COMPARATIVE ANALYSIS OF BISOPROLOL EFFICACY IN PATIENTS WITH NORMAL AND ALTERED CARDIAC ANATOMY IN THE POSTOPERATIVE PERIOD AFTER CATHETER ABLATION OF ATRIAL FIBRILLATION

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Keywords:
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Abstract

Background. The aim of this study was to evaluate the effectiveness of the ß-adrenergic blocker bisoprolol in maintaining sinus rhythm in patients with atrial fibrillation following catheter ablation of the pulmonary vein ostia, considering the anatomical condition of the left atrium.

Material and methods. A total of 50 patients were enrolled and divided into two groups: those with normal left atrial anatomy (n = 25) and those with pathologically altered anatomy (n = 25). All patients received bisoprolol at a dose of 10 mg/day for 12 months post-ablation.

Results. Within the first 6 months of follow-up, no atrial fibrillation recurrences were observed in the group with normal left atrium anatomy (100%), whereas 92% of patients in the altered anatomy group experienced recurrences. In the second half of the follow-up period (months 6–12), differences between the groups were no longer statistically significant. Statistical analysis confirmed a highly significant difference in recurrence rates during the early postoperative period ($p < 0.001$) and no significant difference in the late period ($p > 0.3$).

Conclusion. The effectiveness of bisoprolol in maintaining sinus rhythm is highly dependent on the anatomical condition of the left atrium in the early period following ablation. The results highlight the importance of individualizing antiarrhythmic therapy based on morphofunctional characteristics.

Atrial fibrillation (AF) is one of the most common types of cardiac arrhythmias, significantly affecting patients' quality of life and associated with an increased risk of thromboembolic events and heart failure.[1] In recent years, catheter ablation of pulmonary vein has taken a key place in the treatment of both paroxysmal and persistent forms of AF, demonstrating high efficacy in eliminating arrhythmogenic substrates.[2] However, despite technical achievements and expansion of indications for ablation, the rate of arrhythmia recurrence in the early postoperative period, especially during the first three months, remains significant and reaches, according to several studies, up to 30–50% of cases.[3] The early postoperative period, often referred to as the "blanking period," is characterised by instability of atrial electrical activity due to ongoing inflammatory and remodeling processes.[3] This period is therefore critically important for maintaining sinus rhythm.

Pharmacological antiarrhythmic therapy during this phase aims to prevent early arrhythmia recurrence, stabilize electrophysiological parameters, and reduce the likelihood of repeated hospitalizations.[1] Among the medications used in post-ablation management, ß-adre-

genic blockers (Class II antiarrhythmic agents according to the *Vaughan Williams* classification), such as bisoprolol, hold a distinct position due to their antiarrhythmic, anti-ischemic, and antihypertensive properties, as well as their favorable safety profile.[4] However, the effectiveness of bisoprolol in maintaining sinus rhythm in post-CA may vary depending on the morphofunctional characteristics of the heart, in particular, the anatomical condition of the left atrium.[5] The extent to which the effectiveness of bisoprolol post-ablation is influenced by the presence or absence of structural alterations in cardiac anatomy remains insufficiently explored.[6]

Conducting a comparative analysis of bisoprolol's effectiveness in patients with normal versus pathologically altered left atrial anatomy represents a timely and clinically significant task in modern cardiology and interventional electrophysiology.[7,8] The findings may contribute to the individualization of antiarrhythmic therapy during the postoperative period, enhancing treatment efficacy and improving outcomes in this patient population.[2]

Object of the study. The object of the study was patients with paroxysmal and persistent forms of atrial fibrillation who underwent catheter ablation of pulmonary vein apertures.

Focus of the study. The focus of the study was the effectiveness of the ß-blocker bisoprolol in the postoperative period among patients with varying anatomical characteristics of the left atrium.

The aim of the study. The aim of this study was to assess the efficacy of bisoprolol in maintaining sinus rhythm over a 12-month period following catheter ablation in patients with either normal or altered anatomy of the left atrium.

