journal of clinical practice 2023 Vol 14 №2

EFFICACY OF TWO-STAGE APPROACH FOR INTERVENTIONAL TREATMENT OF COEXISTENT ATRIAL FIBRILLATION AND TYPICAL ATRIAL FLUTTER FOR SINUS RHYTHM MAINTENANCE IN LONG-TERM: A PROSPECTIVE CONTROLLED CLINICAL TRIAL

I.A. Khamnagadaev[1, 2], I.A. Kovalev[2], I.A. Bulavina[3], M.L. Kokov[4], A.S. Zotov[5], A.V. Troitskiy[5], I.I. Khamnagadaev[6], M.A. Shkolnikova[2], L.S. Kokov[7, 8]

[1] Endocrinology Research Centre, Moscow, Russian Federation

[2] The Russian National Research Medical University named after N.I. Pirogov, Moscow, Russian Federation

[3] Moscow City Clinical Hospital in honor of V.M. Buyanov, Moscow, Russian Federation

[4] Russian State Agrarian University — Moscow Timiryazev Agricultural Academy, Moscow, Russian Federation

[5] Federal Scientific and Clinical Center for Specialized Medical Assistance and Medical Technologies, Moscow, Russian Federation

[6] Belgorod State National Research University, Belgorod, Russian Federation

[7] Sklifosovsky Research Institute of Emergency Medicine, Moscow, Russian Federation

[8] Moscow State University of Medicine and Dentistry named after A.I. Evdokimov, Moscow, Russian Federation

Background: *Atrial fibrillation (AF) and coexistent typical atrial flutter (AFL) interventional treatment strategy remains unresolved in cardiology and cardiovascular surgery. Results of this approach remain suboptimal. There are several approaches to the interventional treatment of patients with coexistent AF and AFL: simultaneous pulmonary vein isolation (PVI) and cavotricuspid isthmus (CTI) radiofrequency catheter ablation (RFCA), PVI or CTI RFCA only and two-stage approach. To our knowledge, cumulative efficacy of two-stage approach has not been previously reported.* ***The aim.*** *This study aimed to evaluate the efficacy of two-stage approach for interventional treatment of coexistent AF and AFL for sinus rhythm maintenance in long-term.* ***Methods:*** *Patients (pts) (n=34) with AF and AFL aged 41–82 years (11 women) were divided into two groups (1:1): «One-stage Approach» (group 1; n=17): PVI+CTI RFCA and «Two-stage approach» (group 2; n=17): first stage — CTI RFCA (group 2.1); second stage — PVI in case of AF recurrence after RFCA (group 2.2). Primary endpoint (PEP) was defined as any recurrent atrial tachyarrhythmia at the end of follow-up; group 2 events have been considered after PVI. Secondary endpoint (SEP) — recurrent any atrial tachyarrhythmia in groups 1 and 2 after CTI RFCA in group 2. PEP and SEP were evaluated at the end of the «blind period» (3 months after procedure).* ***Results:*** *Registered recurrent atrial tachyarrhythmia in pts who reached PEP or SEP was AF. AFL has not been detected in any cases. PEP was noted in 8 (47.06%) pts in group 1 and 1 (5.88%) pts in group 2. Further, SEP was observed in 3 pts (17.65%) in group 1 and in 4 (23.53%) pts in group 2 (p=0.671). The probability of long-term maintenance of sinus rhythm was significantly higher in «Two-stage approach» than in «One-stage approach» (94.12% and 52.94%, respectively, p=0.001). Significant differences in procedure length and fluoroscopy time have been found. Those were longer in group 1 compared to group 2.1 (p <0.001) and in group 2.2 compared to group 2.1 (procedure duration — p <0.001; fluoroscopy time — p=0.013). No differences were noted in length of procedure and fluoroscopy time between groups 1 and 2.2 (p=0.374 and p=0.028, respectively).* ***Conclusion:*** *The «two-stage approach» for interventional treatment of coexistent AF and AFL results in better long-term arrhythmia-free survival than «one-stage approach» (94.12% and 52.94%, respectively, p=0.001). CTI RFCA alone in pts with coexistent AF and AFL cause 23.53% AF recurrence rate and associated with shorter procedure duration and fluoroscopy time compared to simultaneous PVI and CTI RFCA (p <0.001).*

Keywords: *atrial fibrillation; typical atrial flutter; radiofrequency catheter ablation; cavotricuspid isthmus; pulmonary vein isolation.*

For citation: Khamnagadaev IA, Kovalev IA, Bulavina IA, Kokov ML, Zotov AS, Troitskiy AV, Khamnagadaev II, Shkolnikova MA, Kokov LS. Efficacy of Two-Stage Approach for Interventional Treatment of Coexistent Atrial Fibrillation and Typical Atrial Flutter for Sinus Rhythm Maintenance in Long-Term: A Prospective Controlled Clinical Trial. *Journal of Clinical Practice*. 2023;14(2):5–18. doi: https://doi.org/10.17816/clinpract114930

Submitted 19.12.2022 Revised 21.02.2023 Published 08.06.2023

ОТДАЛЁННЫЕ РЕЗУЛЬТАТЫ ДВУХЭТАПНОГО ПОДХОДА К ИНТЕРВЕНЦИОННОМУ ЛЕЧЕНИЮ СОПУТСТВУЮЩИХ ФИБРИЛЛЯЦИИ И ТИПИЧНОГО ТРЕПЕТАНИЯ ПРЕДСЕРДИЙ: ПРОСПЕКТИВНОЕ КОНТРОЛИРУЕМОЕ КЛИНИЧЕСКОЕ ИССЛЕДОВАНИЕ

И.А. Хамнагадаев[1, 2], И.А. Ковалев[2], И.А. Булавина[3], М.Л. Коков[4], А.С. Зотов[5], А.В. Троицкий[5], И.И. Хамнагадаев[6], М.А. Школьникова[2], Л.С. Коков[7, 8]

[1] Национальный медицинский исследовательский центр эндокринологии, Москва, Российская Федерация

[2] Российский национальный исследовательский медицинский университет имени Н.И. Пирогова, Москва, Российская Федерация

[3] Городская клиническая больница имени В.М. Буянова, Москва, Российская Федерация

[4] Российский государственный аграрный университет — Московская сельскохозяйственная академия имени К.А. Тимирязева, Москва, Российская Федерация

[5] Федеральный научно-клинический центр специализированных видов медицинской помощи и медицинских технологий, Москва, Российская Федерация

[6] Белгородский государственный национальный исследовательский университет, Белгород, Российская Федерация

[7] Научно-исследовательский институт скорой помощи имени Н.В. Склифосовского, Москва, Российская Федерация

[8] Московский государственный медико-стоматологический университет имени А.И. Евдокимова, Москва, Российская Федерация

