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Immediate Results of Pulmonary Veins Entries Cryoblation of Patients with Atrial Fibrillation // Direkte Ergebnisse der Kryo-Ablation der PV-Ostien bei Patienten mit Vorhofflimmern

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ERWO PHARMA

Immediate Results of Pulmonary Veins Entries Cryoablation of Patients with Atrial Fibrillation

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Kurzfassung: Direkte Ergebnisse der Kryo-Ablation der PV-Ostien bei Patienten mit Vorhofflimmern. *Hintergrund:* Zweck dieser Studie ist es, das Verfahren der Kryo-Ablation der PV-Ostien zu beschreiben und die Ergebnisse der Behandlung von Patienten mit Vorhofflimmern unter Einsatz der Kryotechnologie darzulegen. Es handelt sich um eine Querschnittsanalyse, die in der Abteilung für interventionelle Kardiologie, Herzrhythmusstörung und endovaskuläre Chirurgie, Nationales Forschungszentrum für Chirurgie AG, Kasachstan, durchgeführt wurde.

Materialien und Methoden: Untersucht wurden die gesammelten Daten aus dem Zeitraum von Oktober 2014 bis April 2017 von 240 Patienten mit tachysystolischer AV-Resistenz gegen antiarrhythmische Therapie. Eine invasive elektrophysiologische Untersuchung und 240 Kryo-Ablationseingriffe wurden durchgeführt. In dieser Studie betrug die durchschnittliche Anzahl an Kryoaktivität in einer PV 1,5 ± 0,5, die gesamte durchschnittliche Anzahl von Kryo-Anwendungen betrug 6 ± 2 pro Patient. Die Gesamtdauer der Kryo-Ablation erreichte 24,8 ± 12,6 min. Alle drei Monate wurde Langzeit-EKGs durchgeführt, um sowohl die Arrhythmienfreiheit wie auch eventuelle außergewöhnliche EKGs mit verdächtigen Arrhythmien zu dokumentieren. Darüber hinaus wurden wöchentlich telefonische Befragungen zur detaillierten Abklärung der klinischen Symptome durchgeführt. *Ergebnisse:* Paroxysmales Vorhofflimmern wurde bei 155 Patienten diagnostiziert, persistierendes Vorhofflimmern bei 85 Patienten. Im Falle wiederkehrenden Vorhofflimmerns trotz antiarrhythmischer Therapie wurde eine Vorhofflimmerablation durchgeführt.

Schlussfolgerung: Die Verwendung der Technologie ermöglicht eine 96%ige isolierte elektrische Isolierung des linken Vorhofs.

Schlüsselwörter: Kryo-Ablation, Katheterbehandlung, Vorhofflimmern, Isolierung von PV-Ostien

Abstract: *Background:* The aim of this study is to estimate pulmonary veins ostia cryoablation method and patient treatment results with atrial fibrillation (AF) using cryotechnologies. The study's design is a cross-section analysis of prospective study conducted in the interventional cardiology, arrhythmology, and endovascular surgery department of JSC National Scientific Center of Surgery.

Material and Methods: Collected data from October 2014 to April 2017. There were 240 patients with tachysystolic AF resistance to antiarrhythmic therapy. Had been conducted invasive electrophysiological study and 240 cryoablation interventions. In this study, the average number of cryoactivities in one PV was 1.5 ± 0.5, and the total average number of cryoapplications was 6 ± 2 per patient. Total duration of cryoablation reached 24.8 ± 12.6 min. Every three months, a Holter ECG was conducted to evaluate freedom from arrhythmias and to extraordinary ECG when suspicious arrhythmia symptoms appeared upon Holter monitor. Weekly telephone surveys with detailed clinical symptoms of patients were conducted.

Results: Paroxysmal AF was diagnosed in 155 patients; persistent AF was diagnosed in 85 patients. Repeat left atrium catheter ablation through left atrium linear radiofrequency ablation was performed in the case of clinical manifestations of recurrent AF refractory to antiarrhythmic therapy.