Research hypothesis. It is hypothesized that bisoprolol is more effective in maintaining sinus rhythm after catheter ablation of atrial fibrillation in patients with normal left atrial anatomy compared to those with pathological anatomical changes.

Materials and methods

The study included 50 patients (both men and women) aged 47 ± 15 years with paroxysmal or persistent AF who underwent catheter ablation of the pulmonary vein. All patients were examined and treated at the clinical base of the Syzganov National Scientific Center of Surgery, in the Department of Interventional Arrhythmology.

The inclusion criteria were age between 18 and 75 years, documented AF confirmed by ECG or Holter monitoring, completion of CA of PV procedure, and absence of contraindications to the use of ß-blockers.

Exclusion criteria included: severe heart failure with left ventricular ejection fraction (LVEF) < 35%, significant sinus node dysfunction, second- or third-degree atrioventricular (AV) block without pacemaker, stage IV–V chronic kidney disease, decompensated chronic obstructive pulmonary disease, and hypersensitivity or individual intolerance to bisoprolol.

Patients were randomized in a 1:1 ratio using a random number generator into two equal groups of 25 individuals each, based on the anatomical condition of the LA. Cardiac anatomy was assessed using transthoracic echocardiography and computed tomography, with evaluation of LA volume, presence of dilatation, and structural abnormalities. Group 1 included patients with normal cardiac anatomy, while Group 2 consisted of patients with pathologically altered LA anatomy. All patients received bisoprolol at a fixed daily dose of 10 mg orally following CA of PV, which was continued for 12 months. Treatment was monitored based on clinical status, blood pressure, HR, and drug tolerability. No additional antiarrhythmic medications were administered during the study period. The effectiveness of therapy was evaluated by the recurrence rate of AF, recorded during scheduled visits at 1, 3, 6, and 12 months using ECG and Holter monitoring, as well as during outpatient visits triggered by arrhythmia-related symptoms. The primary endpoint of the study was the absence of a documented recurrence of AF within 12 months following catheter ablation. Secondary endpoints included time to first recurrence, the need for repeat ablation,

hospitalization rate due to arrhythmia, and bisoprolol tolerability.

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki and approved by the Local Ethics Committee of the JSC Syzganov National Scientific Center of Surgery with №4 protocol held on 10.11.2023. Prior to enrollment, all patients were informed about the aims, methods, and potential risks of the study. Each participant signed an informed consent to participate in the study and to process personal medical data. Anonymity and confidentiality of patient information were ensured at all stages of the work. Participation in the study did not affect the scope and nature of the medical care provided and was not accompanied by additional risks for patients.

Statistical analysis was performed using SPSS Statistics v.26. Continuous variables were presented as mean ± standard deviation, and categorical variables as absolute and relative frequencies (n, %). Between-group comparisons of continuous variables were conducted using Student's t-test or the nonparametric Mann–Whitney U test, depending on the data distribution. Kaplan–Meier analysis was used to assess time to recurrence. A p-value of <0.05 was considered statistically significant. The study received approval from the local ethics committee, and all participants provided written informed consent.

