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A new method of left atrial appendage occlusion for the prevention of thromboembolic complications in patients with atrial fibrillation during coronary artery bypass grafting

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Aim. To optimize the surgical technique for left atrial appendage (LAA) occlusion in patients with atrial fibrillation (AF) during coronary artery bypass grafting.

Material and methods. The study included 60 patients with atrial fibrillation (AF). The patients were randomly divided into 2 groups. In the first group of patients, LAA was closed using the developed two-suture technique. In patients of the second group, a purse string suture was applied to the LAA. All patients underwent transesophageal echocardiography (TEE) before surgery to rule out the presence of intracardiac blood clots. To assess the effectiveness of the method in the postoperative period, TEE was performed.

Results. According to postoperative TEE, one case of LAA recanalization in each group was revealed (p>0,05). In the second group, the residual LAA cavity after applying a purse string suture was revealed. During the follow-up period, there were no neurological complications and deaths.

Conclusion. According to the study results, it was found that the proposed two-suture technique for LAA occlusion is not less effective than the purse-string suture. The developed technique of two-suture epicardial occlusion of LAA showed actual technical advantages, allowing to optimize this surgery in different categories of patients.

Key words: atrial fibrillation, left atrial appendage, coronary artery bypass grafting.

Relationships and Activities: none.

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Atrial fibrillation (AF) is the most common type of arrhythmia in clinical practice. AF remains the leading cause of cardioembolic stroke, increasing the risk of cerebrovascular accident 5-fold compared to patients without AF. In patients with nonvalvular AF, the localization of thrombi in the left atrial appendage (LAA) reaches 90% [1, 2]. A variety of surgical approaches have been proposed for LAA occlusion, including suture exclusion, suture excision, stapler exclusion, epicardial exclusion clips. All of these techniques aim to exclude LAA completely to prevent blood clotting. For the first time, the reliability of LAA ligation was evaluated in the early 2000s. After mitral valve surgery and LAA ligation, incomplete exclusion was found in 36% of patients, according to transesophageal echocardiography (TEE) [3]. These results challenged the assumption that surgical exclusion of LAA is always complete and highlighted the need to test the reliability of the intervention.

In the Left Atrial Appendage Occlusion Study (LAAOS), patients after coronary artery bypass grafting were divided into groups of ligation or stapler exclusion of LAA and a control group [4]. Eight weeks after surgery, complete LAA occlusion by ligation was found in only 45% of patients, while stapler exclusion was successful in 72% of patients. Failure to exclude LAA was defined as residual flow into the appendage cavity or a neck >1 cm. The authors concluded that LAA exclusion does not significantly lengthen the cardiopulmonary bypass duration and does not increase the number of postoperative complications, such as bleeding and AF.

Due to the shortcomings of traditional surgical techniques for LAA occlusion, surgical devices have been developed. The effectiveness of these devices primarily depends on their ability to maintain high occlusal pressure. Of the available devices, the AtriClip device has the most clinical experience [5]. Thus, in the EXCLUDE trial, the effectiveness of the AtriClip device was >95% in cardiac surgery patients with a high risk of ischemic stroke [6].

Despite the introduction of highly effective devices for LAA occlusion, the indisputable advantage of suture techniques is the possibility of their use in any shape of LAA, which in some cases is a limitation to the use of occlusion devices.

Material and methods

The prospective study included 60 patients with persistent AF. The patients were divided into 2 groups using the envelope method. The study was approved by the local ethics committee. All patients signed an informed consent. The study included patients with documented AF and indications for myocardial revascularization. The study did not include patients with left ventricular aneurysm, reduced ejection fraction (<40%), and contraindications to anticoagulants. The average age of patients was 62,9±7,1 and 63,7±7,2 in the first and second groups, respectively. In both groups, men predominated (n=53). The patients were comparable in the prevalence of diabetes, history of myocardial infarction, and duration of AF. The baseline characteristics of patients are presented in Table 1. In addition to antiarrhythmic therapy, patients received medical therapy for heart failure, coronary artery disease, and hypertension (Table 2). In the first group of patients, LAA was switched off using the developed two-suture method. In patients of the second group, a purse string suture was applied to the LAA. Patients of the first and second groups underwent epicardial radiofrequency isolation of the pulmonary veins, posterior wall, and LAA using AtriCure electrodes. Initially, bipolar radiofrequency isolation of the right and left pulmonary veins was performed. The right and left pulmonary veins were isolated alternately with a power of 25 W. Then the electrode was passed through the LAA puncture towards the right superior pulmonary vein, thereby creating a line along the left atrial (LA) roof. A line was performed connecting the inferior pulmonary veins. Then the LAA base was ablated.