Conclusion: The use of technology makes it possible to achieve 96% left atrium acute electrical isolation. **Z Gefäßmed 2018; 15 (3): 11–6.**

Key words: Cryoblation, Catheter treatment, Atrial fibrillation, Isolation of pulmonary veins entries.

Abbreviations

AF	atrial fibrillation
CTI	cavotricuspid isthmus
ECG	electrocardiogram
EF	ejection fraction
EPS	Electrophysiology Study
LA	left atrium
LAA	left atrial appendage
LIPV	left inferior pulmonary vein
LLPV	left lower pulmonary vein
LPV	common left pulmonary vein
LSPV	left superior pulmonary vein
LUPV	left upper pulmonary vein
LV	left ventricle
PN	phrenic nerve
PNP	right phrenic nerve paralysis (PNP)
PV	pulmonary vein
PVE	prosthetic valve endocarditis
PVO	pulmonary veins ostia
RA	right atrium
RF	radiofrequency
RFA	radiofrequency ablation
RIPV	right inferior pulmonary vein
RLPV	right lower pulmonary vein
RSPV	right superior pulmonary vein
RUPV	right upper pulmonary vein
TEE	perioperative transesophageal echocardiography

Introduction

Atrial fibrillation (AF) is the most common type of heart rhythm disorder. It affects 0.5% of the population; 5% over age 65 years are affected [1]. AF is accompanied by thromboembolism, the development of arrhythmogenic cardiomyopathy, and increased mortality with heart failure [2]. The most frequently used drugs to rhythm control in AF patients are class I and III antiarrhythmics; unfortunately, they maintain sinus rhythm in only 40% to 50% of patients with persistent AF at 12- to 24-months follow-up [3].

At the end of the 1990's, the concept of trigger factors elimination was introduced, the so-called isolation of ectopic areas in pulmonary veins ostia (PVO) by radiofrequency ablation (RFA), which along with the new methods of left atrium (LA) linear RFA, helped to address paroxysmal and persistent AF [4].

Many randomized trials demonstrated the advantage of catheter ablation over drug therapy in sinus rhythm maintenance in patients with AF; according to two trials, 65–85% of patients

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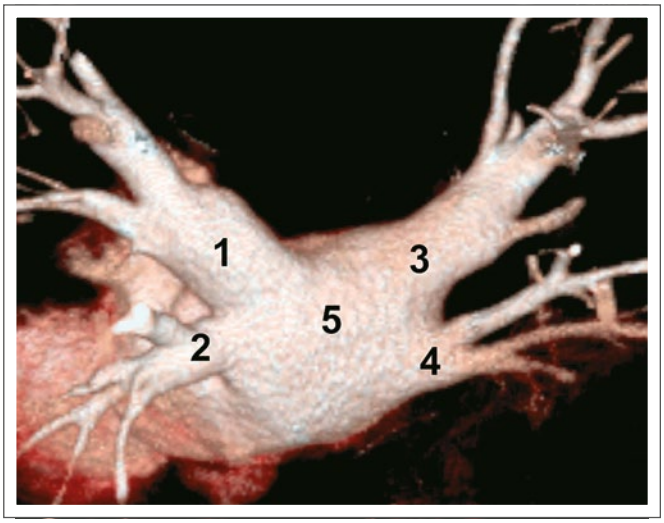

Figure 1. Multispiral computed tomography of left atrium and pulmonary veins (back view). **1:** LUPV, **2:** LLPV, **3:** RUPV, **4:** RLPV, **5:** left atrium back wall.

are free from recurrent arrhythmia after ablation [5, 6]. However radiofrequency energy has side effects: thrombogenicity, formation of LA and PVO heterogeneity structure lesions, RF energy high-penetrating ability, postablative incisional tachycardia, atrial-esophageal fistulas, and stenoses of PVO [7]. Moreover, LA catheter RFA is complex and lengthy, based on sequential applications "point by point" to create solid fault lines [5, 8].