Results

The study included 50 patients with paroxysmal and persistent AF who underwent catheter ablation of the pulmonary vein ostia and received antiarrhythmic therapy with bisoprolol. Patients were evenly divided into two groups based on the anatomical condition of the LA: group 1 (n = 25) included patients with normal atrial anatomy, while group 2 (n = 25) included patients with pathological anatomical alterations of the LA. Follow-up results demonstrated a significant difference in the effectiveness of antiarrhythmic therapy between the groups. In group 1, bisoprolol monotherapy effectively maintained stable sinus rhythm throughout the entire 12-month observation period, with no recorded recurrences of AF or other clinically significant tachyarrhythmias. These findings indicate the high efficacy of ß-adrenergic blocker therapy in patients with anatomically intact atria. By the 6-month follow-up, 23 out of 25 patients (92%) in group 2 had experienced tachyarrhythmia recurrences, including 3 patients (12%) with atrial tachycardia episodes lasting more than 30 seconds, qualifying as reaching the primary endpoint. The remaining 20 patients (80%) had episodes of paroxysmal AF that required the initiation of additional therapy with amiodarone, a class III antiarrhythmic agent according to the Vaughan Williams classification. This distribution highlights the significantly lower efficacy of bisoprolol as monotherapy in patients with morphologically altered LA structure. Particular attention should be paid to the nature of arrhythmic activity in the early postoperative period. In both groups, episodes of supraventricular tachyarrhythmias lasting less than 30 seconds were observed during the first 3 months following ablation; these were considered manifestations of instability of electrical activity within the so-called "blanking period". The episodes were transient in nature and did not influence the therapeutic strategy. Between 6 and 12 months of follow-up, differences between the groups became more pronounced. In patients with normal LA anatomy, sinus rhythm was stably maintained with continued bisoprolol therapy, and no arrhythmia recurrences were observed. In contrast, at least one late episode of LA lasting more than 30 seconds was documented in the second group, confirming the trend toward reduced therapeutic efficacy in this patient category. It is also noteworthy that, regardless of the group, the overall use of antiarrhythmic drugs, especially in the first 3 months after ablation, was accompanied by a reduction in the number of hospitalizations throughout the follow-up period. This effect is presumably related to improved rhythm control and reduced symptom severity, but requires further clarification. The episodes were transient

and did not influence the therapy tactics. In the time interval from 6 to 12 months, the differences between the groups increased. In patients with normal LP anatomy, stable sinus rhythm retention was observed against the background of bisoprolol therapy continuation, without signs of arrhythmia recurrences. At the same time, the second group showed at least one late episode of atrial fibrillation lasting more than 30 seconds, which confirms the tendency to decrease the effectiveness of therapy in this category of patients. It should also be noted that, regardless of the group, the overall use of antiarrhythmic drugs, especially in the first 3 months after ablation, was accompanied by a reduction in the number of hospitalizations throughout the follow-up period. The effect is probably related to improved rhythm control and reduced symptom severity, but requires further clarification.

The stepwise analysis of AF recurrence rates in both groups is presented in Table 1. During the first 6 months following catheter ablation, all patients in the group with normal LA anatomy (n = 25) maintained stable sinus rhythm, corresponding to a 100% freedom from AF recurrence. In contrast, in the second group (with altered anatomy), recurrences were documented in 23 out of 25 patients (92%) during this early period, which underlines extremely low efficacy of bisoprolol monotherapy in conditions of morphological destruction of the LA.

Table 1.
Atrial fibrillation recurrence rates according to left atrial anatomy at different follow-up time points.

Follow-up period	Group	No recurrence, n (%)	With recurrence, n (%)	Total
0–6 months	Normal	25 (100%)	0 (0%)	25
	Altered	2 (8%)	23 (92%)	25
	Total	27 (54%)	23 (46%)	50
6–12 months	Normal	25 (100%)	0 (0%)	25
	Altered	24 (96%)	1 (4%)	25
	Total	49 (98%)	1 (2%)	50

Interestingly, during the 6- to 12-month follow-up period, rhythm stability was observed even among patients with LA pathology, 24 out of 25 patients (96%) remained free from AF recurrence, with only one patient (4%) experiencing a late episode of arrhythmia. This shift toward rhythm normalization may be attributed to atrial myocardial remodeling following ablation, as well as to progressive stabilization of atrial electrical activity. However, the potential impact of additional interventions and therapy adjustments in patients with early recurrences cannot be excluded. Overall, during the first 6 months post-ablation, AF recurrences were recorded in 46% of the total study group (23 out of 50 patients), with the vast majority of these cases (92%) occurring in the group with altered LA anatomy. These findings highlight that the most vulnerable period for this subgroup of patients is within the first six months following catheter ablation. By the 12th month, the number of new AF recurrences was 2%, however, the cumulative proportion of patients who experienced at least one episode of AF over the observation period remained at 46% (23 out of 50), which may indicate a general decline in arrhythmic activity in the late post-ablation period, especially with effective correction of pharmacological management. The results presented in Table 1 underscore high prognostic significance of the anatomical state of the LA in selecting the tactics of drug management after CA. In patients with structurally intact atria, bisoprolol provides stable rhythm control throughout the entire follow-up period. At the same time, in patients with morphological abnormalities of the left atrium, the drug demonstrates limited efficacy during the early postoperative period and may require either escalation of therapy or the initial implementation of a combined approach, taking into account both anatomical and electrophysiological parameters. The results highlight the importance of individualizing antiarrhythmic therapy after ablation, based on the structural condition of the atria. They also