Обоснование. *Оптимизация подходов к интервенционному лечению сопутствующих фибрилляции предсердий (ФП) и типичного трепетания предсердий (ТП) является одной из важных проблем современной кардиологии и сердечно-сосудистой хирургии. При этом результаты лечения данной патологии остаются неудовлетворительными. В настоящее время стратегия интервенционного лечения сопутствующих ФП и типичного ТП не регламентирована, а выбор варианта лечения основан на предпочтениях хирурга и сложившейся практике в медицинской организации: катетерная изоляция лёгочных вен (ИЛВ) в сочетании с радиочастотной абляцией (РЧА) кавотрикуспидального перешейка (КТП), изолированное интервенционное лечение одного из нарушений ритма сердца или их двухэтапное устранение. Работы, которые оценивают отдалённые результаты двухэтапного лечения ФП и типичного ТП как единого процесса, в настоящее время не представлены.* ***Цель исследования*** *— оценить эффективность длительного удержания синусового ритма при двухэтапном подходе к интервенционному лечению сопутствующих ФП и типичного ТП.* ***Методы.*** *Пациенты (n=34) с ФП и типичным ТП в возрасте 41–82 лет (11 женщин) распределены на две группы (1:1). Группа 1 («Одноэтапный подход»; n=17): ИЛВ+РЧА КТП во время одной операции. Группа 2 («Двухэтапный подход»; n=17): «Первый этап» — РЧА КТП (группа 2.1), «Второй этап» — ИЛВ в случае рецидива ФП после РЧА КТП (группа 2.2). Первичная конечная точка: развитие любой предсердной тахикардии в период наблюдения. В группе 1 событие учитывалось после одномоментной ИЛВ и РЧА КТП. В группе 2 событие учитывалось после завершения второго этапа интервенционного лечения. Вторичная конечная точка: развитие любой предсердной тахикардии в группах 1 и 2 в период времени после завершения первого этапа интервенционного лечения (РЧА КТП) в группе 2. Первичная и вторичная конечные точки оценивались по окончанию «слепого периода» (3 месяца после операции).* ***Результаты.*** *У всех пациентов, достигших первичную и вторичную конечную точку, диагностировалась только ФП. Типичное ТП и другие предсердные нарушения ритма сердца не зарегистрированы ни в одном случае. В группе 1 первичную конечную точку достигли 8 (47,06%) пациентов, в группе 2 — 1 (5,88%). При анализе кривых выживаемости выявлено, что вероятность длительного удержания синусового ритма статистически значимо выше в группе 2 («Двухэтапный подход») по сравнению с группой «Одноэтапный подход» (94,12 и 52,94% соответственно; p=0,001). При оценке вторичной конечной точки статистически значимых различий между группами 1 и 2 не выявлено (p=0,671). В группе 1 вторичную конечную точку достигли 3 (17,65%) пациента, в группе 2 — 4 (23,53%). При оценке продолжительности операции и времени*

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

рентгеноскопии выявлены статистически значимые различия: данные временные характеристики больше в группе 1 по сравнению с группой 2.1 (p <0,001) и в группе 2.2 по сравнению с группой 2.1 (продолжительность операции — p <0,001; время рентгеноскопии — p=0,013). Данные параметры статистически значимо не отличались в группах 1 и 2.2 (p=0,374 и p=0,028 соответственно). ***Заключение.*** *Двухэтапный подход к интервенционному лечению сопутствующих ФП и типичного ТП обеспечивает более эффективное удержание синусового ритма по сравнению с одноэтапным подходом (94,12 и 52,94% соответственно; p=0,001). Изолированная РЧА КТП при сопутствующих ФП и типичном ТП ассоциирована с рецидивом ФП в 23,53% случаев и характеризуется меньшей продолжительностью вмешательства и рентгеноскопии по сравнению с подходом, при котором одномоментно выполняется ИЛВ и РЧА КТП (p <0,001).*

Ключевые слова: *фибрилляция предсердий; типичное трепетание предсердий; радиочастотная катетерная абляция; кавотрикуспидальный перешеек; изоляция лёгочных вен.*

Для цитирования: Хамнагадаев И.А., Ковалев И.А., Булавина И.А., Коков М.Л., Зотов А.С., Троицкий А.В., Хамнагадаев И.И., Школьникова М.А., Коков Л.С. Отдалённые результаты двухэтапного подхода к интервенционному лечению сопутствующих фибрилляции и типичного трепетания предсердий: проспективное контролируемое клиническое исследование. *Клиническая практика.* 2023;14(2):5–18. doi: https://doi.org/10.17816/clinpract114930

Поступила 19.12.2022 Принята 21.02.2023 Опубликована 08.06.2023

Abbreviations

AAT — antiarrhythmic therapy.
PVI — pulmonary vein isolation
CTI — cavotricuspid isthmus
AFL — atrial flutter
AF — atrial fibrillation
ECG — electrocardiogram
RFA — radiofrequency ablation

BACKGROUND

Optimizing approaches to interventional treatment of atrial fibrillation (AF) is crucial in modern cardiology and cardiovascular surgery owing to unsatisfactory treatment outcomes and the socioeconomic impact of the problem. The presence of concomitant heart rhythm disorders may reduce the effectiveness of treatment. Typical atrial flutter (AFL) is diagnosed in 35% of patients with AF [1–5]. According to various authors, the high frequency of typical AFL in patients with AF may be because of the shared pathogenetic processes of the heart rhythm disorders [2, 3]. Moreover, typical AFL is considered a predictor of AF recurrence after sinus rhythm restoration [2, 3].

The main surgical treatment methods of AF and typical AFL are catheter-based technologies, such as radiofrequency and cryoballoon pulmonary vein isolation (PVI). In typical AFL treatment, radiofrequency ablation (RFA) of the cavotricuspid isthmus (CTI) is the first-line therapy (class I, level of evidence B). In most cases, this approach is preferred over long term antiarrhythmic drugs [6, 7].

Cox et al. [8] have hypothesized that in AF pathogenesis, AFL is a possible mechanism of AF maintenance. When choosing the “rhythm control” tactic and selecting a patient for interventional treatment of AF with concomitant typical AFL, the question of surgical treatment of the two heart rhythm disorders always arises. The literature on this issue is unclear. Studies have shown that after CTI RFA for typical AFL, patients may experience AF paroxysms within a year [9–12]. Some studies have revealed that additional prophylactic PVI in patients with typical AFL can reduce the probability of AF development in the remote period [13].

Several studies have reported that if typical AFL is detected before interventional treatment of AF or during surgery, performing CTI RFA as part of the catheter PVI procedure may be considered [14, 15]. This reflects link between the pathogenetic processes of AF and typical AFL. To minimize the traumatic nature of the operation, shorten its duration, reduce risks, and alleviate the financial and economic burden of AF, a critical approach to unwarranted interventions in the interventional treatment of AF is required. Gula et al. [16]

have reported that one-step interventional treatment of AF and typical AFL is associated with a higher risk of complications and increased surgery costs compared with staged elimination of heart rhythm disorders.

Currently, three main approaches are used for treating concomitant cardiac rhythm disorders: isolated interventional treatment of one disorder, one-step interventional treatment of AF and typical AFL, and staged interventional treatment of concomitant disorders.

The rate of early recurrence of typical AFL after isolated interventional treatment of AF in this patient category is 24% [17]. Interventional treatment aimed solely at eliminating typical AFL by CTI RFA is associated with a 50% recurrence rate [18–21]. When PVI and CTI RFA are performed during the same procedure, the probability of AF recurrence may reach 50% [17, 22–25]. Interventional treatment approaches for concomitant AF and typical AFL have not yet been regulated. The choice of treatment is based on the surgeon's preferences and the current practice in the medical organization. Currently, no studies have described the long term results of two-step treatment of AF and AFL as a single process.

This study aimed to evaluate the efficacy of long term sinus rhythm retention in a two-step approach to the interventional treatment of concomitant AF and typical AFL.

METHODS

Study design

A controlled prospective clinical study was conducted at multiple centers to analyze the outcomes of interventional treatment of concomitant AF and typical AFL in 34 patients aged 41–82 years (median age: 65.5 years, with a lower quartile of 61 years and an upper quartile of 70 years). Of the 34 patients, 23 (67.65%) were male and 11 (32.35%) were female.

Patients were randomly assigned to one of two groups in a 1:1 ratio, with every other patient being allocated to group 2 (Fig. 1).

Group 1 (one-step approach, *n*=17) consisted of patients with AF and typical AFL who underwent CTI RFA combined with radiofrequency catheter-based PVI.