Table 1

Baseline patient characteristics

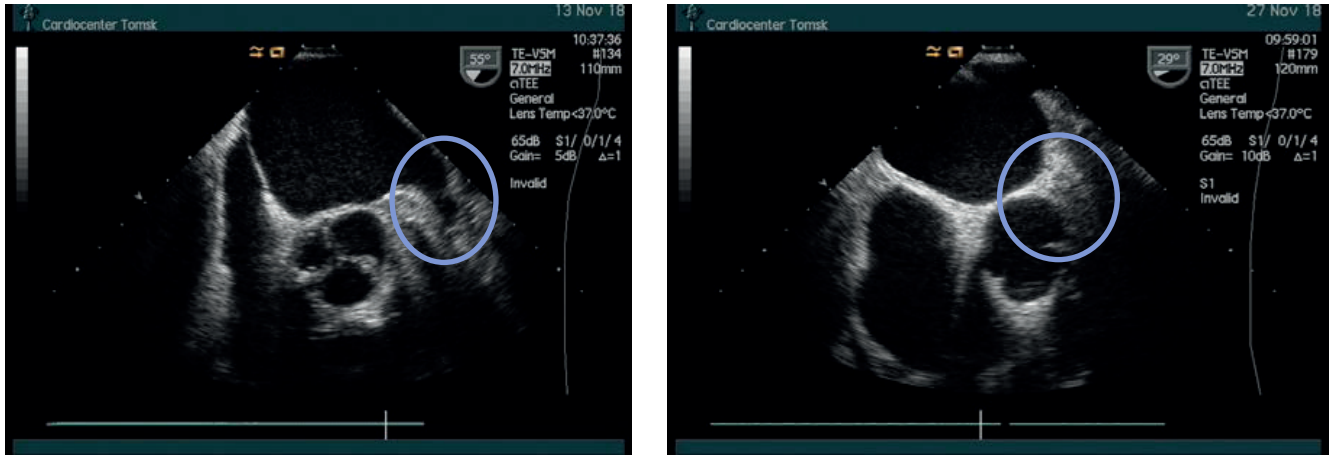
Parameter	Group 1 (n=30)	Group 2 (n=30)	p value
Age (years)	62,9±7,1	63,7±7,2	p>0,05
Men	26 (86,6%)	27 (90%)	p>0,05
Women	4 (13,4%)	3 (10%)	
Previous CVA	1 (3,3%)	1 (3,3%)	p>0,05
CKD	2 (6,6%)	1 (3,3%)	p>0,05
Diabetes	5 (16,6%)	7 (23,3%)	p>0,05
Previous MI	16 (53,3%)	14 (46,6%)	p>0,05

Abbreviations: CVA — cerebrovascular accident, CKD — chronic kidney disease, MI — myocardial infarction.

Table 2

Therapy received by study participants

Medication classes	Number of patients, n (%)	
	Group 1	Group 2
Beta-blockers	19 (63,3%)	25 (83,3%)
Angiotensin-converting enzyme inhibitors	24 (80%)	12 (40%)
Angiotensin II receptor blockers	5 (16,6%)	8 (26,6%)
Diuretics	23 (76,6%)	25 (83,3%)
Statins	30 (100%)	23 (76,6%)
Hypoglycemic agents	5 (16,6%)	7 (23,3%)



A **B**

Figure 1 (A, B). A: Preoperative TEE, **B**: Postoperative TEE (two-suture technique).

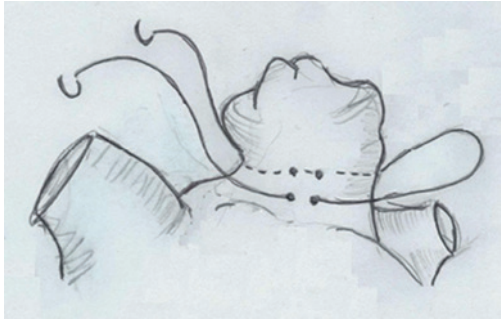


Figure 2. Exclusion of LAA using two-suture technique.

