA) during the operation was performed in 44 patients (91%). Input and output block was achieved in all patients. In the postoperative period, all patients were administered supporting antiarrhythmic therapy with amiodarone and  $\beta$ -blockers, anticoagulant therapy with warfarin or PLA for 6-12 months. The effectiveness of treatment was monitored by a cardiomonitor Reveal XT in the period 1, 3, 6, 12, 24 months after surgery, the mean follow-up length was  $498 \pm 19$  days. Sinus rhythm was restored during surgery in all patients and remained until discharge.

## 1 Introduction

AF is the most common form of supraventricular arrhythmia and is characterized by irregular atrial activation without a discrete P wave during ECG [1]. Episode of AF - atrial fibrillation documented on an ECG with a duration of 30 seconds or more (sinus rhythm should be fixed between episodes of AF). Atrial fibrillation (AF) is the most common form of arrhythmia, in which there is a high prevalence and mortality. It was established that pulmonary veins (PV) are the main source of AF development [1]. Catheter radiofrequency ablation aimed at

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\*Corresponding author: [abzaliyeva.symbat@gmail.com](mailto:abzaliyeva.symbat@gmail.com)

electrically isolating a drug is effective in the paroxysmal form of AF, however, with this technique, a high relapse rate with persistent form of AF is noted [2]. Remodelling of the conductive and structural features of the left atrium, which occurs after prolonged episodes of AF maintains AF substrate [3].

The extensive Cox-Maze surgical procedure, which combines isolation of the PV, LAA resection, coagulation of the ligament of Marshall was very effective in the treatment of persistent and long-term persistent forms of AF (duration > 1 year) [4].

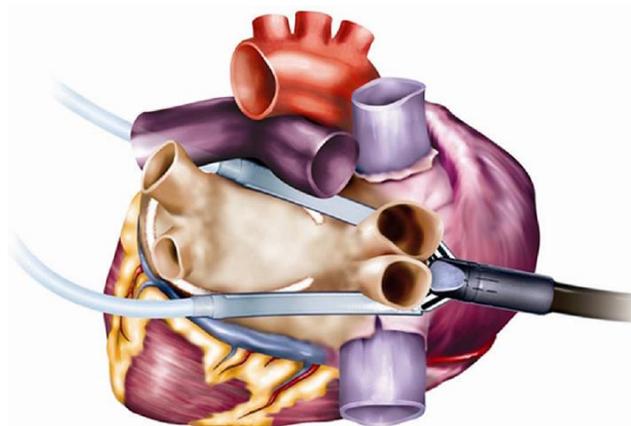
Recent studies in contrast-enhanced MRI (Gadolinium) have shown that LA fibrosis is found in areas of low voltage LA in most cases and is an important component of the structural remodeling of AF, which is significantly expressed on the posterior wall of the LA [5]. Low-voltage regions show a reduced conduction velocity and an effective refractory period, which leads to the formation of “reentry” pathways and the preservation of arrhythmia [6]. Previous studies have shown that the presence of zones with low voltage is a predictor of the inefficiency of catheter ablation of AF and the development of recurrence of AF in the future [5]. Accordingly, it was found that the creation of zones on the posterior wall of the LP with the capture of the mouths of the pulmonary veins by the “box lesion” technique reduces the recurrence of AF after ablation in patients with a paroxysmal and (prolonged) persistent form of AF [7]. An operation using unipolar radiofrequency ablation aimed at isolation using the ‘box lesion’ technique has shown unsatisfactory results, probably due to the insufficiency of the transmural effect [7].

The purpose of this study was to assess the possibility of bipolar thoracoscopic epicardial ablation with isolation of the mouths of the pulmonary veins, confirmed by a bidirectional conduction block in patients with a long-term persistent form of AF.