Group 2 (two-step approach, *n*=17) included patients with AF and typical AFL who were treated in two stages:

- Group 2.1 (first stage): interventional treatment of typical AFL by CTI RFA;
- Group 2.2 (second stage): catheter-assisted PVI performed in the case of recurrent AF after CTI RFA.

Antiarrhythmic therapy was prescribed for 3 months after the intervention. The occurrence of atrial tachycardia during this period was not considered a recurrence of the disease because it was part of the "blind period." The patients received antiarrhythmic therapy during this period, which they had been taking before the surgical intervention. AF and typical AFL recurrences were identified by the presence of registered cardiac rhythm disturbances lasting >30 s on a resting electrocardiogram (ECG) in 12 standard leads or on a 24 h ECG montage. Recurrences of AF and typical AFL were identified at the end of the "blinded period" following the discontinuation of antiarrhythmic therapy.

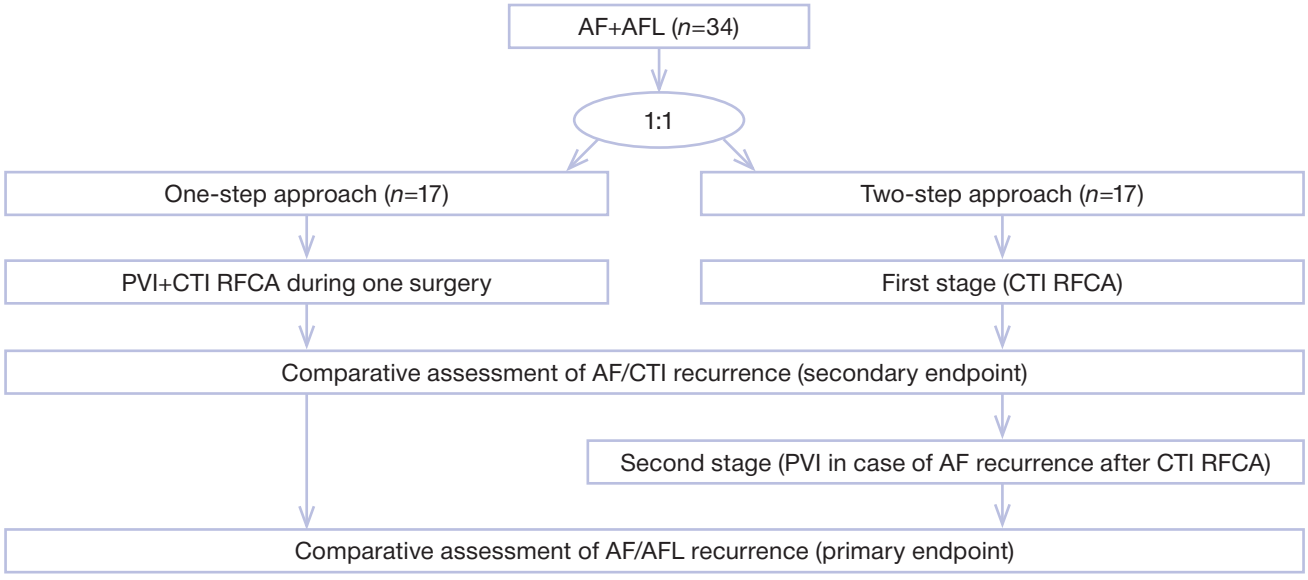

Fig. 1. Study design.
Note: AF, atrial fibrillation; AFL, typical atrial flutter; RFCA, radiofrequency catheter ablation; PVI, pulmonary vein isolation; CPI, cavotricuspid isthmus; *n*, number of patients.

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

To test the working hypotheses, we calculated the sample size using an online calculator (https://sealedenvelope.com/power/binary-superiority/) [26] based on the following formulas:

$$n = f(\alpha/2, \beta) \times [p_1 \times (100 - p_1) + p_2 \times (100 - p_2)] / (p_2 - p_1)^2, \quad (1)$$

where p_1 is the percentage of "success" in the control group (taken as 0.5) and p_2 is the percentage of "success" in the experimental group (taken as 0.9)

$$f(\alpha, \beta) = [\Phi^{-1}(\alpha) + \Phi^{-1}(\beta)]^2, \quad (2)$$

where Φ^{-1} is the cumulative distribution function of the standardized normal deviation, α is the threshold level of statistical significance (taken as 0.05), and β is the probability of erroneous non-rejection of the null hypothesis of no difference (taken as 0.2).

Justification for the choice of p_1 and p_2 values:

- The incidence of AF recurrence after catheter-based PVI with one-step CTI RFA can reach 50% [19, 21, 22, 27]; therefore, p_1 is taken as 0.5.
- Despite the successful elimination of typical AFL, the probability of developing AF paroxysms after CTI RFA reaches 50% (the first step of interventional treatment) [18, 19, 27].
- After the first step of interventional treatment (CTI RFA), catheter PVI may be required in half of the cases, and the efficiency of sinus rhythm retention after catheter PVI in patients with isolated AF may reach 91.3% [28].
- Of the 50% of patients who are expected to relapse after the first stage of interventional treatment (CTI RFA), <10% are expected to relapse after the second stage of interventional treatment (PVI). Thus, the cumulative expected efficacy of the two-step approach is at least 90%.
- The clinically significant increase in treatment efficacy in the case of the two-step approach is considered to be an increase in the efficacy of interventional treatment from 50% to 90%. In this regard, p_2 is taken as 0.9.

Thus, each group should have 17 patients to achieve a study power of 80% at a significance level of 5%.

Eligibility criteria

Inclusion criteria: patients aged >18 years, presence of clinically significant paroxysmal and persistent AF (EHRA ≥2a), and presence of concomitant typical AFL.

Inclusion criteria: persistent AF, left ventricular ejection fraction of <50%, severe extracardiac pathology, cardiac cavity thrombosis, congenital and acquired heart defects, cardiomyopathies, previous open-heart surgery, and contraindications of X-ray contrast agents.

Exclusion criteria: intolerance to the medications used, acute diseases or decompensation of existing conditions requiring therapeutic or diagnostic measures that would prevent continued participation, and patient unwillingness to continue the study.

Settings

Surgical interventions were performed from 2019 to 2022 at two medical facilities in Moscow, Russia. The V.M. Buyanov City Clinical Hospital of the Department of Health of Moscow performed surgeries in 2019–2020, whereas the National Medical Research Center for Endocrinology of the Ministry of Health of Russia conducted surgeries in 2020–2022. To minimize systematic bias, all surgeries were carried out by the same surgeon using the same technique and equipment.

Duration of the study

The study duration was extended from 2 to 3 years because of the COVID-19 pandemic. During the study, intermediate outcomes were assessed by comparing the incidence of recurrent AF in groups 1 (PVI) and 2.1 (performing CTI RFA as the first stage of treatment).

Description of the medical intervention

Antiarrhythmic drugs of classes IC (lappaconitine hydrobromide) and III (sotalol) were administered to maintain drug-induced sinus rhythm. The CARTO electroanatomic mapping system (Biosense Webster, USA) was used in conjunction with a SmartTouch navigation catheter (Biosense Webster, USA). To verify bidirectional conduction block in the CTI area and antral part of the pulmonary veins, multipole catheters were used to construct a three-dimensional (3D) reconstruction of the corresponding heart chamber. Isolated CTI RFA was performed under local anesthesia, whereas endotracheal anesthesia was used during PVI. A single protocol was employed for all surgical interventions [29].

Preparatory stage of surgical intervention (performed in all cases):

- Puncture and cannulation of the main vessels is performed using ultrasound navigation.
- The right internal jugular and right femoral veins were punctured and cannulated with a guide.

