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FACTORS ASSOCIATED WITH THE EFFICACY OF ATRIAL FIBRILLATION RADIOFREQUENCY CATHETER ABLATION: OPINION OF THE SPECIALISTS WHO USE THE "ABLATION INDEX" MODULE

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This document provides an overview of current problems and trends in the catheter ablation of atrial fibrillation, summarizes the opinions of specialists, obtained during a web-based electronic survey, on aspects and parameters of radiofrequency ablation. The approaches on improving the efficacy and safety of radiofrequency catheter ablation of atrial fibrillation are provided.

Key words: atrial fibrillation; radiofrequency ablation; ablation parameters; ablation index; expert consensus

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In the Russian population, atrial fibrillation (AF) occurs in 6.7% of people over 55 years old and is associated with increased cardiovascular and all-cause mortality [1]. The clinical and social significance of AF is determined by a 5-fold increased risk of heart failure (HF), a 5-7-fold increased risk of stroke, and a 2-fold increased cardiovascular mortality [2].

The following main directions in AF treatment are distinguished: better symptom control, stroke prevention, heart failure prevention, and improving the quality of life. To achieve these goals, the following approaches are used: rhythm and rate control strategies, anticoagulation, management of the underlying and concomitant diseases.

Antiarrhythmic drug (AAD) therapy for rhythm control strategy and AF recurrences prevention is often limited, associated with side effects, and ineffective. But AF catheter ablation (CA) is associated with long-term maintenance of sinus rhythm, improvement of quality of life, as well as fewer hospitalization and mortality rate due to HF according to randomized and non-randomized multicenter studies [3-6].

In the Russian Federation, about 8.000-10.000 AF CA are performed per year, which makes a significant contribution to European statistics. However, these figures are still far from the true need for AF catheter treatment [7]. Although, 10-20% of CA are redo procedures due to AF recurrent [6, 8].

Several modifiable clinical factors affect the efficacy of AF CA: obesity, obstructive sleep apnea syndrome (OSA), hypertension, alcohol intake. Successful prevention of AF recurrent lies not only in the elimination of the trigger in the pulmonary veins (PV) and/or modification of the arrhythmogenic substrate in the left atrium (LA) but also in the risk factors modification.

There are several official documents of the professional community summarizing recommendations in the field of AF CA, constantly updated scientific data and the rapid progress of AF ablation technologies stimulate the coverage of some aspects of AF treatment in the expert consensus statement. It also seems impossible to conduct randomized controlled trials on absolutely all aspects of the interventional treatment of AF, which indicates the relevance of providing expert opinion on certain issues.

This project aims to study the opinion of specialists in the atrial fibrillation radiofrequency (RF) catheter ablation about factors contributing to the improvement of the efficacy of AF interventional treatment. This document is a summary of the opinions of specialists in RF CA in Russia. The project was planned during the face-to-face meeting of the authors of the document on September 16, 2019. The work on this project consisted of two steps.

Step 1. Discussion and formation of the clinical aspects, RF parameters, and patient management strategies, potentially influencing the results of AF CA (group of specialists - the authors of this publication). Based on the results of published works and their own clinical experience, the authors agreed on the following main groups of factors that clearly or potentially affect the estimated efficacy of AF CA:

- patients' clinical characteristics undergoing AF ablation (AF type, duration, structural heart disease, HF, comorbidity, etc.);
- the preparation for catheter ablation, including antiarrhythmic therapy before, during and after ablation;
- operators' experience;
- AF ablation technology;
- additional parameters used during catheter ablation (type of catheter, program settings, automatic modules);
- additional linear lesions in the left and right atriums;
- AF recurrence criteria.

Step 2. Interactive voluntary correspondence survey of specialists according to the list of prepared questions. The second step involved specialists who independently perform AF RF CA using the Ablation Index technology (Biosense Webster, USA). The Internet survey was formulated based on the Survey Monkey resource and consisted of 40 questions. After the respondent provided answers to all questions, the Internet survey was blocked to re-fill the questionnaire by IP address. A complete list of questions included in the online questionnaire is presented in the Appendix.

Respondents' characteristics

Invitations to participate in the survey were sent to 73 specialists working in the Russian Federation (10 subjects) and Belarus (Minsk). Answers were received from 37 (51%) specialists. The mean age of the respondents was 41.4±7.6 years (from 27 to 59 years). The mean experience with AF catheter ablation was 9.0±4.1 years. The number of procedures per year of self-performed AF CA by operators varies, with most operators performing a significant amount of ablation (Fig. 1). In addition to the operators' experience, the experience of the clinical department in performing complex catheter ablation is of great importance, since this is associated with the effectiveness of treatment

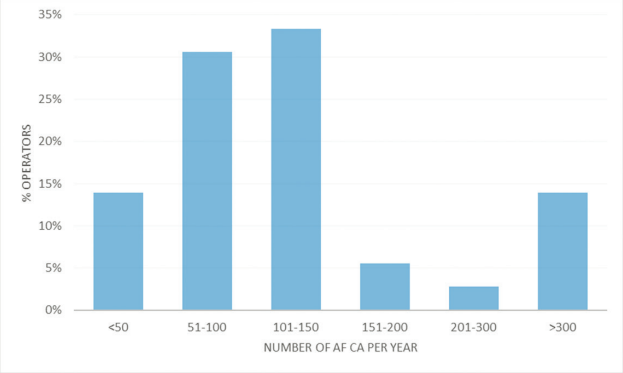

Fig. 1. The number of atrial fibrillation (AF) catheter ablation (CA) performed by a specialist per year.