All patients underwent TEE before surgery to rule out the presence of intracardiac blood clots. There were no blood clots in the cardiac cavities before surgery. To evaluate the effectiveness of the method, all patients underwent postoperative TEE (Figure 1). For illustrative purposes, a number of patients underwent multislice computed tomography of the LA. The follow-up period was 12 months.

The novel two-suture LAA occlusion technique was carried out in the following order (Figure 2): after standard sternotomy and pericardiotomy, a standard conduit isolation was performed. Next, a patient was connected to the cardiopulmonary bypass machine. After the distal anastomoses are applied, the LAA is retracted to the side to visualize the inner surface of LAA base. Then one suture is applied on the medial surface in the area of LAA base. Then the LAA is retracted towards the heart and a second suture is applied on the lateral surface at the LAA base. Next, the thread is tied at the LAA base in the area of LA roof.

To assess qualitative differences, the chi-squared test and Fisher's exact test were used. Differences were considered significant at $p<0,05$. All statistical calculations were performed using the Statistica 10.0 software (StatSoft, USA).

Results

According to TEE, recanalization of LAA in the early postoperative period was registered in one patient of each group. In both cases, the shunt volume was insignificant and was considered as hemodynamically insignificant (Table 3). In the

Table 3

Results

	Two-suture technique	Purse-string suture	p
Recanalization of LAA	1 (3,3%)	1 (3,3%)	p>0,05
Residual LAA cavity	0	1 (3,3%)	p>0,05
Neurological complications	0	0	p>0,05

Abbreviation: LAA — left atrial appendage.

patient of the second group, a residual LAA cavity was due to incomplete capture of the LAA base (Figure 3). During the 12-month follow-up period, there were no cases of neurological complications and deaths.

A three-dimensional reconstruction of the LA obtained before the surgery shows LA with a wide base (Figure 4A). The tomogram obtained 10 days after the operation (Figure 4B) demonstrates the constricted base and no contrast in the LAA, which confirms its complete occlusion.

A novel method of LAA occlusion was developed for thromboembolism prevention. The developed method is not inferior in efficiency to standard methods of occlusion, is easily reproducible and complements the radiofrequency electrical isolation of the LAA.

The described method allows minimizing manipulations on the LA, does not require significant dislocation of the heart and provides complete occlusion of LAA at its base without residual volume.

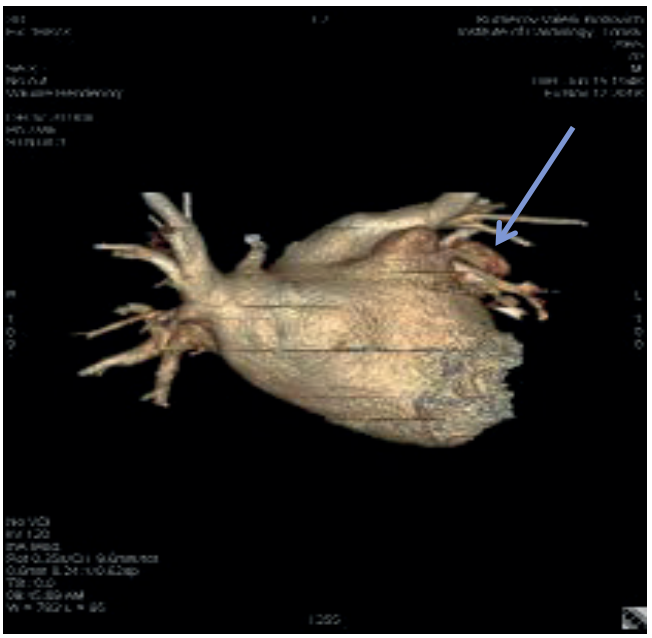
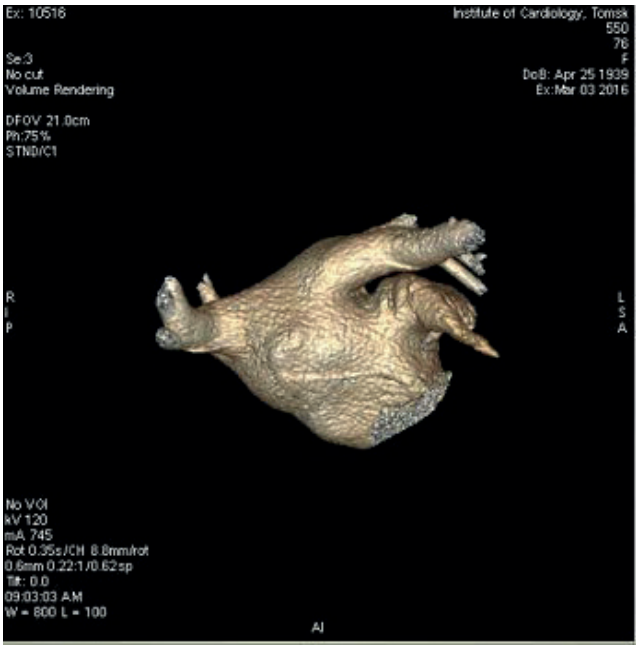