## 2 Materials and methods

The prospective study group included 48 patients who underwent isolated thoracoscopic RFA of the posterior wall of the LA using the “box lesion” technique, with clipping and resection of the LAA, coagulation of the Marshall ligament and intraoperative testing of the conduction block, from 2016 to July 2019. Inclusion criteria were: patients with a symptomatic longstanding persisting form of AF resistant to antiarrhythmic drugs or traditional catheter RFA, with at least one or three classes of antiarrhythmic drugs being ineffective, long-term persistent AF on ECG before surgery was recorded. The definition of a persistent form of AF was based on the recommendations of the Heart Rhythm Society/European Heart Rhythm Association. Clinical and surgical data were collected in the specialized department of JSC “A.N. Syzganova NSCS” and analyzed. The size of the left atrium was measured by transthoracic echocardiography. Transesophageal echocardiography or MSCT was performed to exclude the thrombus of the LA.

The surgery was performed under general anesthesia using double-lumen endotracheal intubation. Bilateral thoracoscopic access. Two guiding catheters were inserted through oblique and transverse sinuses [8]. An RFA bipolar clamp (Cardioblate Gemini-s, Medtronic Inc.) was attached to the guide catheters and placed so as to enclose the left pulmonary veins and the posterior wall of the LA (Fig. 1). Ablation was performed 5 times with the convexity of the clamp in the direction of the LA and 5 times with the convexity of the clamp in the opposite direction to the posterior wall of the pericardium. Each application continued until a transmural effect was achieved by RFA. This procedure is repeated on the left side, creating a zone of the type “box”, which isolates the posterior wall of the LA with the capture of the mouths of the pulmonary veins. Marshall's ligament is dissected. The left atrial appendage (LAA) is isolated using the 60 mm stapler (Endo GIA Universal Stapler, Covidien Surgical Solutions). Later, an electric cardioversion, if during the ablation it was not possible to restore the sinus rhythm was performed.



**Fig. 1.** Creation of the box, posterior wall of the left atrium and pulmonary veins (Medtronic Inc., Minneapolis).

Electrophysiological assessment was carried out by definition Input block: Target - no signals in an isolated area; Output block: The goal was the absence of pulses during stimulation of the heart from an isolated zone. After identifying the mouths of the left pulmonary veins, bipolar electrograms of the left pulmonary veins and the posterior wall of the LA were registered at maximum speed (0.05 mV / mm using the MAPS device (Medtronic Inc.). The input unit was confirmed on the basis of the absence of acute electrograms within the pulmonary veins and “box.” In the case of restoration of the sinus rhythm, 10.0 V bipolar stimulation was performed with a pulse width of 2 ms from the mouths of the pulmonary veins and the “box” zone to ensure the presence of an output block.

The result of ablation was followed up after 1, 3, 6, 12 and 24 months after surgery in accordance with the accepted clinical protocol of treatment. The evaluation was performed using a Reveal XT cardiomonitor and transthoracic Echocardiography (TTE) 3, 6, 12 and 24 months after surgery to evaluate the rhythm or episodes of AF and the size and function of the LA.

All patients begun or continued to take antiarrhythmic drugs, at least until 6-12 months after surgery, if the patient maintained a sinus rhythm. The administration of oral anticoagulants was resumed and continued for at least 6 months after surgery. Anticoagulants were canceled after 6-12 months at the discretion of the cardiologist and on the basis of the CHADS2VA2SC scale, the presence or absence of successful removal of the LAA and the preservation of the sinus rhythm and contractile function of the LA according to echocardiography. Heart rate was recorded at each observation stage using a Reveal cardiomonitor. The mean follow-up was 498 days. AF recurrence was established when any types of atrial arrhythmias were detected on the electrocardiogram or atrial arrhythmias with a duration of more than 30 s after 3 months of light period. Patients were asked to visit the clinic in case of symptoms of arrhythmia. Absolute contraindications were: the presence of sinus node weakness syndrome, left atrial appendage thrombosis, the presence of adhesions in the pericardial cavity and pleural cavities after previous operations, moderate and severe COPD, grade 3 obesity.