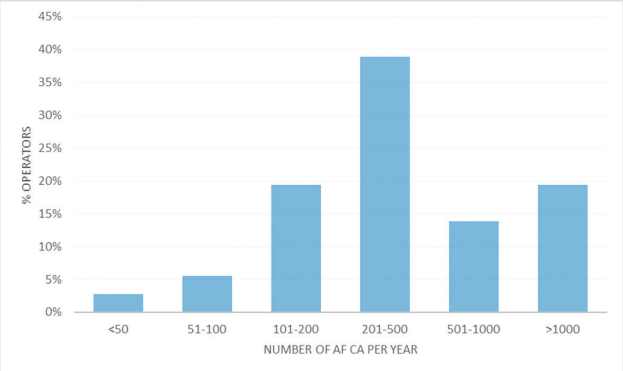

Fig. 2. The number of atrial fibrillation (AF) catheter ablation (CA) performed in the specialists' department per year.

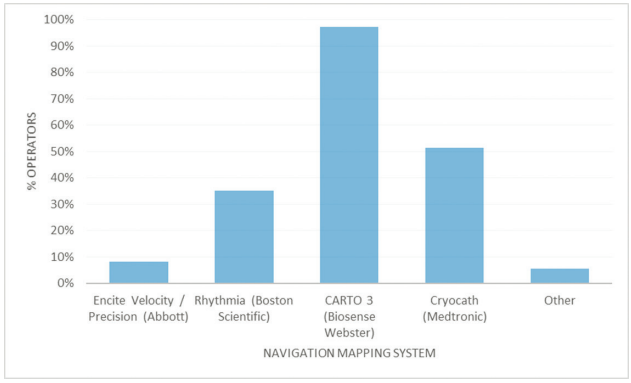

Fig. 3. Navigational mapping systems and ablation technology used by specialists in daily practice.

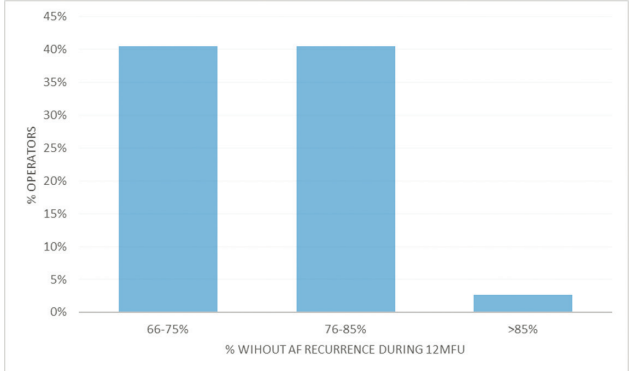

Fig. 4. Efficacy of paroxysmal atrial fibrillation (AF) ablation according to respondents (12 months follow-up (12MFU), without antiarrhythmic therapy).

and the risk of complications [9]. The respondents to this survey in most cases work in clinics with a higher volume of AF CA per year (Fig. 2). It should be noted that most respondents in their daily practice use the CARTO electroanatomical mapping system (Biosense Webster, USA) (Fig. 3).

Patients' characteristics undergoing AF ablation

In 84% of cases, respondents agreed that patient selection is an extremely important step in determining the outcome of catheter ablation. The decision to refer a patient for AF catheter ablation should be made collectively, considering the patient's preferences, after informing him of the risk of arrhythmia recurrence and the risk of adverse events associated with catheter ablation.

Large randomized and observational studies have shown that the following characteristics are associated with a more favorable long-term effect: a short history of AF, a paroxysmal AF, small LA size, no structural heart disease, non-inducible arrhythmia, no recurrence in the blanking period [10, 11]. While the following clinical signs and ablation rates are associated with a higher incidence of arrhythmia recurrence: older age, hypertension, obesity, OSA, non-paroxysmal AF (in particular, long-standing), LA dilation, LA fibrosis, confirmed by magnetic resonance imaging, phased RF ablation of AF (not used in Russia), LA additional linear lesions, antiarrhythmic drug therapy [12-18]. To predict the risk of arrhythmia recurrence, such scores as CAAP-AF, APPLE, SUCCESS have been developed and tested [19-21].

According to the authors of this document, despite the broad indications of AF CA in official documents (the presence of symptomatic AF refractory to antiarrhythmic therapy with 1 AAD, or even in the absence of a history of antiarrhythmic drug therapy in some patient groups) [22, 23], nevertheless the risk of arrhythmia recurrence should be considered when referring patients.

Obese patients (BMI> 30 kg/m^2) should be advised to reduce body weight before AF ablation since high BMI values are associated with a greater risk of arrhythmia recurrence after ablation [24]. The effect of obesity was also studied in the ARREST-AF study, where the strategy of aggressive weight loss led to a 5-fold increase in the likelihood of maintaining sinus rhythm after AF ablation compared with the control group [13]. It is well-known that the AF prevalence and progression are closely related to OSA, mainly due to atrial remodeling [14]. Although the OSA in patients with AF increases the risk of arrhythmia recurrence after AF CA, CPAP therapy increases the frequency of maintaining sinus rhythm to a level comparable to the patient population without OSA [15]. Hypertension is a well-known and independent predictor of both the risk of development and the risk of AF recurrence after ablation [16]. Patients with medically controlled hypertension have the same risk profile for AF recurrence as patients without hypertension. Although studies show a decrease in the recurrences in patients with controlled hypertension, the effect of aggressive blood pressure lowering, including with interventional treatment methods (renal denervation, baroreceptor stimulation), on AF recurrence after ablation has not been fully understood. However, blood pressure control significantly reduces the risk of major cardiovascular events that occur in both hypertensive and AF patients [10]. The relationship between alcohol consumption and the development of AF after ablation is known [17], while changes in the atria caused by the toxic effect of alcohol are associated with the presence of AF triggers outside the PV. The ARREST-AF study also demonstrated that modification of risk factors for cardiovascular complications, including a decrease in alcohol consumption of less than 30 g per week, is associated with a decrease of AF recurrence [13].