indicate the advisability of more intensive monitoring and possible connection of class III antiarrhythmic agents in patients with altered LA anatomy during the initial months after intervention.

The Pearson's x^2 test was used to confirm the differences in AF recurrence rates between the groups with normal and altered LA anatomy. In analyses covering the first 6 months of follow-up,the results demonstrated a high level of statistical significance, Pearson's x^2 value was 42.593 with one degree of freedom, and asymptotic significance was less than 0.001 ($p < 0.001$). An additional continuity-corrected test yielded a similar result ($x^2 = 38.969$; $p < 0.001$), indicating that the differences between groups were extremely reliable. Likelihood ratios ($x^2 = 55.056$) and Fisher's exact test also confirmed statistically significant differences ($p < 0.001$ in both directions), indicating a dramatic difference in the efficacy of bisoprolol in patients with different LA anatomical status in the early postoperative period. However, during the follow-up period of 6 to 12 months, a similar x^2 analysis did not reveal statistically significant differences between the groups. The The Pearson's x^2 value was 1.020 with $p = 0.312$, and both the continuity correction and Fisher's exact test also indicated a lack of significance ($p = 1.000$). This may be attributed to the stabilization of myocardial electrical activity in the late post-ablation period, when anatomical differences lose their determining influence, and other factors, such as tissue remodeling and possible adjustment of therapy following early recurrences, begin to contribute to rhythm maintenance. The results of statistical analysis suggest that:

- during the first 6 months after ablation, LA anatomy has a pronounced effect on the efficacy of bisoprolol;

- In the period of 6-12 months, the differences between the groups become less apparent and lose statistical significance, which may indicate the completion of the phase of electrical instability and myocardial adaptation to postablation conditions.

The data emphasise the need for intensified monitoring and a more flexible therapeutic strategy in the first months after CA, especially in patients with altered atrial anatomy. A potential solution may involve the use of combination antiarrhythmic therapy or more frequent ECG monitoring in this group. Further studies may be aimed at identifying additional modifying factors such as the degree of fibrosis, LA size on CT, or the level of inflammatory biomarkers influencing the outcome of treatment. To gain a more precise understanding of the dynamics of differences in the time and severity of recurrence, additional comparative analyses were performed by time intervals. The results are summarised in Table 2.

Table 2.
Comparative analysis of AF recurrence rates between groups with normal and altered LA anatomy at different follow-up periods.

Follow-up period	Comparison group	Pearson's x^2 (p)	t-test (p)	Mean recurrence rate (M ± SD)	Effect size (Cohen's d)	Interpretation of the observed differences
0–6 months	Normal vs Altered	42.593 (p<0.001)	–16.61 (p<0.001)	0.00 ± 0.00 vs 0.92 ± 0.28	0.196 (smalleffect)	Statistically significant difference; bisoprolol efficacy is significantly lower in patients with altered atrial anatomy.
6–12 months	Normal vs Altered	1.020 (p=0.312)	–1.00 (p=0.322)	0,00 ± 0,00 vs 0.04 ± 0.20	0.141 (negligible effect)	No significant difference; bisoprolol is equally effective in maintaining sinus rhythm at the later stage