During the last 10 years, cryotechnology has been used extensively in catheter ablation of cardiac arrhythmias. One of them is the catheter ablation with cryoballoon; the point is to achieve PVO electric isolation in a single application. By using an inflatable balloon completely adjacent to PVO, the method simplifies the procedure and achieves PVO isolation instantly [9]. In practice, tissue freezing is used to create PVO circular damage. Intracellular ice formation with subsequent thawing causes reliable and safer damage than radiofrequency [10].

The purpose of this work is to describe PV isolation using cryoablation method and results of AF treatment using cryotechnology. Results evaluated PVO electric isolation using second-generation cryoballoon and absence of persistent AF (more than 30 sec) in the early postoperative period (6–8 months).

Materials and Methods

From October 2014 to April 2017, in the interventional cardiology, arrhythmology, and endovascular surgery department of JSC National Scientific Center of Surgery, 240 patients with tachysystolic AF resistant to antiarrhythmic therapy underwent invasive electrophysiological study (EPS) and cryoablation procedure using cryoballoon catheter second-generation (Arctic Front Advance, Medtronic). Data were collected prospectively in the Institutional AF Registry. The cross-section analysis of prospective study was conducted in the interventional cardiology, arrhythmology, and endovascular surgery department of National Scientific Center of Surgery among 240 patients (142 men and 95 women) with tachysystolic AF resistant to antiarrhythmic therapy (Tab. 1). The study protocol was approved by our Institutional Local Research Ethics Committee (June 26, 2016), and study protocol conformed to the ethical standards of The Declaration of Helsinki. All participants in the study received informed consent.

Preoperative procedures

Paroxysmal AF was diagnosed in 155 patients. Persistent AF was diagnosed in 85 patients. Seventy-six patients manifested type I atrial flutter on electrocardiogram (ECG), and 11 patients with AF combined with Wolff-Parkinson-White syndrome and atrioventricular nodal reentrant tachycardia. Antiarrhythmic drug administration was cancelled 48 to 72 hours before EPS (amiodarone was cancelled 45 days before procedure). All patients were examined to exclude thrombosis of left atrium appendage – perioperative transesophageal echocardiography was conducted. In 85% of patients, multi-spiral computed tomography was done to study topographic anatomy and size of LA (Fig. 1).

Table 1. Patient characteristics

Characteristic	Paroxysmal AF		Persistence AF		CI	Chi-squared
	n	%	n	%		
Patients, No	155	64.6	85	35.4	15.5; 41.8	18,8*
Men, n (%)	88	56.7	54	63.5	10.8; 23.6	0.64
Age, years	47.5 ± 15.5		55.5 ± 23.5		3.0; 12.9	3.2*
Arrhythmic anamnesis, mth	9 ± 5		27 ± 19		16.2; 19.8	19.9*
Coronary artery disease	25	16.1	33	38.8	3.2; 44.5	3.5
Diabetes	12	7.7	29	34.1	7.8; 47.6	2.9
Hypertension	35	22.6	47	55.3	9.7; 57.8	8.7*
LA size, mm	40 ± 3		43 ± 7		1.7; 4.3	4.6*
LV Ejection fraction, %	59 ± 5		53 ± 9		4.2; 7.8	6.6*
Warfarin, %	88	56.7	57	67.1	6.9; 26.6	1.6
Rivaroxaban, %	41	26.4	38	44.7	4.5; 39.4	2.8

*Statistical significance $p \leq 0.05$

All patients were taking anticoagulants for 4 weeks before and 3 months after the procedure under monitoring of international normalized ratio (2.0–3.0). In 225 patients, all 4 pulmonary veins (PVs) were completely isolated; in 14 patients, 3 PVs, in 1–2 left PVs because of phrenic nerve palsy during right inferior PV cryoablation. They further underwent standard RFA. In 76 patients with type I atrial flutter, impulse holding bidirectional block in the cavo-tricuspid isthmus of the heart was created.