Respondents' perception of the current AF ablation effectiveness

The effectiveness of a first AF ablation according to Russian data was 66% when followed for one year after the intervention [12], which is comparable with global data [25]. However, due to the improvement of ablation technologies and the increase in the experience of the intervention, the efficacy of ablation continues to grow [26, 27]. One of the tasks of the survey was to assess the expected effectiveness of AF ablation by operators themselves. Thus, the distribution of the expected effectiveness of catheter ablation of paroxysmal and persistent AF is shown in Fig. 4 and 5, respectively. In this aspect, the results of a survey of experts on the alleged absence of arrhythmia recurrence are presented when observed within 12 months after ablation without antiarrhythmic therapy. At the same time, the proportion of patients with persistent AF is on average 30-50% (Fig. 6).

We consider it necessary to comment on these results. In the European registry AF CA, which collected Russian data, the efficacy of AF ablation, taking into account both

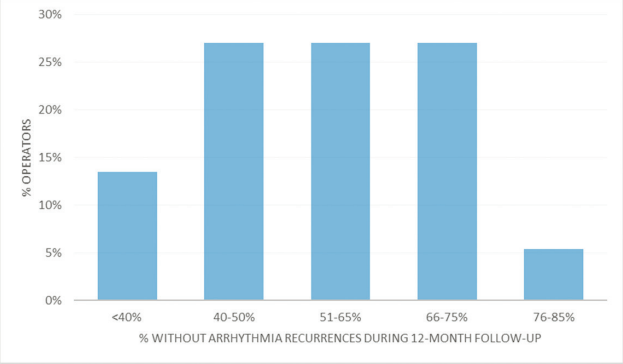

Fig. 5. Efficacy of persistent atrial fibrillation catheter ablation according to respondents' opinion (12 months follow-up, without antiarrhythmic therapy).

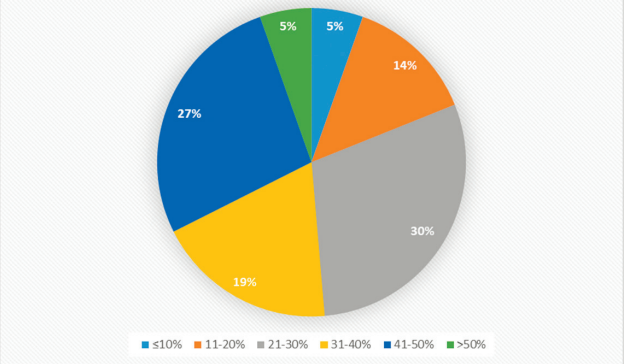

Fig. 6. Percentage of patients with non-paroxysmal atrial fibrillation undergoing ablation in respondents' practice.

paroxysmal and non-paroxysmal AF, was 66% [12], which is comparable to the efficacy with other technologies [28]. In this survey, the effectiveness of paroxysmal AF ablation is 76-85% according to 40% of respondents. These values may reflect both the real frequency of the absence of arrhythmia recurrences with the use of modern technologies (introduced into practice after 2016), and the theoretical assumption of operators, to a lesser extent based on careful registration of all arrhythmia recurrences.

Regarding the need for redo ablation to maintain sinus rhythm, according to most responders, one in five patients with paroxysmal AF requires a redo ablation (Fig. 7). In the case of redo CA of persistent AF, the distribution of responses turned out to be more diverse: from 20 to 50% of patients in the practice of responders may require repeated ablation (Fig. 8). Thus, the need for AF CA in Russia is comparable to world data [6], with a greater need for patients with persistent AF.

Patient management after AF ablation

Conventionally in the early period after catheter ablation (the first 3 months, blanking period) recurrences of arrhythmias occur quite often (up to 30-40% of cases), but in most cases, such recurrences are self-administered and are not observed further [29, 30]. This statement is currently disputed by some authors since the risk of late recurrences in patients with early arrhythmia recurrence is quite high and increases with prolonged follow-up [31-33]. It is believed that early recurrences can be caused by transient changes in the atrial myocardium after ablation, as well as by the "electrophysiological memory" of the atria due to a long arrhythmic history [10, 34]. To suppress early and late arrhythmia recurrences, protective antiarrhythmic therapy is prescribed in most cases, which is consistent with international and national clinical guidelines [35]. It has been shown that the use of antiarrhythmic drugs in the period up to three months after CA significantly reduces recurrences, however, this strategy does not seem so convincing in the long-term 6-12 months follow-up [36, 37]. At the same time, newer studies demonstrate that if patients do not develop arrhythmia recurrence by the end of the first three months, then the use of a previously ineffective antiarrhythmic drug is associated with a decrease in the incidence of atrial tachyarrhythmias during long-term follow-up [38]. Thus, the benefits of prescribing or discontinuing AAD after the "blanking period" on long-term results of AF CA are unknown and require further research.

At the same time, interest in increasing the long-term efficacy of AF ablation does not stop only with the study of antiarrhythmic drug therapy. It is known that when RF energy is applied to the atrial myocardium, acute inflammatory changes occur. Recently, the use of anti-inflammatory drugs in the perioperative period has been of great interest. Short-term use of corticosteroid therapy in the perioperative period is associated with a decrease in early recurrences of arrhythmia (3 months after ablation) but is not effective in preventing late recurrences when followed up to 24 months [39]. Colchicine is another drug used to suppress the inflammatory response and reduce the risk of early AF recurrence after surgical ablation [40-42].

In addition to antiarrhythmic drug therapy, it is necessary to continue therapy for cardiovascular diseases by the relevant recommendations. The use of beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor antagonists, mineralocorticoid receptor blockers is associated with reverse cardiac remodeling and a lower risk of arrhythmia recurrence [10, 21, 43]. Patient compliance with diet, lifestyle (performing regular aerobic physical activity) modification, limiting alcohol consumption is associated with a decrease in cardiovascular risks and a decrease in AF recurrence [13]. Most respondents (97%) indicated the need to monitor adherence to recommendations for antiarrhythmic therapy and therapy of concomitant cardiovascular diseases, lifestyle modifications in patients after AF ablation since this significantly affects the risk of arrhythmia recurrence.