- 6F introdes are placed, diagnostic electrodes are inserted into the right heart and placed in the coronary sinus and right ventricle, and an intracardiac electrophysiology study is performed.

The main surgical steps when performing CTI RFA:

- 3D reconstruction of the right atrium and linear ablation of the CTI (40 W; ablation index, 400) are performed.
- Biodirectional conduction block in the CTI region is verified.

The main surgical steps in performing PVI:

- Transseptal catheterization of the left atrium is performed under transesophageal or intracardiac ultrasound control in the oval fossa.
- Systemic heparinization is initiated to maintain an activated clotting time of 300–400 s.
- Left atrium and pulmonary veins are contrasted with frequent ventricular stimulation.
- 3D reconstruction of the left atrium is conducted.
- A bipolar map of the left atrium is constructed.
- Radiofrequency energy is applied in a series of linear applications in the antral part of the left atrium. The anterior wall is treated with 30 W (ablation index, 400), whereas the posterior wall of the left atrium is treated with 25 W (ablation index, 350).
- Biodirectional conduction block in the distal pulmonary veins is verified.
- Heparin is inactivated with protamine sulfate solution.

Final stage of surgical intervention (performed in all cases):

- If tachycardia is not eliminated during RFA, electrical cardioversion is performed.
- Decannulation of the central veins followed by manual compression of the vascular approaches and application of pressure dressing are performed.
- X-ray and echocardiographic control is conducted to exclude hemopericardium and hemopneumothorax.

Study outcomes

Study endpoints

The primary study endpoint was the development of atrial tachycardia during the follow-up period after completion of all stages of interventional treatment at the end of the blind period. In group 1, the event was counted after the first stage of interventional treatment (PVI+CTI RFA). In group 2, the event was counted after the completion of the second stage of interventional treatment, which involved PVI in cases of AF recurrence after CTI RFA.

The secondary study endpoint was to determine the development of atrial tachycardia in groups 1 and 2 after the completion of the first stage of interventional treatment (CTI RFA) in group 2.

Subgroup analysis

Comparative assessment of surgical duration and fluoroscopy time was performed in groups 1 (PVI+CTI RFA), 2.1 (CTI RFA), and 2.2 (PVI).

Methods for recording outcomes

The outcomes were recorded using clinical and anamnestic methods and instrumental methods of investigation. These outcomes were represented by resting ECG in 12 standard leads and 24-h ECG monitoring.

Ethical review

This study was conducted as part of the research titled "Personalized approach to interventional treatment of atrial fibrillation," which was approved by the local ethical committee of the Veltischev Institute of the N.I. Pirogov Russian National Research Medical University of the Ministry of Health of Russia (protocol no. 7; September 10, 2019). The results of this study have not been previously published.

Statistical analysis

Statistical processing was performed using the Statistica 13 program (StatSoft). Quantitative characteristics are presented as Min–Max (Me, IQR), where Min is the minimum value, Max is the maximum value, Me is the median, and IQR is the interquartile range (25%–75%Q). Nonparametric criteria were used for statistical calculations. The Mann–Whitney U test was used to obtain the statistical significance of differences between continuous variables. To test the hypotheses about the independence of nominal signs, conjugacy tables were used with Pearson's chi-square criterion (Pearson $\chi 2$), and the number of degrees of freedom was calculated. If any cell in the conjugacy tables had an expected occurrence of 5, the maximum likelihood method (M-L$\chi 2$) was used for analysis. For analyzing bipolar tables, Fisher's exact test (*F*-test) was used. Furthermore, we used the rank correlation coefficient to evaluate the relationship between the traits measured on a nominal scale. Additionally, Cramer's V coefficient and conjugacy coefficient were used to determine the strength of the relationship between nominal traits. The Kaplan–Meier survival function was estimated, and statistical hypotheses were tested using Cox's F-criterion.

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

In testing the statistical hypotheses, a significance level of 5% was used. The null hypothesis of no differences was rejected only if the probability of incorrectly rejecting it did not exceed 5%. The sample size was calculated using an online calculator [26].

RESULTS

Objects (participants) of the study

The groups of patients were comparable regarding sex, age, and body weight. No statistically significant differences were found between the studied groups when analyzing the form of AF course, severity of its clinical manifestations, and the classes of antiarrhythmic drugs used (Table 1).

Main results of the study

The study included patients with a follow-up period ranging 175–730 (Me=730, IQR: 730–730) days. The primary endpoint was reached by 8 (47.06%) patients in group 1 and 1 (5.88%) patient in group 2 (p=0.020) (Table 2).

The one-step approach resulted in a 52.94% rate of sinus rhythm retention, whereas the two-step approach had a rate of 94.12%. All the patients who reached the primary endpoint were diagnosed with AF, and no typical AFL or other cardiac rhythm disturbances were recorded. The analysis of survival curves indicated that the probability of long term sinus rhythm retention was significantly higher in the two-step approach (group 2: CTI RFA

Table 1

Patient's baseline characteristics

Index	Group 1 (PVI + CTI RFCA during one surgery) *n*=17	Group 2 (CTI RFCA at the first stage, PVI in case of recurrent AF at the second stage) *n*=17	*p*
Age, years; Min–Max: Me (Q1; Q3)	50–74: 66 (62; 69)	41–82: 65 (61; 72)	0.796
Sex, *n* (%)	Female — 4 (23.53) Male — 13 (76.47)	Female — 7 (41.18) Male — 10 (58.82)	0.269
Duration of disease, months Min–Max: Me (Q1; Q3)	1–120: 36 (12; 56)	2–96: 18 (8; 60)	0.605
Body weight deficit, *n* (%)	0 (0)	0 (0)	0.319*
Normal body weight, *n* (%)	1 (5.88)	3 (17.65)	
Overweight, *n* (%)	3 (17.65)	5 (29.41)	
Obesity	13 (76.47)	9 (52.94)	
Paroxysmal AF, *n* (%)	15 (88.23)	12 (70.59)	0.197*
Persistent AF, *n* (%)	2 (11.77)	5 (29.41)	
AAT duration, months Min–Max: Me (Q1; Q3)	1–120: 36 (12; 56)	2–96: 17 (7; 36)	0.352
AAT IC (lappaconitine hydrobromide)	3 (17.65)	1 (5.88)	0.277*
AAT III (sotalol)	14 (82.35)	16 (94.12)	
Arterial hypertension, *n* (%)	14 (82.35)	16 (94.12)	0.27737
Diabetes mellitus, *n* (%)	3 (17.65)	7 (41.18)	0.12809
CHA2DS2-VASc scale >1, *n* (%)	14 (82.35)	15 (88.24)	0.62722
EHRA ≥3, *n* (%)	10 (58.82)	11 (64.71)	0.16729
Ischemic heart disease, *n* (%)	2 (11.77)	3 (17.65)	0.62722
Chronic heart failure, *n* (%)	2 (11.77)	8 (47.06)	0.02048
Chronic obstructive pulmonary disease, *n* (%)	2 (11.77)	1 (5.88)	0.54188

Note: * The significance level was calculated using contingency tables; *p* — probability of rejecting a true null hypothesis; *n* — number of patients; Me — median: Q1 — first (lower) quartile, Q3 — third (upper) quartile, Min — minimum value, Max — maximum value. AF — atrial fibrillation; EHRA (European Heart Rhythm Association) — Scale of Atrial Fibrillation related Symptoms; CHA2DS2-VASC Score — a scale for assessing the risk of thromboembolic complications; PVI — pulmonary vein isolation; RFCA — radiofrequency catheter ablation; CTI — cavotricuspid isthmus; AAT — antiarrhythmic therapy.