Operative procedures

In all patients, three standard punctures were performed: the left subclavian and right femoral veins 2 punctures to conduct catheters for cryoballoon ablation. A 10-pole electrode was introduced through the left subclavian vein to the

coronary sinus. If that was not possible, lower access was used through the femoral vein. Transseptal puncture was used to enter the LA through the right atrium (RA), according to standard procedure under fluoroscopic guidance through right femoral vein puncture. Right after transseptal puncture, heparin was injected 0.5 mg × 1 kg per dose intravenously with subsequent titration and maintenance of the ACT > 300 sec. level. Then, an 8 Fr transseptal puncture introducer was replaced by a 14 Fr cryoballoon delivery catheter. The second-generation cryoballoon set includes the Achieve 8-pole mapping catheter, which is delivered to LA through the inner shaft of the cryoballoon. One more 4-pole diagnostic electrode was introduced through right femoral vein puncture into the right ventricle, and it was used for RA pacing with vasovagal response (bradycardia). It was also placed to the superior vena cava during ablation in right PVs for phrenic nerve pacing. The Achieve catheter was introduced through the cryoballoon inner shaft; it was placed alternately to all PV to document initial PV electrical potentials and to control PVO electrical isolation during ablation (Fig. 2).

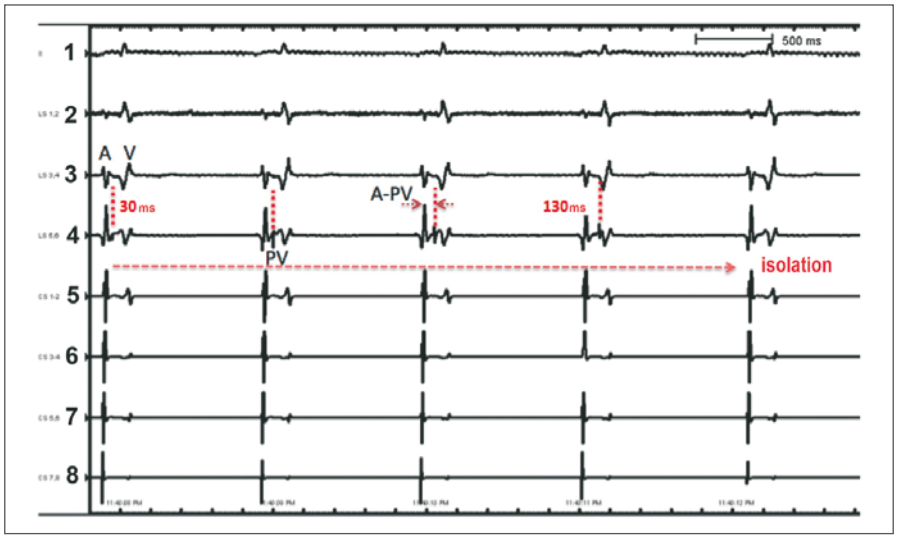

Figure 2. Record of ECG and endograms during pulmonary veins entries cryoblation. **1:** surface ECG (2nd derivation); Endograms: **2–4:** mapping "achieve" catheter (LS 2–8), **5–8:** diagnostic probe within coronary sinus; Potentials: A) for atriums, V) for ventricles, PV) for pulmonary veins; Gradual blocking of PV potentials and their total disappearance upon reaching PV isolation from LA is displayed.

Then, the Achieve catheter was placed at one of the biggest branches of PV. The cryoballoon catheter was conducted so that the distal part was in the ostium of the pulmonary vein. A balloon with a 28 mm diameter was inflated and at the same time pushed against the PVO. Contrast agent was injected through a lumen of catheter, which went stagnant in achieving full lumen of the PV occlusion, and it does not seem like exit to left ventricle (LV) area (Fig. 3).