Figure 3. Three-dimensional reconstruction of LA. The arrow indicates the residual LAA cavity after the purse-string suture.



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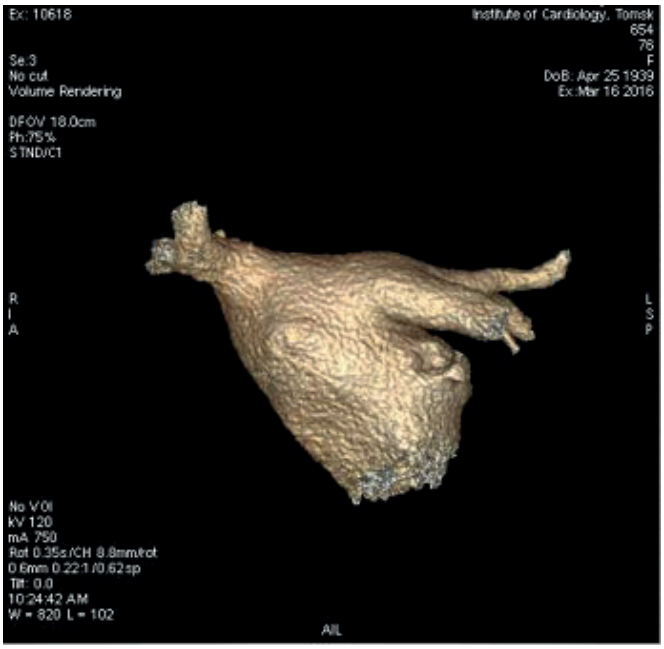

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Figure 4 (A, B). Three-dimensional reconstruction of LAA. **A** — before exclusion, **B** — after exclusion using two-suture technique.

Discussion

In this study, all patients with AF underwent LAA exclusion during coronary artery bypass grafting, which is consistent with the 2019 guidelines for the management of AF patients, in which the class of recommendation for surgical occlusion of LAA remains IIb, but the level of evidence has increased from C to B [7]. Thus, in the 2019 meta-analysis, which included over 280,000 patients, a protective effect was shown against cerebrovascular accident and thromboembolic events in studies where the proportion of patients with AF was >70% [8]. Mortality in the medium- and long-term period was also significantly lower in patients who underwent surgical occlusion of LAA. Thus, surgical occlusion of LAA, as a concomitant procedure to the main intervention, is associated with a decrease in the risk of strokes and embolic events.

However, despite the available evidence in favor of LAA exclusion, this intervention is not performed in all patients with AF during cardiac surgery. Refusal to occlude LAA is explained by the its fragile anatomical structure, and possible complications are difficult to treat [9].

In our study, recanalization was detected in one patient (3,3%) in the two-suture group and in one patient (3,3%) in the purse-string suture group. In one of the studies, LAA recanalization after its suturing and stapler exclusion was also shown. Only in the case of its resection, no residual flow was observed, but at the same time a residual stump containing thrombotic masses was detected in 25% of cases [10].