Table 2

Interventional treatment results in two groups

Index	Group 1 (PVI + CTI RFCA during one surgery) *n*=17	Group 2 (CTI RFCA at the first stage, PVI in case of recurrent AF at the second stage) *n*=17	*p*
AF recurrence within 3–6 months after surgery, *n* (%)*	1 (5.88)	3 (17.65)	0.595
AF recurrence between 6 and 12 months after surgery, *n* (%)*	3 (17.65)	4 (23.53)	0.671
AF recurrences between 12 and 24 months after surgery, *n* (%)**	4 (25.53)	1 (5.88)	0.333
AF recurrence between 3 and 24 months after surgery, *n* (%)**	8 (47.06)	1 (5.88)	0.020
Complications, *n*	2	0	-

Note: * AF recurrence in group 2 after first stage: CTI RFCA (secondary endpoint); ** AF recurrence in group 2 after second stage: PVI in case of AF recurrence after CTI RFCA (primary endpoint); *p* — probability of rejecting a true null hypothesis; *n* — number of patients. AF — atrial fibrillation; PVI — pulmonary vein isolation; RFA — radiofrequency catheter ablation; CTI — cavotricuspid isthmus.

at the first stage and PVI in case of AF recurrence at the second stage) than in the one-step approach (group 1: PVI+CTI RFA during one surgery), accounting for 94.12% and 52.94%, respectively (p=0.001) (Fig. 2).

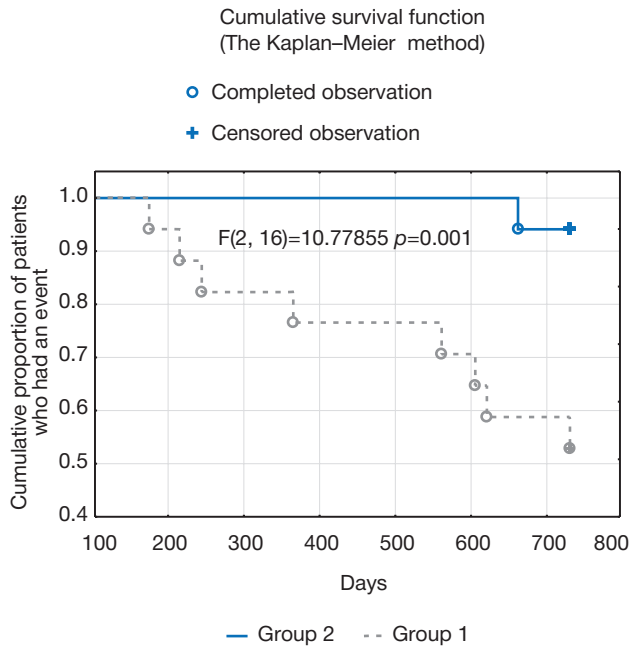

Fig. 2. Long-term sinus rhythm maintenance comparative assessment in groups 1 (n=17) and 2 (n=17): the probability AF recurrence in "One-stage approach" (PVI+CTI RFCA during the one procedure) is significantly higher than in "Two-stage approach" (First stage — CTI RFCA; Second stage — PVI in AF recurrence patients).
Note: *p* — probability of rejecting a true null hypothesis; *n* — number of patients. AF — atrial fibrillation; PVI — pulmonary vein isolation; RFCA — radiofrequency catheter ablation; CTI — cavotricuspid isthmus.

No statistically significant differences were found between groups 1 and 2 (p=0.671) when assessing the secondary endpoint. In group 1, the secondary endpoint was reached by 3 (17.65%) patients and by 4 (23.53%) patients in group 2. All patients who reached the secondary endpoint were diagnosed with AF. No typical AFL or other cardiac rhythm disorders were observed.

Additional results of the study

The intervention duration in the study groups was as follows: group 1 (PVI+CTI RFA), 40–110 min (Me=60, IQR: 50–67); group 2.1 (CTI RFA), 15–45 min (Me=18, IQR: 15–20); and group 2.2 (PVI in case of AF recurrence after CTI RFA), 52–120 min (Me=65, IQR: 54–110).

Fluoroscopy time was measured in the study groups: group 1 (PVI+CTI RFA), 8–30 min (Me=20, IQR: 16–24); group 2.1 (CTI RFA), 5–25 minutes (Me=7, IQR: 6–9); and group 2.2 (PVI in case of AF recurrence after CTI RFA), 6–30 minutes (Me=12, IQR: 9–15).

A comparison was made between the intervention duration and fluoroscopy time of the studied groups (Figs. 3 and 4). The time characteristics were found to be greater in group 1 (PVI+CTI RFA) than in group 2.1 (CTI RFA) (p <0.001) and in group 2.2 (PVI in case of AF recurrence after CTI RFA) than in group 2.1 (CTI RFA) (duration of intervention, p <0.001; fluoroscopy time, p=0.013). These parameters did not show a statistically significant difference between groups 1 (PVI+CTI RFA) and 2.2 (PVI in case of AF recurrence after CTI RFA) (p=0.374 and p=0.028, respectively).

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

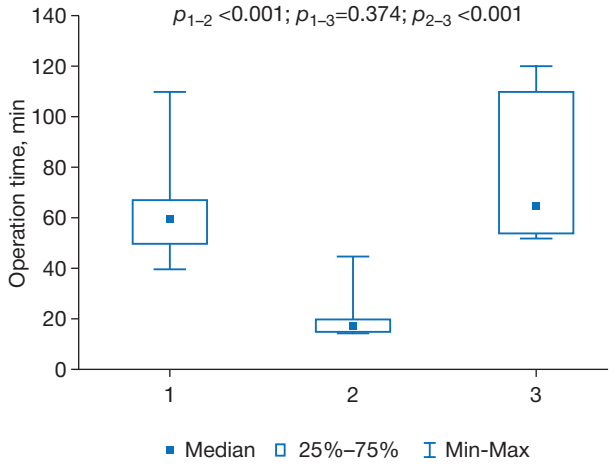

Fig. 3. Comparative assessment of the procedure duration in groups: p_{1-2} <0,001; p_{1-3}=0,374; p_{2-3} <0,001 (n=34).
Note: p — probability of rejecting a true null hypothesis; n — number of patients. 1 — PVI+CTI RFCA during the one procedure (group 1); 2 — CTI RFCA: first stage (group 2.1); 3 — PVI: second stage (group 2.2). PVI — pulmonary vein isolation; RFCA — radiofrequency catheter ablation; CTI — cavotricuspid isthmus.

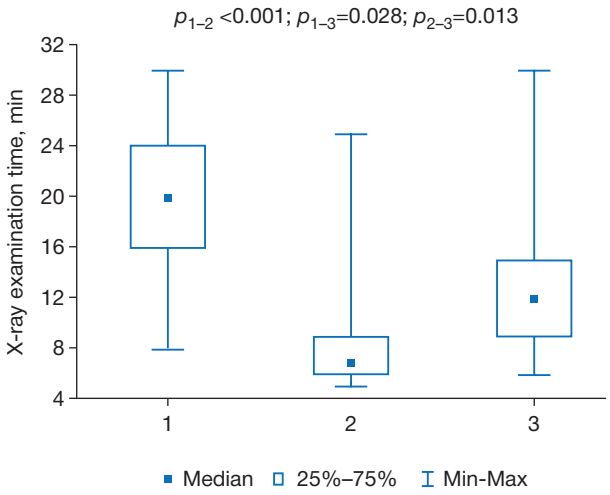

Fig. 4. Fluoroscopy time comparative assessment in groups: p_{1-2} <0,001; p_{1-3}=0,028; p_{2-3}=0,013 (n=34).
Note: p — probability of rejecting a true null hypothesis; n — number of patients. 1 — PVI+CTI RFCA during the one procedure (group 1); 2 — CTI RFCA: first stage (group 2); 3 — PVI: second stage (group 2). PVI — pulmonary vein isolation; RFCA — radiofrequency catheter ablation; CTI — cavotricuspid isthmus.