### 3 Results

Of the 48 patients included in the study, 79% were men. The mean age was 58 years (33-74 yr), the mean AF duration was 4y (1.5 months to 21 years), and the mean size of the LA was

4.15 ± 0.9 cm (2.9-8.8 cm), the mean LVEF was 57.7% (39-73%), mitral regurgitation of 1-2 degrees was present in 14 patients, LV EDV of 147.7 ml (81-224). The most common disease was arterial hypertension which occurred in 41 patients (85.4%), coronary heart disease was the least in prevalence: in 5 patients (10.4%) and diabetes mellitus in 4 patients (8.3%). 4 patients had a history of cerebrovascular accident. (Table 1)

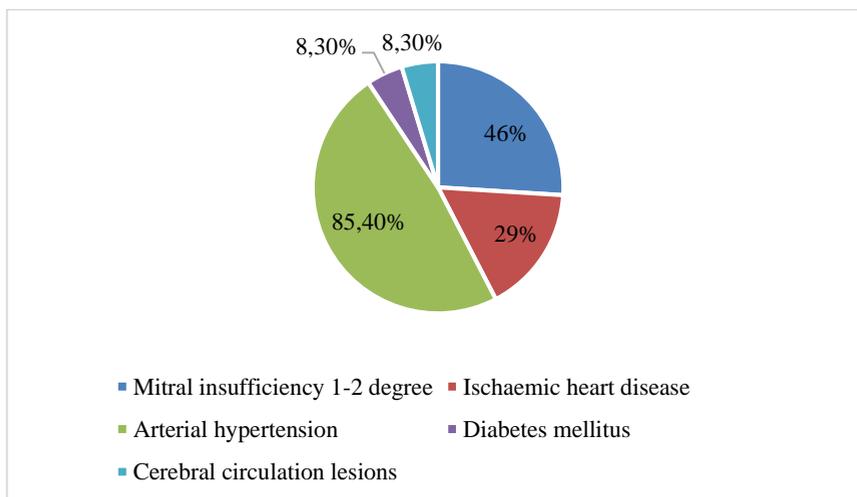
**Table 1.** Main characteristics of the studied patients.

Characteristics	n	%
Men	38	79
Age at the time of the intervention (yr)	58	33-74y
Body mass index (kg/m <sup>2</sup> )	29,7	
Left atrium size (cm)	4,15±0,9	
AF life-duration (years)	4y	1,5 months - 21 years
Previous ablation, % (n)	22	46
Mitral insufficiency 1-2 degree (n)	14	29
Ischaemic heart disease % (n)	5	10,4
Arterial hypertension % (n)	41	85,4
Diabetes mellitus % (n)	4	8,3
Cerebral circulation lesions % (n)	4	8,3

In the study group, arterial hypertension was detected in 85.4% of patients, signs of mitral insufficiency were found in 29%, coronary heart disease (CHD) was detected in 10.4%, 8.3% of patients suffered from diabetes, 8.3% there was a history of acute cerebrovascular accident (Figure 2).

12 months. The effectiveness of treatment was monitored by cardiomonitor Reveal XT in the period 1, 3, 6, 12, 24 months after surgery; the mean follow-up was 498 ± 19 days.

Over the entire observation period, 2 deaths occurred: in one patient, while taking warfarin, massive bleeding developed after 10 months; in the second patient, against the background of a stable sinus rhythm, without episodes of AF, after 7 months, according to REAVEL, bradycardia developed with a transition to asystole. In all patients after the intervention, a restoration of the sinus rhythm was observed, which remained until discharge.



**Fig. 2.** Concomitant diseases.

Primary catheter ablation was performed in 22 patients (5 of them were performed repeatedly). Resection of the LAA during the operation was performed in 44 patients. The input and output block was achieved in all patients.

**Table 2.** Characteristic of the procedure.

Ablation time (min)	10,46
Operation time (min)	183
Cardioversion % (n)	72,3% (39)
LAA resection and clipping % (n)	92% (44)

All patients were discharged with sinus rhythm. In 1 patient, pneumothorax was noted and therefore left-side thoracotomy was performed in the postoperative period. In 1 patient, a conversion was performed due to bleeding. It was also noted that during ablation, insufficient transmurality was visually observed in the part where the base is cauterized by a bipolar clamp, so in one patient after surgery, an impulse break is observed during the mapping of this zone.

Complications during the procedure were observed in 4% of the subjects. Pneumothorax was observed in 1 patient, and therefore left-side thoracotomy was performed in the postoperative period, and 1 patient showed sinus node weakness syndrome after the procedure, for which a temporary pacemaker was installed. In two cases, a minithoracotomy was performed due to the adhesion process of the lungs. In these cases, the procedures were performed through minimally invasive thoracotomy instead of thoracoscopic access. During this procedure, sections providing access to the chest were 6–7 cm long. This increased the invasiveness of the procedure, which probably led to higher risks of complications.