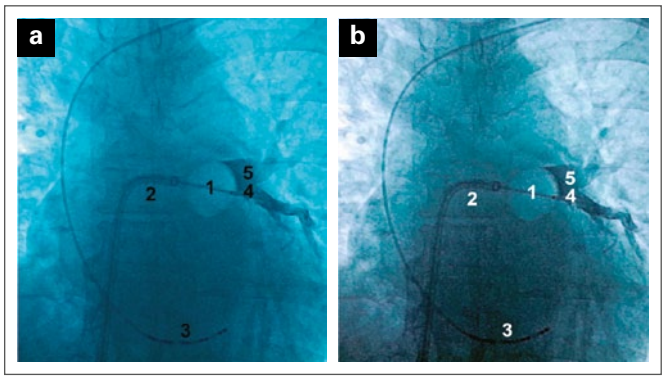

Figure 3. a + b: Cryoablation of LUPV. Full obstruction of target vein. **1:** Cryoballoon in inflated state at LUPV entry, **2:** delivery catheter to LA, **3:** 10-polar probe within coronary sinus, **4–8:** polar "achieve" catheter in LUPV, **5:** contrast stagnation confirms full obstruction of ablating PV

LA contrast medium leaked past the balloon, the vein obturation was considered incomplete, and the position of the balloon was changed. The ablation started by feeding the cooling agent into the balloon, reaching a temperature of –37 to –60°C (Fig. 4).

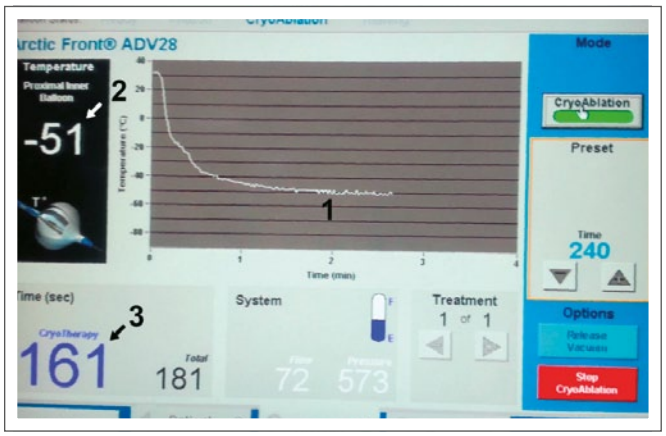

Figure 4. Cryoconsole display during ablation. **1:** the curve shows the reached temperature at the point of contact of cryoballon with tissue of LA and PVE, **2:** temperature indicator, **3:** cryotherapy time indicator

Every application lasted 240 sec. After the application was finished, the filling of cooling agents was stopped and the balloon was blown off. If temperature exceeded 60°C, the filling of cooling agents was stopped; in one vein the filling was resumed until 240 sec. The PVO cryoablation sequence was observed the next way: the first was left superior PV (LSPV), and then left inferior PV (LIPV). After left PVs were completed, we switched to right PVs. The ablation has been started with right inferior (RIPV), after complete isolation RIPV switched to right superior (RSPV), as many studies and our own experience showed, phrenic nerve palsy (PNP) mainly occurs during RSPV cryoablation, which was the last application. In our study, only one of 15 patients had PNP with RIPV. 4-pole diagnostic electrode was replaced from right ventricles to superior vena cava during right PV ablation, and the right phrenic nerve was stimulated (12 mA, 2–3 ms) with a frequency of 15 imp/min. After all PVs were isolated, an AF induction was attempted with an super-frequent atrial pacing. If AF registered after achieving, all PVs complete isolation and sinus rhythm did not restore spontaneously, as well as in case of patients with AF persistent form, external electrical cardioversion under 300 J was performed to

restore sinus rhythm. Catheters and introducers were removed with careful hemostasis.