Adverse events

The analysis showed that adverse events occurred solely in group 1, including the development of a pulsating hematoma, which was eliminated by manual compression during the day of observation. Moreover, one patient experienced cardiac tamponade along with hemopericardium during surgery, which required pericardial drainage and hemostatic therapy with heparin inactivation.

DISCUSSION

This study evaluated the efficacy of long term sinus rhythm retention in the two-step approach for interventional treatment of AF. The first step involves CTI RFA, and the second step involves PVI in cases of AF recurrence after CTI RFA (group 2). The two-step approach was compared with an alternative strategy: PVI and CTI RFA during the same surgery (group 1). In analyzing the long term results, the two-step approach was found to be more effective in ensuring long term sinus rhythm retention than the one-step approach (p <0.001).

In contrast to previous studies, this study considers the two-stage interventional treatment of AF and typical AFL as a single process. Cumulative efficacy was assessed after the second stage of interventional treatment. Previous studies have focused on the interventional treatment of AF in patients with typical AFL. The studies aimed to address issues such as assessing the incidence of AF after CTI RFA in patients without anamnestic evidence of AF [30] and comparing the effectiveness of two approaches in patients with AF and typical AFL (PVI combined with CTI RFA versus isolated CTI RFA) [16, 25]. Several studies have evaluated the feasibility of prophylactic CTI RFA in patients with AF without a history of typical AFL. The incidence of AF after isolated CTI RFA was found to be as high as 50% [18, 25]. Our study found similar data when assessing the rate of AF recurrence in group 2 after the first stage of interventional treatment. After CTI RFA, AF recurrence was noted in 23.53% of cases, which is higher than that in group 1, wherein the rate of AF recurrence was 17.65% (p=0.671). Although no significant differences were noted, our data are comparable with the results of the APPROVAL study. The authors of the study concluded that PVI combined with CTI RFA during a single surgery is more effective in providing long term sinus rhythm retention compared with isolated CTI RFA. After the withdrawal of antiarrhythmic therapy, long term sinus rhythm retention was observed in 64% and 19% of cases, respectively (p <0.001) [25]. Unlike the present study, the APPROVAL study did not assess the cumulative effectiveness of long term sinus rhythm retention after the second stage of interventional treatment.

The present study found that the duration of intervention and fluoroscopy time were significantly higher (p <0.001) in group 1 (PVI+CTI RFA) than

in group 2.1 (CTI RFA). These results confirm those of earlier studies. Thus, in the REDUCE-AF [30] and PREVENT AF [18] studies, the authors concluded that performing CTI RFA and PVI simultaneously resulted in longer intervention and fluoroscopy times compared with treating typical AFL (CTI RFA) alone. However, it has been demonstrated in our study and in several others that performing CTI RFA in patients with AF and typical AFL can ensure long term maintenance of sinus rhythm after discontinuation of antiarrhythmic therapy [25]. According to Gula et al. [16], the two-step approach (CTI RFA at the first stage and PVI at the second stage in case of recurrent AF) is associated with a lower risk of complications and financial costs compared with the one-step approach (PVI+CTI RFA). The authors concluded that the one-step approach should not be included in routine clinical practice because of the increased risk of complications and financial costs. Complications were observed only in group 1 (PVI+CTI RFA), and the small number of these adverse events does not allow for a comparative assessment of the studied groups based on this factor.

The current study complements the research conducted by Gula et al. [16]. It evaluates the cumulative efficacy of the two-step approach, which involves CTI RFA at the first stage and PVI at the second stage in cases of recurrent AF. The results show that this approach is significantly more effective than the one-step approach (PVI+CTI RFA) regarding long term sinus rhythm retention. The high cumulative efficacy of the two-stage approach (CTI RFA at the first stage and PVI at the second stage in case of AF recurrence) is explained in a study by Cox [8, 31] in which AFL is considered a possible mechanism for inducing and maintaining AF. Thus, it can be concluded that eliminating AFL in some cases can lead to long term maintenance of sinus rhythm. This conclusion is supported by both the present study and earlier research [25].

Therefore, in the case of the two-step approach (CTI RFA as the first step and PVI as the second step in the case of recurrent AF), PVI is not performed if it does not contribute to the long term maintenance of sinus rhythm. CTI RFA is an effective surgical treatment for typical AFL with a low recurrence rate [32]. In our study, typical AFL recurrence was not observed in any case, whereas unwarranted performance of PVI may lead to incisional tachycardia. For instance, according to the Triple A study, AF recurrence is due to ablation line failure in the antral part of the pulmonary veins [33]. The study indicated that this may also account for the higher rate of AF recurrence in patients who underwent PVI and CTI RFA during the same surgery (group 1). The present study shows that performing PVI as the first stage of treatment for patients with AF may be inappropriate because it may not address the underlying trigger or mechanism of AF maintenance.

Limitations of the study

The limitations of the present study include the lack of intracardiac electrophysiology study in cases AF recurrence after PVI because of ethical reasons, the absence of loop recorders to objectify the development of recurrent atrial tachyarrhythmias in the postoperative period, and the use of only radiofrequency ablation for electrical PVI from the atrial myocardium without comparison to cryoballoon ablation.

CONCLUSIONS

The two-step approach, which involves CTI RFA at the first stage and PVI at the second stage in case of AF recurrence, is more effective in retaining sinus rhythm than the one-step approach.

Performing CTI RFA alone in the presence of concomitant AF and typical AFL resulted in AF recurrence in 23.53% of cases. This approach was associated with a shorter duration of intervention and fluoroscopy than simultaneous PVI and CTI RFA.

ADDITIONAL INFORMATION

Authors' contribution. *I.A. Khamnagadaev* — participation in the operation, processing and discussion of the results of the study, writing the manuscript; *I.A. Kovalev, I.I. Khamnagadaev* — search and analytical work, writing the manuscript; *I.A. Bulavina* — statistical processing of the material, participation in the treatment of patients, writing the text of the article; *M.L. Kokov* — preparation of illustrations, writing the manuscript; *A.S. Zotov* — selection of patients, writing the manuscript; *A.V. Troitsky, M.A. Shkolnikova, L.S. Kokov* — research planning, discussion of research results. The authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

Funding source. The study had no sponsorship.

Competing interests. The authors declare that there is no conflict of interests.

Acknowledgments. The authors express their gratitude to the Doctor of Medical Sciences, Professor of the Department of Endocrinology of the Institute

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

of Higher and Additional Postgraduate Education of the Federal State Budgetary Institution National Research Center for Endocrinology of the Ministry of Health of Russia, Professor of the Department of Medical Cybernetics and Informatics of the Faculty of Biomedical Science of the Federal State Autonomous Educational Institution of Higher Education of the Russian National Research Medical University. N.I. Pirogov of the Ministry of Health of the Russian Federation Rebrova Olga Yurievna for consulting support on the design of the study, calculation of the sample size and description of the results of statistical data processing.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. *И.А. Хамнагадаев* — руководство исследованием, выполнение оперативных вмешательств, написание текста статьи; *И.А. Ковалев, И.И. Хамнагадаев* — поисково-аналитическая работа, написание статьи; *И.А. Булавина* — статистическая обработка материала, участие в лечении пациентов, написание текста статьи, *М.Л. Коков* — подготовка иллюстраций, написание текста статьи, *А.С. Зотов* — отбор пациентов, написание текста статьи, *А.В. Троицкий, М.А. Школьникова, Л.С. Коков* — планирование исследования, обсуждение результатов исследования. Авторы подтверждают соответствие своего авторства международным критериям ICMJE (все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией).