During the first 6 months after catheter ablation, a high rate of AF recurrence was observed in the group of patients with pathologically altered LA anatomy (92%), whereas in the group with normal anatomy, recurrences were completely absent. Pearson's χ^2-criterion confirmed statistically significant differences between the groups (x^2 = 42.593, $p < 0.001$). Also, Student's t-test revealed a highly significant difference in the mean values of recurrence rates ($t = -16.61$, $p < 0.001$). The mean recurrence rate was 0.92 ± 0.28 in the Altered group versus 0.00 in the Normal group. Although Cohen's d effect size is estimated to be small (0.196), the level of significance, confidence interval, and directionality of the effect support the practical significance of the differences. Thus, in the early postoperative period, the efficacy of bisoprolol is significantly lower in patients with atrial morphofunctional changes. In the period from 6 to 12 months, the differences between the groups practically disappear: in the Altered group, recurrences were registered in only one patient (4%), whereas they were still absent in the Normal group. Pearson's χ^2 (1.020; $p = 0.312$) and t-criterion ($t = -1.00$; $p = 0.322$) revealed no statistically significant differences. The mean recurrence rate in the Altered group decreased to 0.04 ± 0.20, and the effect size ($d = 0.141$) was below the threshold of clinical significance, which may indicate stabilisation of atrial electrical activity, tissue remodelling, and/or effectiveness of corrective therapy after early recurrences. These findings underscore the need for a personalised approach to the management of patients in the first months after ablation, taking into account the anatomical characteristics of the heart. At the same time, in the long-term period (6-12 months), bisoprolol may be effective in most patients, regardless of LA morphology, especially in the absence of early recurrences.

Further analysis of atrial fibrillation recurrence rate depending on left atrial anatomy is presented in Figure 1. Figure 1 shows the comparative frequency of AF recurrences and early arrhythmias at different periods after catheter ablation in patients with normal and pathologically altered left atrial anatomy. According to the presented data, the greatest differences between the groups were observed in the interval 0-6 months after the procedure. Thus, in the group of patients with altered anatomy (Altered), the recurrence of AF during this period was observed in 92 % of patients, whereas in the group with normal anatomy (Normal), the recurrences were completely absent (0 %). This difference is statistically significant (χ^2 = 42.593, $p < 0.001$) and indicates a pronounced negative impact of morphological changes in the left atrium on the short-term efficacy of ablation therapy.

Figure 1.
Incidence of early arrhythmia and AF recurrence according to left atrial anatomy at different time points after catheter ablation.

Interestingly, during the early postoperative period (0–3 months), known as the "blanking period", the incidence of any arrhythmias (including paroxysmal AF and atrial flutter) was also higher among patients with altered atrial anatomy—60% compared to 40% in the group with normal anatomy. Although these episodes do not indicate a persistent recurrence, they may be considered predictors of adverse clinical outcomes, particularly in patients with morphological atrial changes such as increased volume, wall thickening, or areas of fibrosis. In the second half-year following ablation (6–12 months), the differences

between the groups were markedly reduced: atrial fibrillation recurrence was observed in only 4% of patients in the Altered group and remained absent in the Normal group. Statistical analysis for this interval did not reveal significant differences ($\chi^2 = 1.020$, $p = 0.312$), which may indicate stabilization of atrial electrical activity following the completion of the remodeling phase or greater effectiveness of antiarrhythmic therapy initiated in the higher-risk group. Overall, the presented data confirm that anatomical characteristics of the LA have a significant impact on early and mid-term outcomes after ablation. The high recurrence rate within the first 6 months among patients with altered anatomy highlights the need for closer follow-up in this group, potential prolongation of antiarrhythmic therapy, and the implementation of a personalized approach in the planning and performance of ablation procedures.