Methodology of RF pulmonary veins isolation (PVI) for AF treatment

Several recent studies have shown that in CA for PV isolation, adherence to the following principles is associated with the highest treatment efficacy in patients by increasing the transmurality and continuity of the created ablation lines around the PV [44, 45]. During the face-to-face meeting of experts, all participants agreed with these positions:

- maintenance the catheter position stability during RF application;
- maintenance of a sufficient RF application time;
- maintenance adequate contact force;
- interlesion distance between application points should be the minimum to prevent the gaps formation;
- RF application with sufficient power.

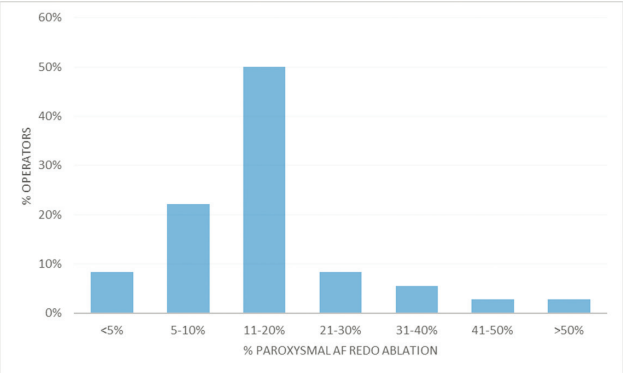

Fig. 7. Frequency of redo ablation in patients with paroxysmal atrial fibrillation (AF).

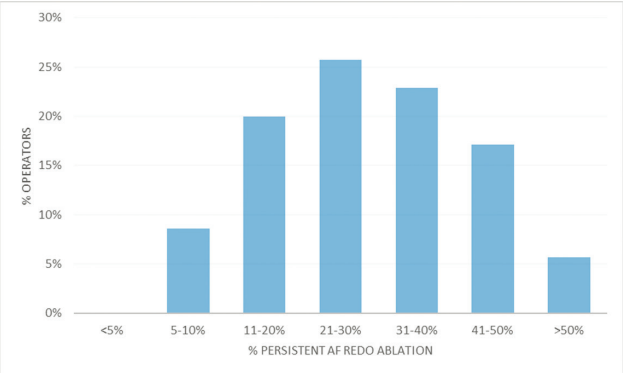

Fig. 8. Frequency of redo catheter ablation in patients with persistent atrial fibrillation (AF).

At the same time, the minimum threshold values for these parameters may vary depending on the technology used, patients' characteristics, and among different operators. The combination of parameters with different values can lead to the formation of lines of necrosis of different widths, depths, and continuity. The following differences were found when interviewing experts: RF power (Fig. 9), duration of each RF application (Fig. 10), the maximum distance between ablation points around the PV (Fig. 11), the width of the isolation zone around the PV - is the distance from the ostium to the ablation points (Fig. 12).

Ablation aspects: contact force monitoring

Before the Contact Force (CF) was implemented in daily practice, operators were guided by the X-ray and/or relied on their tactile sensations during ablation. However, CF-sensing catheters were introduced operators can measure their own «tactile sensation». With unchanged values of RF power and application time, the size of the damage increases with increasing contact force, excessive CF values are associated with the development of the "steam-pop" effect and thrombosis in the LA, and with simultaneous control of the CF, power, and RF application time, it is possible to predict lesion size [10]. The use of CF in real-time has demonstrated a high acute and long-term effectiveness, and a decrease in the procedure time [46-48]. In the studies EFFICAS I and EFFICAS II, the practical role of CF was studied: it became known that at its minimum value, the risk of a breakthrough in conduction in the PV increases. The target values of the CF and the associated Force-Time Integral (FTI) were determined [49, 50]. Nevertheless, although the CF is an important physical unit, its use does not provide any information about the amount of energy delivered directly to the myocardium. It has also been shown in some studies that the use of catheters with CF control did not lead to an improvement in the results of ablation and may also be associated with a higher incidence of esophagus injury [51]. In a meta-analysis of 5 studies, it was shown that the use of the ablation index compared with the CF is associated with a reduced risk of PV reconnections during the acute period AF ablation and a low incidence of atrial arrhythmias during a one-year follow-up [52]. Most experts noted that the introduction of CF-sensing catheters into practice significantly improved the results of ablation in comparison with standard catheters (Table 1). One answer "the use of the CF has harmed" was left without comment, and we cannot give a reason for such a response.

Ablation aspects: Ablation Index

The RF ablation technique using the Ablation Index (AI, Biosense Webster, USA) was developed to predict the size of myocardial injury during RF application and to standardize the AF ablation procedure for each operator. The ablation index is an integral product of power, time, and contact force, and has a linear relationship with the size of RF damage in a certain range. Although catheter stability values are not included in the formula, only applications with stable values (range in mm, time in seconds) are assigned a specific AI value. AI is widely used in clinical practice, and its higher values are associated with a higher frequency of maintaining sinus rhythm [53-55]. The target values of the AI are determined for each operator individually after 10 "blinded" procedures. The median

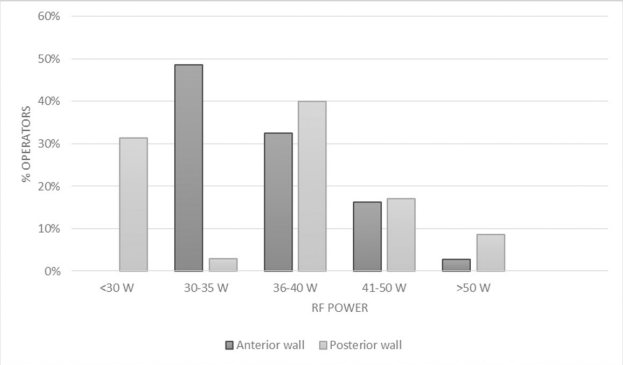

Fig. 9. Differences in the radiofrequency (RF) power parameter along the left atrium anterior and posterior walls.