Источник финансирования. Исследование и публикация статьи осуществлены на личные средства авторского коллектива.

Конфликт интересов. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Благодарности. Авторы выражают признательность доктору медицинских наук, профессору кафедры эндокринологии Института высшего и дополнительного постдипломного образования ФГБУ «НМИЦ эндокринологии» Минздрава России, профессору кафедры медицинской кибернетики и информатики медико-биологического факультета ФГАОУ ВО РНИМУ им. Н.И. Пирогова Минздрава России Ребровой Ольге Юрьевне за консультативную поддержку по вопросам дизайна исследования, вычисления объёма выборки и описания результатов статистической обработки данных.

REFERENCES / ЛИТЕРАТУРА

1. Celikyurt U, Knecht S, Kuehne M, et al. Incidence of new-onset atrial fibrillation after cavotricuspid isthmus ablation for atrial flutter. *Europace*. 2017;19(11):1776–1780. doi: 10.1093/europace/euw343
2. Bertaglia E, Bonso A, Zoppo F, et al. Different clinical courses and predictors of atrial fibrillation occurrence after transisthmic ablation in patients with preablation lone atrial flutter, coexistent atrial fibrillation, and drug induced atrial flutter. *Pacing Clin Electrophysiol*. 2004;27(11):1507–1512. doi: 10.1111/j.1540-8159.2004.00668.x
3. Nabar A, Rodriguez LM, Timmermans C, et al. Class IC antiarrhythmic drug induced atrial flutter: Electrocardiographic and electrophysiological findings and their importance for long term outcome after right atrial isthmus ablation. *Heart*. 2001;85(4):424–429. doi: 10.1136/heart.85.4.424
4. Enriquez A, Sarrias A, Villuendas R, et al. New-onset atrial fibrillation after cavotricuspid isthmus ablation: identification of advanced interatrial block is key. *Europace*. 2015;17(8): 1289–1293. doi: 10.1093/europace/euu379
5. Krisai P, Roten L, Zelijkovic I, et al. Prospective evaluation of a standardized screening for atrial fibrillation after ablation of cavotricuspid isthmus dependent atrial flutter. *J Clin Med*. 2021;10(19):4453. doi: 10.3390/jcm10194453
6. Page RL, Joglar JA, Caldwell MA, et al. ACC/AHA/HRS guideline for the management of adult patients with supraventricular tachycardia: executive summary: A report of the American College of Cardiology / American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. *Circulation*. 2016;133(14):e471–e505. doi: 10.1161/CIR.0000000000000310
7. Bastani H, Drea N, Insulander P, et al. Cryothermal vs radiofrequency ablation as atrial flutter therapy: A randomized comparison. *Europace*. 2013;15(3):420–428. doi: 10.1093/europace/eus261
8. Cox JL, Canavan TE, Schuessler RB, et al. The surgical treatment of atrial fibrillation: II. Intraoperative electrophysiologic mapping and description of the electrophysiologic basis of atrial flutter and atrial fibrillation. *J Thoracic Cardiovasc Surg*. 1991;101(3):406–426.
9. Chinitz JS, Gerstenfeld EP, Marchlinsky FE, et al. Atrial fibrillation is common after ablation of isolated atrial flutter during long-term follow-up. *Heart Rhythm*. 2007;4(8):1029–1033. doi: 10.1016/j.hrthm.2007.04.002
10. Mittal S, Pokushalov E, Romanov A, et al. Long-term ECG monitoring using an implantable loop recorder for the detection of atrial fibrillation after cavotricuspid isthmus ablation in patients with atrial flutter. *Heart Rhythm*. 2013;10(11):1598–1604. doi: 10.1016/j.hrthm.2013.07.044
11. Ellis K, Wazni O, Marrouche N, et al. Incidence of atrial fibrillation post-cavotricuspid isthmus ablation in patients with typical atrial flutter: Left-atrial size as an independent predictor of atrial fibrillation recurrence. *J Cardiovasc Electrophysiol*. 2007;18(8):799–802. doi: 10.1111/j.1540-8167.2007.00885.x
12. Luria DM, Hodge DO, Monahan KH, et al. Effect of radiofrequency ablation of atrial flutter on the natural history of subsequent atrial arrhythmias. *J Cardiovasc Electrophysiol*. 2008;19(11):1145–1150. doi: 10.1111/j.1540-8167.2008.01206.x
13. Romanov A, Pokushalov E, Bayramova S, et al. Prophylactic pulmonary vein isolation during isthmus ablation for atrial flutter: Three-year outcomes of the PREVENT AF I study. *J Cardiovasc Electrophysiol.* 2018;29(6):872–878. doi: 10.1111/jce.13485
14. Schmieder S, Ndrepepe G, Dong J, et al. Acute and long-term results of radiofrequency ablation of common atrial flutter and the influence of the right atrial isthmus ablation on the occurrence of atrial fibrillation. *Eur Heart J*. 2003;24(10): 956–962. doi: 10.1016/s0195-668x(02)00846-1
15. Bandini A, Golia P, Caroli E. et al. Atrial fibrillation after typical atrial flutter ablation: A long-term follow-up. *J Cardiovasc Med.* 2011;12(2):110–115. doi: 10.2459/JCM.0b013e3283403301