Postoperative management and follow-up

Patients with the connection of continuous cardiac activity monitoring remained under observation in the ward until the next morning.

Before discharge, ECG was registered daily and 24-hour ECG Holter monitoring was done. After discharge, patients were followed up every 3 months, and in case suspicious arrhythmia symptoms appeared, ECG and Holter monitor were performed. Weekly telephone surveys of patients with questioning detailed clinical symptom were conducted. In case of clinical manifestations of recurrent AF refractory to antiarrhythmic therapy, repeat LA catheter ablation with LA linear RFA was performed.

Statistical analysis

All analyses were conducted with SPSS software version 18.0 and MedCalc a Z-statistic, Chi-squared (χ^2), and odds ratio (OR) relative to P-value of < 0.05 were used to determine significance. Continuous data are presented as mean standard deviation or median, and categorical data are presented as frequency in percentages. Comparisons of patients' characteristics and outcomes were conducted in the 2 patient groups with persistent and paroxysmal AF.

Table 2. Patient cryoablation data

No	Data	Rate
1	Patients, n (%)	240 (100%)
2	LSPV, number (isol)	212 (82%)
3	LIPV, number (isol)	212 (94%)
4	LPV, number (isol)	28 (62%)
5	RSPV, number (isol)	240 (88%)
6	RIPV, number (isol)	240 (78%)
7	Complete isolation, n (%)	233 (97%)
8	Cardioversions, %	93 (39%)
9	Effects to PV	1.5 ± 0.5
10	Fluoroscopic time (min)	19.5 ± 5.7
11	Duration of the procedure (min)	95 ± 29

Results and Discussion

Study population

From October 2014 to April 2017, in the interventional cardiology, arrhythmology, and endovascular surgery department of National Scientific Center of Surgery, 240 patients (142 males) with tachysystolic AF resistant to antiarrhythmic therapy (including amiodarone) underwent invasive EPS and cryoablation procedure. Ages were 29 to 78 years (53.5 ± 24.5 years old) (Tab. 1).

Estimate of clinical characteristics and possible complications were conducted in the 2 patient groups with paroxysmal and persistent AF. Both groups were dominated by men (z = 3.2, 95-%-CI: 3.0–12.9, p ≤ 0.05). The arrhythmic anamnesis in patients with persistent AF 27 ± 19 months was higher than in the patients paroxysmal AF 27 ± 19 months (z = 19.9, 95-%-CI: 16.2–19.8, p ≤ 0.05).

Patients with persistent AF had significantly increased LA, 43 ± 4 mm (z = 4.6, 95-%-CI 1.7–4.3, p ≤ 0.05) and reduced ejection fraction (EF) of the LV, 53 ± 9% (z = 6.6, 95-%-CI: 4.2–7.8, p ≤ 0.05) than patients with paroxysmal AF.

Postoperative outcomes

In this study, the average number of cryoactivities in one PV was 1.5 ± 0.5, and total average number of cryoapplications was 6.0 ± 2.0 per patient. Total duration of cryoablation reached 24.8 ± 12.6 min. Patient parameters of cryoablation are presented in Table 2.

In average follow-up of 11.8 ± 6.8 months, 187 (78%) patients remained in sinus rhythm, and 96 (51%) received antiarrhythmic because they had risk factors of arrhythmia recurrence after first ablation.

Sustained AF paroxysms refractory to 3 antiarrhythmic drugs, including amiodarone, were registered in 53 (22%) patients. They underwent another EPS with a multi-electrode Lasso catheter. After PV electrical conduction was identified, segmental ablation of PVO and linear ablation along the posterior wall and the roof of LA via radiofrequency energy were conducted. Atrial flutter type 1 was registered in 76 of 240 patients; RFA via cavo-tricuspid isthmus was performed. Subsequently, arrhythmias did not recur at the antiarrhythmic therapy background.