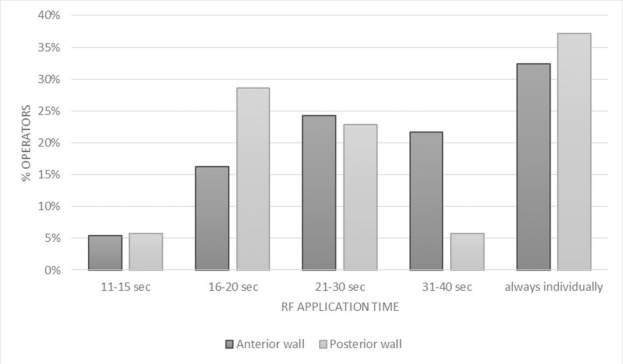

Fig. 10. Differences of the radiofrequency (RF) application time for the left atrium anterior and posterior walls.

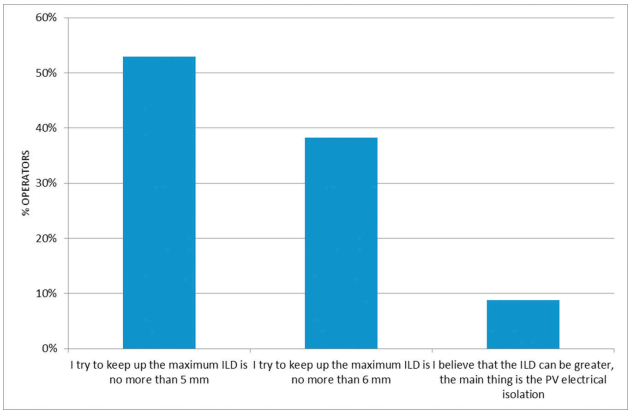

Fig. 11. Maximum interlesion distance (ILD) around the pulmonary vein (PV) to which operators aim.

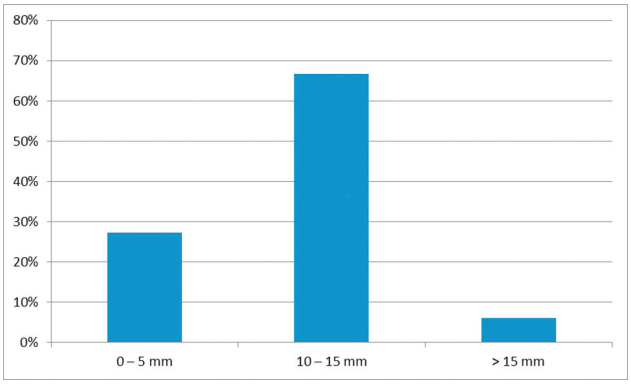

Fig. 12. Distance from the pulmonary vein' ostia to the ablation points.

value of the AI is calculated for each segment of the PV. The same AI value can be obtained for different values of contact force, time, and power.

There is significant variation in technology use, adaptation of different ablation parameters to achieve similar AI values and pronounced variation in target index values across operators. The predictive power of the AI has been shown in several studies: M. Das et al. demonstrated that an AI value of >480 for the LA anterior wall and roof and> 370 for the posterior wall is associated with a low probability of reconnection when followed for two months [56]. In the OPTIMUM study, similar efficacy was obtained with AI values ≥ 450 and ≥350 for the anterior and posterior walls, respectively [55]. In studies using the "CLOSE" protocol, a cutoff AI value of ≥550 for the anterior LA wall and ≥400 for the posterior LA wall was used [57]. Thus, the spread in the AI values is obvious. Since the AI correlates with the transmurality of RF lesion, an insufficient AI value may be associated with a high frequency of PV reconnection, and if its value is too high, the risk of myocardial overheating, collateral damage, and myocardial perforation increases. Optimal values of the AI are currently being studied in a multicenter prospective register [58].

Most of the survey participants noted that the introduction of AI technology made it possible to improve the results of AF CA (Table 2). Most experts are guided by the following AI parameters: 400-500 for the anterior LA wall and 350-450 for the posterior LA wall (Fig. 13).

Table 1.

Expert opinions on the benefit of CF-sensing catheters

Answer options	Response rate, %
No benefits	0
Moderate benefits over standard RF ablation catheters for AF	5,4
Significant benefits over standard RF ablation catheters for AF	40,5
The introduction of this technology has fundamentally changed the practice of AF CA, significantly improved treatment outcomes	51,4
Harm has been done	2,7

Hereinafter: AF - atrial fibrillation, CA - catheter ablation, CF - contact force, RF - radiofrequency

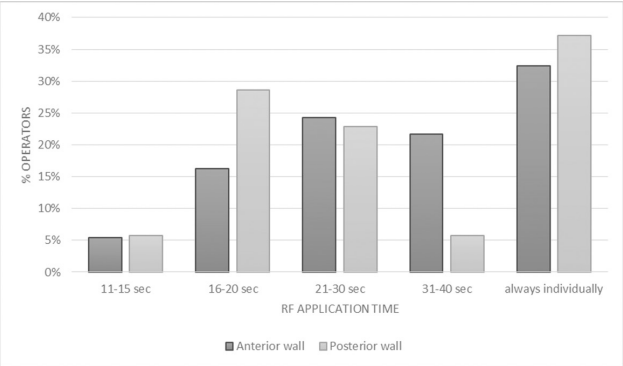

Fig. 13. Frequency of application of a particular ablation index value among responders.