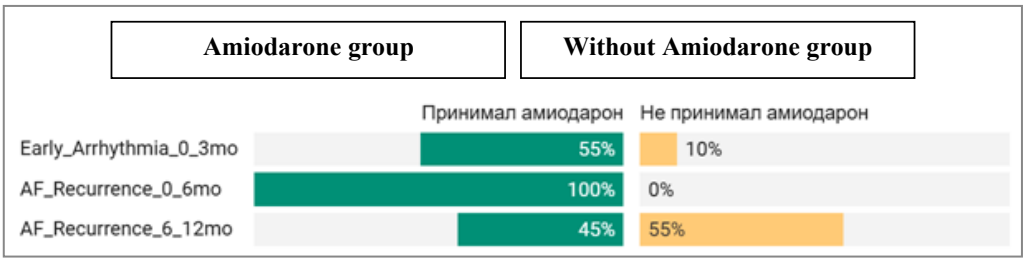

Figure 2.
Effect of amiodarone on the recurrence rate of atrial fibrillation and early arrhythmias after catheter ablation.

Figure 2 illustrates the differences in the incidence of early arrhythmias and AF recurrence between patients treated with amiodarone and those who did not receive the drug during the one-year follow-up after catheter ablation. The data demonstrate both temporal and clinical heterogeneity in the effect of antiarrhythmic therapy.

In the early postoperative period (0–3 months), known as the "blanking period," episodes of supraventricular tachyarrhythmias were recorded in 55% of patients receiving amiodarone, compared to only 10% in those who were not prescribed the drug. Although amiodarone has strong antiarrhythmic properties, this difference may be attributed to the fact that the drug is more often administered to patients at higher risk of recurrence or those who had already exhibited early arrhythmias. A statistically significant difference ($x^2 = 6.522$, $p = 0.011$) confirms an association between amiodarone use and the occurrence of early arrhythmias; however, it does not indicate a causal protective effect of the drug. The most pronounced differences were observed during the 0–6 month interval. All cases of AF recurrence in this cohort were observed exclusively among patients receiving amiodarone (100%), while no recurrences occurred in the group without the drug (0%). This situation may, on one hand, indicate the limited efficacy of pharmacological control in certain patient categories, and on the other hand, suggest that amiodarone was prescribed after the onset of recurrence in an attempt to prevent its reappearance. Given the high statistical significance ($x^2 = 50.000$, $p < 0.001$), it can be asserted that recurrence rates in this phase are closely associated with the fact of drug administration; however, the direction of this association requires clarification through prospective study designs. In the 6–12 month period following ablation, the differences in recurrence rates between the groups become less pronounced: 45% among those who continued taking amiodarone and 55% among those who did not. The results in this interval did not reach statistical significance ($x^2 = 1.198$, $p = 0.274$), which may reflect both the completion of atrial electrical remodeling and the stabilization of the clinical course following the active phase of intervention. The presented data indicate that amiodarone use is associated with a higher frequency of arrhythmia detection in the early post-ablation period. However, this association should be interpreted with caution, as the drug was

likely prescribed in response to already occurring AF episodes. This highlights the need for additional stratified analysis and prospective studies with a clear distinction between prophylactic and reactive use of antiarrhythmic therapy.

Discussion

The results of the study demonstrate that left atrial anatomy significantly affects the short-term effectiveness of bisoprolol in maintaining sinus rhythm after catheter ablation of AF. During the first six months, patients with normal LA anatomy had no AF recurrence, whereas in patients with pathological anatomical alterations, recurrences were observed in 92% of cases. These findings are consistent with earlier studies, which identified LA structural remodeling, such as dilatation and fibrosis, as key predictors of arrhythmia recurrence after CA.[3,5,9] Moreover, the results are consistent with current clinical guidelines, which emphasise the need to select a rate or rhythm control strategy based on the structural and functional characteristics of the heart.[1,2]

Bisoprolol, as a selective ß1-adrenergic blocker, has pronounced antiarrhythmic and rate-controlling properties, particularly in the early postoperative period, when atrial electrical instability is most pronounced.[4] Similar to the data from *Suzuki et al.,*[4] our study confirms the high efficacy of bisoprolol in patients without morphological alterations in the LA. However, in patients with pronounced atrial remodelling, the drug's effectiveness appears to be limited, which is probably due to the presence of stable arrhythmogenic substrates and changes in impulse conduction pathways.[6]