Despite the fact that LAA resection is more effective than epicardial occlusion, this method is poorly accepted in minimally invasive surgery due to its complexity [10]. Resection of LAA requires more time, is quite injurious and is associated with bleeding risk, and in addition, there may be non-resected areas of LAA [11]. Thus, it was necessary to improve the suture technique. The technology of two-suture epicardial occlusion of LAA was developed, which combines the reliable fixation of the purse-string technique and the availability of ligation. It is easily reproducible, does not require special skills and tools, significantly reduces the number of manipulations, takes into account the geometry of LAA, and can be performed in minimally invasive approaches. In this study, the efficacy and safety of this method was to be examined. The study showed that the novel method is not inferior to the purse-string suture in the efficiency of LAA exclusion, but at the same time, in contrast to the purse, it is simpler, faster and more promising with limited approach. The technical advantage of this method is the ability to exclude the LAA with one thread using two sutures, minimizing its mechanical damage.

It should be emphasized that the most reliable way to prevent thromboembolic complications is to achieve and maintain sinus rhythm. LAA exclusion, along with radiofrequency fragmentation of the LA, makes an additional contribution to LA electrical isolation and thereby contributes to the maintenance of sinus rhythm.

Study limitations. Since all participants had documented AF, each patient received anticoagulants in the pre- and postoperative period. In the present study, it is difficult to assess the true efficacy of LAA exclusion in the prevention of thromboembolic complications while taking anticoagulants. Further research is needed to study the associations and role of LAA occlusion in patients without documented AF.

Conclusion

Thus, the proposed method of LAA exclusion by a two-suture technique is an effective and safe way to prevent thromboembolism in patients with AF after CABG. The presented method of two-suture exclusion of LAA is not inferior to the standard purse-string suture in preventing strokes, while being simpler and faster to apply.

Relationships and Activities: none.

References

1. Al-Saady NM, Obel OA, Camm AJ. Left atrial appendage: structure, function, and role in thromboembolism. Heart. 1999;82(5):547-54.
2. Blackshear JL, Odell JA. Appendage obliteration to reduce stroke in cardiac surgical patients with atrial fibrillation. Ann. Thorac. Surg. 1996;61(2):755-9.
3. Katz ES, Tsiamtsiouris T, Applebaum RM, et al. Surgical left atrial appendage ligation is frequently incomplete: a transesophageal echocardiograhic study. J. Am. Coll. Cardiol. 2000;36(2):468-71.
4. Healey JS, Crystal E, Lamy A, et al. Left Atrial Appendage Occlusion Study (LAAOS): results of a randomized controlled pilot study of left atrial appendage occlusion during coronary bypass surgery in patients at risk for stroke. Am. Heart J. 2005;150(2):288-93.
5. Salzberg SP, Gillinov AM, Anyanwu A, et al. Surgical left atrial appendage occlusion: evaluation of a novel device with magnetic resonance imaging. Eur J Cardiothorac Surg. 2008;34 (4):766-70.
6. Ailawadi G, Gerdisch MW, Harvey RL, et al. Exclusion of the left atrial appendage with a novel device: early results of a multicenter trial. J. Thorac. Cardiovasc. Surg. 2011;142(5):1002-9.
7. Craig T, Samuel L, Calkins H, et al. 2019 AHA/ACC/HRS Focused Update of the 2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society in Collaboration With the Society of Thoracic Surgeons. J Am Coll Cardiol. 2019;74(1):104-132.
8. Gutiérrez M, Castaño M, Gualis J, et al. Beneficial effect of left atrial appendage closure during cardiac surgery: a meta-analysis of 280585 patients. J. Cardiothorac Surg. 2020;57(2):252-62.
9. Hanke T. Surgical management of the left atrial appendage: a must or a myth? European Journal of Cardio-Thoracic Surgery. 2018;53:33-8.
10. Kanderian AS, Gillinov AM, Pettersson GB, et al. Success of surgical left atrial appendage closure: assessment by transesophageal echocardiography. J. Am. Coll. Cardiol. 2008;52:924-9.
11. Squiers J, Edgerton J. Surgical Closure of the Left Atrial Appendage: The Past, The Present, The Future. J Atr Fibrillation. 2018;10(5):1642.