PVI separately or carina ablation between ipsilateral veins

Earlier, in some studies, it was shown that the carina between the upper and lower PV can be the source of trigger arrhythmias that induce and maintain AF [59, 60]. It was also noted that considering the likelihood of PV reconnection through the ablation lines, isolation of two PV using one circle of ablation may be associated with reconnection from two PVs at once. Thus, separate isolation of each PV or routine carina ablation between the superior and inferior PV may be associated with a lower risk of reconnection from two PV simultaneously [61, 62]. At the same time, transmural and continuous myocardial injury using one circular line around two ipsilateral PV should be sufficient for persistent bidirectional conduction block two PV at once. A third of the experts participating in the survey do not perform carina ablation in their clinical practice. Experts' views on routine ablation between ipsilateral veins are summarized in Table 3.

Additional linear lesion in the left atrium

Several studies have shown a relationship between the occurrence and presence of AF with LA electrical and

Table 2.

Benefits of using modules for standardization of RF pulmonary vein isolation (for example, Ablation Index)

Answer options	Response rate, %
No benefist	2,7
Moderate benefits over standard RF ablation catheters for AF	10,8
Significant benefits over standard RF ablation catheters for AF	56,8
The introduction of this technology has fundamentally changed the practice of AF CA, significantly improved treatment outcomes	27
Harm has been done	2,7

Table 3.

Routine performance of the carina ablation between the ipsilateral vein

Answer options	Response rate, %
Almost always do	22
Sometime do	46
Almost never do	32
Never do	0
I consider it harmful	0

Table 4.

Frequency of use of the esophagus temperature control during radiofrequency ablation

Answer options	Response rate, %
Never	86,5
Rarely	8,1
Personalized decision making	2,7
Often	2,7
Always	0

structural remodeling [63, 64]. Based on the magnetic resonance tomography data with late gadolinium enhancement, a group of authors led by N.F.Marrouche formed LA fibrosis degree score UTAH. According to the UTAH score, LA fibrosis can be minimal, which corresponds to UTAH I (≤5% of the LA myocardium), mild or UTAH II (from 5%-20%), moderate or UTAH III (20-35%), and severe or UTAH IV (> 35%) [65]. Myocardial fibrosis can be indirectly detected by determining the atrial electrical activity amplitude. Thus, with the LA voltage mapping, areas with a reduced amplitude of electrical potentials may reflect the presence of myocardial fibrosis.

It is known that the presence and severity of the electroanatomical substrate are responsible for AF recurrence after PVI alone [66]. On the other hand, empirical linear lesion, in the hope of modifying an additional arrhythmia substrate, in patients with persistent AF does not lead to an improvement in sinus rhythm maintenance [67, 68]. At the same time, voltage-oriented RF modification of areas with a low signal amplitude (<0.5 mV at three nearby points) is associated with high rates of freedom from arrhythmia after one ablation procedure in patients without antiarrhythmic therapy during one year of follow-up and represents a personalized AF treatment approach [69].

The unanimous opinion of experts is that it is necessary to achieve complete electrical PV in all AF CA procedures. Opinions were divided regarding additional substrate ablation outside the PV. Thus, the expediency of catheter ablation of areas with complex fractionated atrial electrograms in some patients (mainly with persistent AF) is recognized by a minority of specialists (24%). In paroxysmal AF, the need for empirical linear ablation in the LA is denied by almost all specialists (94%). Personalized ablation/ablation of LA low-amplitude activity areas is considered appropriate by 30 out of 37 (81%) experts during the primary ablation procedure.

Most respondents believe that in paroxysmal AF, the primary catheter ablation strategy should be only PV electrical isolation of the - 35/37 experts. In non-paroxysmal AF, the primary catheter ablation strategy was distributed as follows:

- only PV isolation and cardioversion to restore sinus rhythm - 31/37 specialists;
- routine additional substrate ablation outside the PV - 8/37 specialists;
- after PV isolation with ineffective cardioversion or induction of atrial tachycardia, a combined approach to substrate ablation (search for arrhythmia triggers, linear ablation) - 22/37 specialists;
- personalized decision on additional ablation outside the PV for each patient based on clinical, echocardiographic and electrophysiological patterns (LA voltage map) - 22/37 specialists.

Table 5.

Frequency of use of acute efficacy control technics

Answer options	Response rate, %
Pulmonary vein perimeter stimulation	60
Stimulation by ablation points	5,7
Adenosine	2,9
Multiple approaches	23
Other	8,4

Table 6.

Necessary of the ablation protocol standardization (power, RF application time, catheter stability, circular and / or linear lesions)

Answer options	Response rate, %
Mandatory	16,2
Rather needed	18,9
Rather not needed	16,2
Harmful	2,7

Safety: temperature control in the esophagus during ablation on the LA posterior wall

When performing RF ablation, there is a risk of heating the esophagus anterior wall. The significance of this complication varies from the degree of subsequent damage to the esophageal mucosa; in the most severe cases, an extremely rare but catastrophic complication can develop - an atrioesophageal fistula. Esophageal temperature monitoring is used to control RF energy, early detection of potentially dangerous overheating of the posterior LA wall and extracardiac structures damage and has a high level of recommendation from the professional community (Class IIa C-EO) [10]. When registering an increase in temperature on the sensor by 1-2 °C or up to a level of 39-40 °C, it is recommended to stop the ablation. However, there are technical difficulties in using the temperature sensor due to the anatomical features of the esophagus, which can give a false impression of safe RF exposure. On the other hand, the cessation of energy supply results in low efficacy of the ablation itself. In addition, cases of development of esophageal fistula are known even with satisfactory temperature control [70]. There are various types of temperature sensors, differing in size, the number of sensors, however, due to the low incidence of complications associated with overheating of the LA posterior wall, it is not possible to assess the significant efficacy of the sensors. In the Russian Federation, esophagus temperature control is rarely used for several reasons. To prevent esophagus damage, other approaches have been proposed: active cooling of the esophageal mucosa [71], mechanical displacement of the esophagus with a guided probe [72]. The effectiveness and safety of these techniques have been little studied. According to this survey, esophagus temperature control during AF ablation is very rarely used in the Russian Federation (Table 4).