The observed trend toward equalization of results between groups in the 6–12 month interval may reflect the cumulative effect of reverse myocardial remodelling after ablation, adaptation of atrial electrical activity, and optimization of antiarrhythmic therapy, including the prescription of amiodarone in patients at high risk of recurrence.[6,7] This dynamic is consistent with data indicating that outcomes in the late postoperative period are less dependent on the initial anatomy of the LA, as the completion of fibrosis and scarring processes after ablation contributes to rhythm stabilisation.[9]

It should be noted that all early AF recurrences in the group with altered LA anatomy occurred during bisoprolol therapy, confirming the need for a personalized pharmacological approach in this cohort.[8] A possible option is the initial use of combined antiarrhythmic therapy including class III agents, as suggested in recent studies on rhythm control in patients with high anatomical risk.[6,7] Furthermore, the use of advanced imaging and left atrial reconstruction techniques based on artificial intelligence appears promising.[10]

Compared to previously published studies, the novelty of our work lies in demonstrating a pronounced dependence of bisoprolol efficacy in the early postoperative period on the morphological state of the LA. Although ß-adrenergic blockers are widely considered a key element of pharmacological management after CA,[1,4] few studies have directly stratified clinical outcomes by anatomical type of atria.[5,7] Thus, the results obtained contribute to the development of the concept of structurally oriented personalization of antiarrhythmic therapy.[2]

Atrial fibrillation (AF) remains one of the most prevalent types of arrhythmias, associated with an increased risk of cardiovascular complications and a decreased quality of life for patients.[1] Catheter ablation of the pulmonary vein is currently considered the gold standard for the treatment of paroxysmal and persistent AF.[2] Its success largely depends on the anatomical features of the left atrium, as well as on the choice of pharmacological support during the early postoperative period.[3,5] In this context, the use of ß-adrenergic blockers, in particular bisoprolol, has gained significant clinical relevance.[4]

Several studies confirm the effectiveness of bisoprolol in reducing AF recurrence rates after CA. Thus, *Marazzi et al. (*2011) and *Konishi et al.* (2010)

demonstrated that in patients with concomitant heart failure, bisoprolol exerted a pronounced antiarrhythmic effect, outperforming other ß-blockers such as carvedilol in several key parameters.[11,12] These findings are supported by more recent studies, which highlight the favorable tolerability and safety profile of bisoprolol, particularly in patients with preserved ejection fraction and normal LA volume.[6]

At the same time, the literature emphasizes that the morpho-functional condition of the LA is a key modifying factor influencing the effectiveness of both the ablation procedure and subsequent antiarrhythmic therapy.[3] Several authors demonstrated that LA dilation and the presence of fibrosis significantly increase the risk of AF recurrence within the first 12 months following the procedure.[3,13] Similar conclusions were reported by *Yamamoto et al.,* who emphasized that LA volume, degree of remodeling, and changes in its geometry are directly correlated with unfavorable clinical outcomes.[3]

Given the anatomical variability of the left atrium (LA), including rare pulmonary vein drainage patterns and the presence of accessory venous ostia, achieving complete electrical isolation can be challenging.[5] *Babic et al.* highlight the clinical implications of these structural anomalies, emphasizing the need for a personalized approach to catheter ablation.[5] In this context, novel imaging and mapping techniques are gaining relevance, enabling accurate anatomical reconstruction of the atrium.[10]

Of particular interest is the comparative analysis of bisoprolol formulations. In a study by *Suzuki et al.,* transdermal bisoprolol demonstrated superior efficacy in reducing the incidence of early AF recurrences following ablation compared to the oral form. These findings support the hypothesis that maintaining stable ß-blocker levels in the early postoperative period may be especially important in the context of unstable atrial electrical activity.[4]