In the postoperative period all patients were receiving supporting antiarrhythmic therapy with amiodarone and  $\beta$ -blockers, anticoagulant therapy with warfarin or PLA for 6-

## 4 Discussion

The study evaluates the effectiveness of thoracoscopic isolation of the mouths of the pulmonary veins according to the “box lesion” method with intraoperative measurement of the conduction block degree in the treatment of a longstanding persisting form of AF.

The main findings of this study are:

- High efficiency of isolation of the mouths of the pulmonary veins according to the “box lesion” method using a bipolar electrode in the treatment of a longstanding persisting form of AF;
- High reliability of intraoperative testing of isolation of the mouths of the pulmonary veins according to the “box lesion” method using electrostimulating devices and an implantable Reavel XT cardiomonitor.

Currently, there are studies confirming that thoracoscopic drug ablation is a feasible and safe procedure [13]. However, there is evidence that thoracoscopic isolation according to the “box lesion” technique, performed using a monopolar electrode, does not lead to isolation according to the “box lesion” type and long-term preservation of the sinus rhythm [8]. As a result of the use of monopolar ablation, it is not possible to achieve a transmural damaging effect, which does not contribute to a long-term antiarrhythmic effect [14]. Incomplete damaging effects are a risk factor for recurrence of AF and the induction of other forms of arrhythmia of the LA [15]. Therefore, ablation using a bipolar energy source is the preferred technique, since the energy is directed to the entire thickness of the LA walls between the jaws of the clamp, increasing the likelihood of a transmural effect of the energy used. In addition, intraoperative testing of the impulse conduction block during this procedure is quite

possible and can confirm the transmural damaging effect. This effect was confirmed by Dr. Krul and others who performed minimally invasive hybrid surgical ablation under electrophysiological control in a group of patients with paroxysmal AF and in a group of patients with (long-term) persistent AF [16].

Patients with a prolonged persistent form of AF (n = 48) were isolated from the pulmonary veins with additional ablation of the LA until a bidirectional block was confirmed. This procedure was possible and showed a high frequency of successful results for the entire observation period. The average duration of ablation was 10 min 46 sec. In 9 patients (18.7%), the sinus rhythm was restored spontaneously during ablation, and in 39 patients (72.3%) after electrical cardioversion. Sinus rhythm was maintained during the year of observation after surgery in 87.5% of patients.

Our study showed that performing thoracoscopic epicardial ablation according to the “box lesion” method using bipolar RFA showed high effectiveness in the prevention of relapses both in the early period after surgery and in the long-term follow-up (24 months) of observation.

Sinus rhythm in all 48 patients was restored during surgery and remained until discharge. It was also noted that during ablation, insufficient transmural ablation was visually observed in the part where the base is cauterized by a bipolar clamp, so in one patient after surgery, an impulse break is observed during the mapping of this zone. In the postoperative period after 30 days in 2% of patients against dilatation of the cardiac cavities and low LVEF (36%) flutter of the right atrium was noted, in 4.1% - flutter of the left atrium was noted in the 2nd year (for which a successful transcatheter RFA was performed).

In the observation group, in 12.5% of patients, a relapse of AF occurred in the observation period from 30 days to 2 years, in 6% of patients with a sinus rhythm short episodes (no more than 30 seconds) of AF were observed a year after the operation. Thus, a good effect on AF prevention was achieved in 87.5% of patients after thoracoscopic radiofrequency ablation of pulmonary veins using the “box lesion” technique using a bipolar electrode and intraoperative block testing.

## 5 Conclusion

Thoracoscopic radiofrequency ablation of pulmonary veins using the “box lesion” technique using a bipolar electrode and intraoperative conduction block testing is a promising treatment for atrial fibrillation, which is accompanied by a high efficiency of 87.5%, a low risk of complications (4%), especially with catheter ablation and in patients with large sizes of the left atrium. The combination of this method of treatment with catheter ablation of the left or / and right isthmus gives greater efficiency.

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