RF ablation acute effectiveness

There are several generally accepted and recommended techniques for assessing the acute efficacy of AF CA, which include (1) waiting 20 minutes after PV isolation to determine early conduction recovery and assessing the need for additional applications (Class IIa), (2) adenosine / ATP test (Class IIb), as well as electrical stimulation of the PV perimeter along with the ablation points and a combination of techniques [10]. The effectiveness of the above techniques for long-term maintenance of sinus rhythm is still questionable [73, 74]. There is no single consensus among operators on this issue, and each operator applies or adapts one or another methodology following personal

experience. In our survey, operators to assess bidirectional conduction block more often use PV stimulation by diagnostic catheters (Table 5).

Anesthesia and mechanical ventilation for AF ablation

Several studies have shown that mechanical ventilation with deep anesthesia is associated with a more stable position of the ablation catheter, which leads to a more continuous ablation line around the PV [75]. However, deep anesthesia may be associated with a higher risk of severe complications esophagus damage [76]. Deep sedation without mechanical ventilation can be accompanied by a periodic awakening of the patient, irregular breathing, making it difficult to stable positioning of the ablation catheter. In a survey of 6/37 operators during AF ablation, they routinely use deep sedation with mechanical ventilation, while 23/37 experts routinely use light sedation during RF PVI, and in 20% of cases deep anesthesia may be required due to the painfulness of the ablation, the duration of the procedure or the patient's fatigue.

AF ablation standardization

The existing dispersion in the values of AF CA efficacy and safety among different operators and centers predetermines the importance of the ablation protocol standardization [9, 77, 78]. The implementation of the CLOSE protocol [57] became the starting point for standardization, the goal of which is reproducibility and achievement of the same high level of ablation success in the hands of different operators. A standardized and optimized approach to ablation, maintaining RF application continuity and achieving the AI target values (Ablation Index, AI, Biosense Webster, USA) led to PV reliable isolation and was associated with acute and long-term efficacy [79-81]. Most experts (81%) note that PVI standardization is rather necessary or even mandatory to obtain reproducible and stable results of AF treatment (Table 6).

Among the arguments against total standardization is the limitation of the possibility of further development of the methodology, since changing the exposure parameters to try to further improve the results will be limited by the adopted intervention protocols. Another argument against the complete standardization of the ablation approach is the need to consider the clinical features of arrhythmia and electrophysiological remodeling of the atrial myocardium.

CONCLUSION

This paper presents an analysis of Russian specialists' opinions on the factors influencing the results of AF CA. A variety of parameters used for RF PVI and additional ablation approaches of the arrhythmogenic atrial substrate are presented. It should be noted that a survey was conducted of specialists who perform RF PVI, who has experience working with technologies for controlling the contact force and the Ablation Index. Thus, the opinion of specialists, to a greater extent using other ablation technologies, could not be sufficiently considered. Such areas as standardization of the ablation protocol, standardization of the protocol of antiarrhythmic therapy in the post-ablation period require further research and evaluation of the efficacy and safety in randomized and/or observational multicenter studies.

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APPENDIX
ONLINE QUESTIONNAIRE ON ASPECTS OF ATRIAL FIBRILLATION ABLATION

1. Please indicate your age:
2. How many years have you been performing atrial fibrillation (AF) ablation?
3. In my clinical practice (the practice of my department), paroxysmal AF catheter ablation efficacy (single ablation, 12 months follow-up, without antiarrhythmic therapy) is:
   A. <50%
   B. 51-65%

C. 66-75%
D. 76-85%
E. >85%

4. In my clinical practice (the practice of my department), persistenr AF catheter ablation efficacy (single ablation, 12 months follow-up, without antiarrhythmic therapy) is:
A. <40%
B. 40-50%
C. 51-65%
D. 66-75%
E. 76-85%
F. >85%

5. In my practice (the practice of my department), the proportion of patients with non-paroxysmal AF in relation to all patients with AF ablation is:
A. ≤10%
B. 11-20%
C. 21-30%
D. 31-40%
E. 41-50%
F. >50%

6. Number of AF ablation performed by me during the year:
A. <50
B. 51-100
C. 101-150
D. 151-200
E. 201-300
F. >300

7. Number of AF ablation performed in my department per year:
A. <50
B. 51-100
C. 101-200
D. 201-500
E. 501-1000
F. >1000

8. Maximum inrerlesion distance between ablation points around the pulmonary vein:
A. I try to keep up the maximum ILD is no more than 5 mm
B. I try to keep up the maximum ILD is no more than 6 mm
C. I believe that the ILD can be greater, the main thing is the PV electrical isolation

9. Approximate distance from the ostia of the pulmonary vein to the ablation line:
A. 0-5 mm
B. 10-15 mm
C. >15 mm

10. The preferred, in my opinion, RF power for ablation along the left atrium anterior wall:
A. <30 W
B. 30-35 W
C. 36-40 W
D. 41-50 W
E. >50 W

11. The preferred, in my opinion, RF power for ablation along the left atrium posterior wall:
A. <25 W
B. 25-29 W
C. 30-35 W
D. 36-40 W
E. 41-50 W
F. >50 W

12. Flow (irrigation) rate of the ablation catheter for ablation along the left atrium anterior wall:
A. <17 ml/min
B. 17-30 ml/min
C. >30 ml/min

13. Flow (irrigation) rate of the ablation catheter for ablation along the left atrium posterior wall:
A. <17 ml/min
B. 17-30 ml/min
C. >30 ml/min

14. Application time at one ablation point along the left atrium anterior wall:
A. <5 sec
B. 6-10 sec
C. 11-15 sec
D. 16-20 sec
E. 21-30 sec
F. 31-40 sec
G. >41 sec
H. always individually