Current guidelines[1,2] emphasize the importance of selecting a HR or rhythm control strategy based on the patient's anatomical and functional characteristics. Although a rhythm control strategy, including the use of antiarrhythmics and CA, is effective in maintaining sinus rhythm, it carries potential risks, especially in the presence of significant LA fibrosis or residual pulmonary vein (PV) activity.[3] In this context, ß-blockers serve as a versatile tool for HR control and rhythm stabilization during the "blanking" recovery phase.[4] The available literature supports the notion that bisoprolol remains a key component of post-ablation pharmacological management for AF, especially in patients with normal LA anatomy.[4] At the same time, anatomical features of the LA may significantly affect the effectiveness of antiarrhythmic therapy, underlining the need for comparative studies aimed at identifying tailored treatment approaches.[5] The present study, which analyzes the efficacy of bisoprolol in patients with normal versus altered LA anatomy, addresses this gap and represents a timely contribution to the field of personalized arrhythmology.[6,9]

Limitations. This study has a number of limitations that should be taken into account while interpreting the results. First, the sample size was relatively small (50 patients), which limits the statistical power and the ability to extrapolate the data obtained to a broader population. Second, the study was single-centered, which may reflect the organizational structure and clinical protocols of a specific institution. Third, in several cases, amiodarone was prescribed after the recurrence of arrhythmia had been detected, which could have affected the dynamics of the indicators in the subgroups and made it difficult to assess the preventive effect of the drug. Fourth, morphological assessment of the LA was performed using standard echocardiography and CT methods, without the use of additional tissue mapping parameters, which may have limited the accuracy of stratification. Finally, the follow-up period was 12 months, which does not allow for an assessment of the long-term effective-

ness of bisoprolol in maintaining sinus rhythm in different anatomical phenotypes.

What's Known? Bisoprolol, a selective ß-blocker, is commonly prescribed to control heart rate and maintain sinus rhythm after catheter ablation for atrial fibrillation. Its safety and effectiveness are well established, but previous research has rarely stratified outcomes according to left atrial morphology, despite evidence that structural remodeling significantly affects recurrence rates and long-term rhythm stability.

What's New? This study demonstrates that bisoprolol is highly effective in patients with normal left atrial anatomy, achieving complete prevention of early arrhythmia recurrences, whereas patients with structural alterations showed a 92% recurrence rate in the first six months. The findings highlight the importance of anatomical assessment for individualized pharmacological strategies in the early post-ablation period.

Conclusion

The aim of the present study was to evaluate the effectiveness of bisoprolol in maintaining sinus rhythm in patients with AF after catheter ablation, depending on the anatomical condition of the LA. The obtained results clearly demonstrated that the anatomical state of the left atrium significantly influences the efficacy of bisoprolol-based antiarrhythmic therapy in the early postoperative period. The study hypothesis that bisoprolol is more effective in patients with normal left atrial anatomy compared to those with morphological alterations was confirmed. During the first 6 months of follow-up, no AF recurrences were observed in patients with intact atrial structure (100%), whereas in the group with pathological anatomical changes, recurrences were recorded in 92% of patients, a difference that was statistically significant ($x^2 = 42.593$, $p < 0.001$). In the time interval between 6 and 12 months, the differences between the groups were no longer evident, which may be associated with the completion of the remodeling processes and myocardial adaptation, as well as with adjustments in therapy following early recurrences. Thus, the aim of the study was achieved, and the hypothesis was verified. The data obtained confirm that bisoprolol can be an effective agent for maintaining sinus rhythm in patients after catheter ablation, however, its efficacy in the early postoperative period is strongly dependent on the morphofunctional state of the left atrium. In patients with normal anatomy, bisoprolol demonstrated high clinical effectiveness and stability of outcomes, whereas in patients with anatomical alterations, therapy had to be revised and intensified. The scientific and practical significance of this study lies in its substantiation of the need for an individualized approach to pharmacological management of patients after ablation, taking into account the anatomical features of the heart. Stratifying patients according to the anatomical type of the atria prior to initiating therapy may enhance clinical treatment efficacy, reduce the incidence of recurrences and hospitalizations, and improve prognosis in patients with atrial fibrillation. Future research prospects include expanding the sample size, incorporating patients with varying degrees of left atrial fibrosis, utilizing additional imaging modalities, and developing algorithms for combined antiarrhythmic therapy based on the anatomical and electrophysiological characteristics of the atria.

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