Table 3. Patient postoperative results

Result	Paroxysmal		Persistence		CI	OR	Z statistic
	n	(%)	n	(%)			
Patients, No	155	64.6	85	35.4	15.5; 41.8		18,8*
Hospital stay (days)	7 ± 2		10 ± 3		2.4; 6.6		9.2*
Complications	–	–	2	2.3	0.4; 196.2	9.3	0.15
Postoperative bleeding	–	–	1	0.2	0.2; 137.0	5.5	1.04
Phrenic nerve palsy	9	5.8	6	7.1	0.4; 3.6	1.2	0.38
Cardioversion	14	9.1	79	92.9	49.0; 358.7	132	9.6*
RFA CTI	28	18.1	48	56.5	3.3; 10.6	5.9	5.8*

*Statistical significance p ≤ 0.05

Repeat LA catheter ablation through LA linear RFA was performed in the case of clinical manifestations of recurrent AF refractory to antiarrhythmic therapy in 48 (56.5%) patients with persistence AF, which indicates a direct relationship between refractory and antiarrhythmic therapy and arrhythmia duration (OR = 5.9, 95-%-CI: 3.3–10.6, p ≤ 0.05). Later, rhythm disturbances did not recur at the drug therapy background (Tab. 3).

Lethal cases among patients with AF were not in hospital during and after ablation.

Complications

Complications were classified as in-hospital death, nonlethal complications, and PNP.

Nonlethal complications included embolic event, tamponade, femoral/subclavian hematoma, arteriovenous fistula, PV stenosis, PNP, and esophageal injury, which were not in hospital during and after ablation.

In our study, only one of 15 patients had RF paresis with RLPV. Four-pole diagnostic electrode was replaced from RVs to superior vena cava during right PV ablation, and it was stimulating the right phrenic nerve (12 mA, 2–3 ms) with a frequency of 15 imp/min.

Six (7.1%) cases of PNP was at persistent AF patients and at 9 (5.8%) paroxysmal AF patients (OR = 1.2, 95-%-CI: 0.4–3.6, $p \geq 0.05$) (Tab. 3). Cardioversion, aimed to restore native sinus rhythm, was considered to be conducted in 79 (92.9%) patients with persistent AF than in patients with paroxysmal AF, 14 (9.1%), which indicates a direct relationship between the restoration rate of sinus rhythm and arrhythmia duration (OR = 132, 95-%-CI: 49.0–358.7, $p \leq 0.05$).

Recent studies

Major findings of the present study are as follows: 1) Pulmonary vein catheter isolation using second-generation cryoballoon is a promising method for AF treatment, which simplifies ablation in the left atrium; 2) PVO isolation can be successful in up to 97% of pulmonary veins. More than 78% of patients are in sinus rhythm without recurrence of persistent arrhythmia paroxysms in the period of 6 to 18 months.

Diagnosis and treatment of patients with cardiovascular disease are a serious problem, which explains why numerous studies have been devoted to it [11–13]. Based on the results of major studies with many patients, freedom of atrial arrhythmias ranges from 59% to 77% [14–16]. In these studies, significant efficiency discrepancy could be attributed to differences in ablation protocols, different balloon diameters, methods for detecting arrhythmia recurrences variability, the presence or absence of a „blanking" 3-month follow-up period after ablation, and in the recording of antiarrhythmic therapy differences in ablation efficacy assessing.