15. Application time at one ablation point along the left atrium posterior wall:
A. <5 sec
B. 6-10 sec
C. 11-15 sec
D. 16-20 sec
E. 21-30 sec
F. 31-40 sec
G. >41 sec
H. always individually

16. Acute control of pulmonary vein isolation:
A. Using a multipolar diagnostic catheter (circular or otherwise)
B. Using only ablation catheter
C. I believe that after ablation around the pulmonary vein, control is not needed
D. Other (indicate)

17. Additional control of ablation around the pulmonary vein:
A. I stimulate pulmonary vein with a diagnostic electrode
B. I perform stimulation at the ablation points
C. With adenosine
D. Multiple approaches
E. Other (indicate)

18. Do you perform routine ablation between the ipsilateral vein (carina between the superior and inferior pulmonary vein on the right and left side) to improve the overall efficacy of ablation?
A. I almost always do
B. Sometime I do
C. I almost never do
D. I never do
E. I consider it harmful

19. Is it necessary to fully standardize (on a national level) the ablation protocol (power, RF application time, catheter, circular and / or linear lesions)?
A. Mandatory

B. Rather needed
C. Rather not needed
D. Harmful

20. Is it necessary, in your opinion, to routinely perform LA voltage mapping to identify low-amplitude and / or fragmented activity areas (regardless of the inducibility of atrial tachycardia or AF) in patients with paroxysmal AF, in addition to pulmonary vein isolation?
A. Mandatory
B. Rather needed
C. Rather not needed
D. Harmful

21. In patients with paroxysmal AF, in the case of low-amplitude and / or fragmented activity (regardless of the inducibility of atrial tachycardia or AF) areas:
A. Need to ablate
B. Rather, should be ablated
C. Rather, should not be ablated
D. Additional ablation is harmful

22. Is it necessary, in your opinion, to routinely perform LA voltage mapping to identify low-amplitude and / or fragmented activity areas (regardless of the inducibility of atrial tachycardia or AF) in patients with persistent AF, in addition to pulmonary vein isolation?
A. Mandatory
B. Rather needed
C. Rather not needed
D. Harmful

23. In patients with persistent AF, in the case of low-amplitude and / or fragmented activity (regardless of the inducibility of atrial tachycardia or AF) areas:
A. Need to ablate
B. Rather, should be ablated
C. Rather, should not be ablated
D. Additional ablation is harmful

24. Do you routinely perform additional ablation (linear lesions, ganglionic plexus ablation, CFAE ablation) in patients with paroxysmal AF in addition to pulmonary vein isolation?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

25. Do you routinely perform additional ablation (linear lesions, ganglionic plexus ablation, CFAE ablation) in patients with persistent AF in addition to pulmonary vein isolation?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

26. Do you routinely use deep sedation for AF catheter ablation?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

27. Do you use esophagus temperature control for RF ablation along the LA posterior wall?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

28. Do you perform paroxysmal AF ablation with IC or III class antiarrhythmic drugs?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

29. Do you perform persistent AF ablation with IC or III class antiarrhythmic drugs?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

30. Do you recommend for patients to modify cardiovascular risk factors before AF ablation (body weight reducing, blood glucose controlling, blood pressure controlling, aerobic exercise, HF therapy optimization, etc.)?
A. Never
B. Rarely
C. Personalized decision making
D. Often
E. Always

31. In my clinical practice (the practice of my department), the percentage of patients with paroxysmal AF who require redo ablation to achieve an acceptable clinical effect:
A. <5%
B. 5-10%
C. 11-20%
D. 21-30%
E. 31-40%
F. 41-50%
G. >50%

32. In my clinical practice (the practice of my department), the percentage of patients with persistent AF who require redo ablation to achieve an acceptable clinical effect:
A. <5%
B. 5-10%
C. 11-20%
D. 21-30%
E. 31-40%
F. 41-50%
G. >50%

33. What systems do you use in your clinical practice (practice of your department) for the AF treatment?
A. Encite Velocity / Precision (Abbott)
B. Rhythmia (Boston Scientific)
C. CARTO 3 (Biosense Webster)
D. Cryocath (Medtronic)
E. Other

34. Do you use catheters with contact force control (for example, Smart Touch) for AF ablation in your clinical practice (practice of your department)?
A. Never
B. Rarely

C. Personalized decision making
D. Often
E. Always

35. Do you use in your clinical practice (practice of your department) modules for standardization of RF AF ablation (for example, Ablation Index)?
A. I apply Ablation Index
B. I apply LSI
C. I apply other one (indicate)

36. The Ablation Index value on the LA anterior wall in your clinical practice:
A. <300
B. 300-350
C. 351-400
D. 401-450
E. 451-500
F. 500-550
G. 551-600
H. 601-650
I. >650
G. Do not apply

37. The Ablation Index value on the LA posterior wall in your clinical practice:
A. <250
B. 250-300
C. 301-350
D. 351-400
E. 401-450
F. 451-500
G. 500-550
H. 551-600
I. 601-650
G. >650
K. Do not apply

38. What percentage of AF ablation procedures in your clinical practice (the practice of your department) are performed using the Ablation Index technology?
A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%

39. How significant, in your opinion, are the benefits of using catheters with contact force control for the AF treatment:
A. No benefits
B. Moderate benefits over standard RF ablation catheters
C. Significant benefits over standard RF ablation catheters for AF
D. The introduction of this technology has fundamentally changed the practice of AF CA, significantly improved treatment outcomes
E. Harm has been done (please clarify)

40. How significant, in your opinion, are the benefits of using modules for standardizing RF and pulmonary vein isolation (for example, Ablation Index):
A. No benefits
B. Moderate benefits over standard RF ablation catheters
C. Significant benefits over standard RF ablation catheters for AF
D. The introduction of this technology has fundamentally changed the practice of AF CA, significantly improved treatment outcomes
E. Harm has been done (please clarify)