16. Gula LJ, Scanes AC, Klein GJ, et al. Atrial flutter and atrial fibrillation ablation: Sequential or combined? A cost-benefit and risk analysis of primary prevention pulmonary vein ablation. *Heart Rhythm*. 2016;13(7):1441–1448. doi: 10.1016/j.hrthm.2016.02.018
17. Wazni O, Marrouche NF, Martin DO, et al. Randomized study comparing combined pulmonary vein-left atrial junction disconnection and cavotricuspid isthmus ablation versus pulmonary vein-left atrial junction disconnection alone in patients presenting with typical atrial flutter and atrial fibrillation. *Circulation*. 2003;108:2479–2483. doi: 10.1161/01.CIR.0000101684.88679.AB
18. Steinberg JS, Romanov A, Musat D, et al. Prophylactic pulmonary vein isolation during isthmus ablation for atrial flutter: The PReVENT AF Study I. *Heart Rhythm*. 2014;11(9):1567–1572. doi: 10.1016/j.hrthm.2014.05.011
19. Bianco I, Silva GO, Forno AR, et al. Risk of atrial fibrillation after ablation of cavotricuspid isthmus-dependent atrial flutter: Is combined ablation of atrial fibrillation worthwhile? *Arquivos Brasileiros Cardiologia.* 2020;114:775–782. doi: 10.36660/abc.20190238
20. Laurent V, Fauchier L, Pierre B, et al. Incidence and predictive factors of atrial fibrillation after ablation of typical atrial flutter. *J Interv Card Electrophysiol*. 2009;24:119–125. doi: 10.1007/s10840-008-9323-1
21. Brembilla-Perrot B, Girerd N, Sellal JM, et al. Risk of atrial fibrillation after atrial flutter ablation: Impact of AF history, gender, and antiarrhythmic drug medication. *J Cardiovasc Electrophysiol.* 2014;25:813–820. doi: 10.1111/jce.12413
22. Pontoppidan J, Nielsen JC, Poulsen SH, et al. Prophylactic cavotricuspid isthmus block during atrial fibrillation ablation in patients without atrial flutter: A randomised controlled trial. *Heart*. 2009;95(12):994–999. doi: 10.1136/hrt.2008.153965
23. Koerber SM, Turagam MK, Gautam S, et al. Prophylactic pulmonary vein isolation during cavotricuspid isthmus ablation for atrial flutter: A meta-analysis. *Pacing Clin Electrophysiol.* 2019;42(5):493–498. doi: 10.1111/pace.13637
24. Mesquita J, Ferreira AM, Cavaco D, et al. Impact of prophylactic cavotricuspid isthmus ablation in atrial fibrillation recurrence after a first pulmonary vein isolation procedure. *Int J Cardiol.* 2018;259:82–87. doi: 10.1016/j.ijcard.2018.01.025
25. Mohanty S, Mohanty P, di Biase L, et al. Results from a single-blind, randomized study comparing the impact of different ablation approaches on long-term procedure outcome in coexistent atrial fibrillation and flutter (APPROVAL). *Circulation*. 2013;127(18):1853–1860. doi: 10.1161/CIRCULATIONAHA.113.001855
26. Sealed Envelope Ltd. 2012. Power calculator for binary outcome superiority trial [Accessed Sat Feb 18 2023]. Режим доступа: https://sealedenvelope.com/power/binary-superiority/. Дата обращения: 18.02.2023.
27. Pérez FJ, Schubert CM, Parvec B, et al. Long-term outcomes after catheter ablation of cavo-tricuspid isthmus dependent atrial flutter: A meta-analysis. *Circulation Arrhythmia Electrophysiol*. 2009;2(4):393–401. doi: 10.1161/CIRCEP.109.871665
28. Taghji P, El Haddad M, Phlips T, et al. Evaluation of a strategy aiming to enclose the pulmonary veins with contiguous and optimized radiofrequency lesions in paroxysmal atrial fibrillation: A pilot study. *JACC Clin Electrophysiol.* 2018;4(1):99–108. doi: 10.1016/j.jacep.2017.06.023
29. Zotov AS, Khamnagadaev IA, Sakharov ER, et al. The first experience of using a hybrid approach in the surgical treatment of atrial fibrillation. *J Clin Pract.* 2022;13(4):38–50. (In Russ). Зотов А.С., Хамнагадаев И.А., Сахаров Э.Р., и др. Первый опыт применения гибридного подхода при хирургическом лечении фибрилляции предсердий // *Клиническая практика.* 2022. Т. 13, № 4. С. 38–50. doi: 10.17816/clinpract116052
30. Mohanty S, Natale A, Mohanty P, et al. Pulmonary vein isolation to reduce future risk of atrial fibrillation in patients undergoing typical flutter ablation: Results from a randomized pilot study (REDUCE AF). *J Cardiovasc Electrophysiol.* 2015;26(8):819–825. doi: 10.1111/jce.12688
31. Cox JL, Schuessler RB, Boineau JP. The surgical treatment of atrial fibrillation. I. Summary of the current concepts of the mechanisms of atrial flutter and atrial fibrillation. *J Thoracic Cardiovascular Surg.* 1991;101(3):402–405.
32. Dechering DG, Gonska BD, Brachmann J, et al. Efficacy and complications of cavotricuspid isthmus-dependent atrial flutter ablation in patients with and without structural heart disease: Results from the German Ablation Registry. *J Int Cardiac Electrophysiol.* 2021;61(1):55–62. doi: 10.1007/s10840-020-00769-z
33. Schneider R, Lauschke J, Tischer T, et al. Pulmonary vein triggers play an important role in the initiation of atrial flutter: Initial results from the prospective randomized Atrial Fibrillation Ablation in Atrial Flutter (Triple A) trial. *Heart Rhythm*. 2015;12(5):865–871. doi: 10.1016/j.hrthm.2015.01.040

AUTHORS' INFO

The author responsible for the correspondence:
Irina A. Bulavina;
address: 26 Bakinskaya street, 115516 Moscow, Russia;
ORCID: https://orcid.org/0000-0002-6267-3724;
eLibrary SPIN: 1275-2773; e-mail: doctoroirb@yandex.ru

Co-authors:
Aleksandr S. Zotov, MD, PhD;
ORCID: https://orcid.org/0000-0003-0494-0211;
eLibrary SPIN: 9315-6570; e-mail: zotov.alex.az@gmail.com

Igor A. Khamnagadaev, MD, PhD;
ORCID: https://orcid.org/0000-0002-9247-4523;
eLibrary SPIN: 6338-4990; e-mail: i@khamnagadaev.ru

Igor A. Kovalev, Dr. Sci. (Med.), Professor;
ORCID: https://orcid.org/0000-0001-8195-5682;
eLibrary SPIN: 5024-6323; e-mail: igor.kovalev64@mail.ru

Mikhail L. Kokov;
ORCID: https://orcid.org/0000-0003-4766-5213;
e-mail: mikhailkokov@gmail.com

ОБ АВТОРАХ

Автор, ответственный за переписку:
Булавина Ирина Андреевна;
адрес: Россия, 115516, Москва, ул. Бакинская, д. 26;
ORCID: https://orcid.org/0000-0002-6267-3724;
eLibrary SPIN: 1275-2773; e-mail: doctoroirb@yandex.ru

Соавторы:
Зотов Александр Сергеевич, к.м.н.;
ORCID: https://orcid.org/0000-0003-0494-0211;
eLibrary SPIN: 9315-6570; e-mail: zotov.alex.az@gmail.com

Хамнагадаев Игорь Алексеевич, к.м.н.;
ORCID: https://orcid.org/0000-0002-9247-4523;
eLibrary SPIN: 6338-4990; e-mail: i@khamnagadaev.ru

Ковалёв Игорь Александрович, д.м.н., профессор;
ORCID: https://orcid.org/0000-0001-8195-5682;
eLibrary SPIN: 5024-6323; e-mail: igor.kovalev64@mail.ru

Коков Михаил Леонидович;
ORCID: https://orcid.org/0000-0003-4766-5213;
e-mail: mikhailkokov@gmail.com

https://doi.org/10.17816/clinpract114930

journal of clinical practice 2023 Vol 14 №2

Aleksandr V. Troitskiy, Dr. Sci. (Med.);
ORCID: https://orcid.org/0000-0003-2143-8696;
eLibrary SPIN: 2670-6662; e-mail: dr.troitskiy@gmail.com

Igor I. Khamnagadaev, Dr. Sci. (Med.), Professor;
ORCID: https://orcid.org/0000-0001-8541-0364;
eLibrary SPIN: 6883-5175; e-mail: khamnaga@yandex.ru

Maria A. Shkolnikova, Dr. Sci. (Med.), Professor;
ORCID: https://orcid.org/0000-0001-7115-0186;
eLibrary SPIN: 9051-7107; e-mail: Arrithmolog@gmail.com

Leonid S. Kokov, Dr. Sci. (Med.), Professor,
Academician of the Russian Academy of Sciences;
ORCID: https://orcid.org/0000-0002-3167-3692;
eLibrary SPIN: 1655-5794; e-mail: lskokov@mail.ru

Троицкий Александр Витальевич, д.м.н.;
ORCID: https://orcid.org/0000-0003-2143-8696;
eLibrary SPIN: 2670-6662; e-mail: dr.troitskiy@gmail.com

Хамнагадаев Игорь Иосифович, д.м.н., профессор;
ORCID: https://orcid.org/0000-0001-8541-0364;
eLibrary SPIN: 6883-5175; e-mail: khamnaga@yandex.ru

Школьникова Мария Александровна, д.м.н., профессор;
ORCID: https://orcid.org/0000-0001-7115-0186;
eLibrary SPIN: 9051-7107; e-mail: Arrithmolog@gmail.com

Коков Леонид Сергеевич, д.м.н., профессор,
академик РАН;
ORCID: https://orcid.org/0000-0002-3167-3692;
eLibrary SPIN: 1655-5794; e-mail: lskokov@mail.ru