In recent studies like "Fire & Ice", comparing effectiveness of cryoablation and RFA of PVs, there was no statistically significant difference in ablation results (freedom of arrhythmia at 88% and 92% after 1.2 procedures with a follow-up period of 33 months). In this large-scale randomized study across Europe, 769 patients from 16 clinics were included [17]. In this study, the primary endpoint by the efficacy criterion was achieved; it was proven that Arctic Front ablation catheters without three-dimensional mapping were noninferior to ThermoCool RFA catheters with three-dimensional mapping ($p = 0.0004$) in terms of reducing frequency of arrhythmia relapses or necessity in antiarrhythmic drug therapy and/or re-ablation. The primary endpoint was also achieved by safety criterion, before the first death time for any reason, before the stroke or transient ischemic attack for any reason, or to serious adverse events due to treatment ($p = 0.24$). Both technologies showed comparably low rates of complications. According to the study results, cryoablation technology provides a shorter duration of procedures (mean = 124 minutes) compared with RFA (mean = 141 minutes, $p = 0.0001$).

Studies have shown that the restoration of electrical conduction from PV to LA is the main factor in the AF recurrence after catheter ablation [18]. Thirty minutes after cryoablation, 97.2% of PVs remain electrically isolated [19], in 56–84 days, 88% of PVs remain isolated, and after 144 days, only 46% of PVs remain isolated. Most often, the restoration of electrical conduction is noted in lower PVs and between LAA and left PVs.

In our study, patients who had risks of arrhythmia recurrence admitted antiarrhythmic therapy. These risks include long arrhythmic anamnesis, older age, dilated LA, and availability associated heart diseases [13, 20].

Unlike traditional radiofrequency, the energy effect of cryoablation damage has clearly defined necrosis line, homogeneous necrosis zone, preserved endocardial layer, and absence of thrombosis at site of exposure [21]. One study showed that cryothermic damage diameter is directly proportional to ablation electrode; however, the depth of damage remains unchanged [22].

The most common complication of PVO cryoablation is right PNP, which develops in 1.7% to 12.0% of patients [23]. Close disposition of the right PN to the anterior wall of the right upper PV facilitates this complication. PN paresis risk is higher when the balloon is placed deep in the PV. Practice shows that using a larger-diameter (28 mm) cryoballoon and monitoring phrenic contractions (paced from the superior vena cava) during the ablation can reduce the risk of this complication. In most patients, nerve function is restored in 1 to 12 months. In this study, we observed PNP in 15 (6.25%) out of 240 patients. In 10 patients, phrenic nerve function was restored in 1 day to 1 month, and in 4 patients, in 3 to 6 months. In one patient, it was restored in 12 months.

Traditional LA and PVO RFA complications such as PV stenosis, esophageal wall damage, atrial-esophageal fistula formation, and incisional tachycardia after the development of sites of delayed conduction around the injury zone with cryoballoon ablation rarely occur [24].

PV cryoballoon isolation is a technique that provides single-shot circular electrical PV isolation for AF treatment. Cryoablation is a safer and easier technique than traditional RFA. Further cryotechnology improvement, such as changing the balloon elasticity and changing the distal part of the balloon, will improve the results of AF cryotherapy.

Conclusion

Authors have described PVE cryoblation method and results of FA patients' treatment with use of cryotechnology. The results had been evaluated by the degree of reaching PVE electrical isolation and absence of atrial tachyarrhythmia manifestations during early postoperative period. Data processing had been

carried out using method of variance analysis with help of specialized computer software. The veracity of compared values had been defined by the criteria of Student, Fisher and authentic probability – p. The statistically significant indicator had been considered $p < 0.05$.

Pulmonary vein catheter isolation using second-generation cryoballoon is a promising method for treating AF, which simplifies ablation in the left atrium. At the same time, the technology is easily produced in EP laboratories. PVO isolation can be successful in up to 97% of PVs. More than 78% of patients are in sinus rhythm without recurrence of persistent arrhythmia paroxysms in the period of 6 to 18 months.

Limitations

First, this study was not a randomized controlled study, and the sample size was relatively small. Second, there were no definite criteria for strategy selection, except for operators' experience, skills, and clinical judgments. Third, our study focused only on cryoballoon ablation, and the cost-effectiveness of this approach was not analyzed in the present study.

Conflict of Interest

None.

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