Modified epicardial left atrial appendage occulusion during thoracoscopic radiofrequency ablation of atrial fibrillation.

Jinlong Zhao[1], Yakun Gao[2], Yueli Zhang[1], Zhongyun Zhuang[3], Liang Fu[1], Yinkai Ni[1], zhe-xin Lu[1], Zonghui Chen[1], Cheng Zhang[1], and Feng Li[1]

[1]Shanghai Jiao Tong University Affiliated Sixth People's Hospital
[2]Ningbo First Hospital
[3]Shanghai Push Medical Device Technology Inc.

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Abstract

Aims To investigate a modified method of epicardial left atrial appendage (LAA) occlusion under the guidance of thoracoscopy and transesophageal echocardiography (TEE) during radiofrequency ablation of atrial fibrillation. Methods and Results 19 patients with atrial fibrillation underwent left atrial appendage occlusion and atrial fibrillation radiofrequency ablation in two centers under the guidance of thoracoscopy and TEE. All of the surgeries were completed in a general surgery setting, avoiding fluoroscopy, and in each case the entire procedure was guided by TEE. Radiofrequency ablation of atrial fibrillation was performed by Wolf mini-maze. All operations went smoothly with no serious complications. Postoperative TEE indicated that each device was in a good position and there was no residual shunt around any of the devices. Conclusions It is safe and reliable to apply the left atrial appendage closure device to perform epicardial left atrial appendage occlusion guided only by TEE, which is radiation-free. And it can be performed simultaneously during the thoracoscopic radiofrequency ablation of atrial fibrillation.

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Introduction

Atrial fibrillation is the most common type of persistent arrhythmia. In addition to causing palpitations and discomfort, the onset of atrial fibrillation increases the risk of thromboembolism (1). Evidence reported in the literature both at home and abroad indicates that thrombosis from the left atrial appendage is the main cause of stroke in atrial fibrillation (2). Multiple observational studies indicate the feasibility and safety of surgical LAA occlusion/exclusion(3,4). Surgical occlusion techniques include excision, stapler removal and running sutures, and with more recent technological advances, occlusion via innovative devices such as AtriClip and TigerPaw (5). However, the above methods cannot completely isolate the LAA. Some of these operations may have thrombosis complications in the long term(6). Some of them need to be operated after cardiac arrest by extracorporeal circulation, and this surgical method has a high risk of bleeding and is difficult to stop the bleeding. Therefore, we chose to perform thoracoscopic radiofrequency ablation of atrial fibrillation and implant the left atrial appendage occluder through the epicardial pathway.

Methods

Written informed consent was obtained from each patient. Procedures were performed in accordance with ethical standards. From April 2018 to December 2019, surgical LAA occlusion and radiofrequency ablation of atrial fibrillation were performed in a total of 19 patients. All of the LAA occlusion were video-assisted thoracoscopic surgery, which were guided by TEE in a general surgery setting.

Inclusion/Exclusion Criteria

These were atrial fibrillation patients with contraindications for long-term anticoagulant treatment, and the CHA2DS2-VASC scores of the patients included in this group were greater than or equal to 2. Furthermore, all of these patients had previous multiple and failed catheter ablations for persistent AF.

The exclusion criteria were as follows, patients with other cardiac diseases should undergo elective heart surgery, such as CABG, valvular surgeries. The FEV1 was still $< 50\%$ after pulmonary functional exercise in patients with pulmonary dysfunction. Patients with inner diameter of LA > 65mm, spontaneous development of intracardiac thrombus, severe mitral valve lesions and pericardial effusion > 3mm, life expectancy less than one year, low risk of stroke or low risk of bleeding, taking warfarin for other reasons, complex atherosclerotic plaques in the ascending aorta/aortic arch, and who were in cardiac dysfunction were also excluded.

Occluder Device

We choose the Amplatzer (SJM) and LACbes (PushMed) occluder devices because the direction of releasing the occluder must be in the reverse direction of the femoral vein pathway, and the two types of devices currently have such characteristics.

Device Implantation

LAA occlusion through the epicardial pathway, which was video-assisted thoracoscopic surgery (VATS), was as follows (Figure 1). The patient lied supine on the operating table with the middle of the chest raised. Firstly, the surgical bed was rotated to the left, and a 1 cm operation hole was opened at the front of the fourth intercostal axillary line. Under the condition of ventilation of the left lung, the pericardium was opened, and the right pulmonary veins were dissociated. The right pulmonary veins were electrically isolated by radiofrequency ablation. Then the surgical bed shaked to the right, after a 3cm left incision at the intercostal midline was made, the left pleura was opened, and the right lung was ventilated separately. Then the pericardium was opened, the Marshall ligament was cut, and the left pulmonary veins were electrically isolated. Afterwards, the LAA was sewn with two purse-string sutures and a 12F transport sheath was placed in the middle of the sutures. Under the guidance of TEE, the occluding plate of the occluder was released in the left atrium and pulled back until the opening of the LAA was completely covered. At this time, the fixing plate of the occluder was released. After 2D and 3D TEE showed that there was almost no residual blood flow in the LAA, the transmission cable and sheath were withdrawn when the occluder device was in a good position.

End Points

The endpoints of this study refered to the standardized endpoints/criteria included in the Munich consensus paper on LAAO by Tzikas et al. (7). The primary end point of the study included successful implantation of the LAA occlusion device. Successful closure of the LAA was determined by TEE as the absence of flow or minimal flow (jet of $<$5mm width; we set it to be $<$ 3mm width) around the device according to the echocardiographic sealing criteria described previously (8). The second end points were the occurrence of adverse events, which included composite endpoints such as all-cause mortality, ischemic stroke or systemic embolism, and periprocedural complications including pericardial effusion/tamponade, bleeding, pericarditis, myocardial infarction, access-related complications, renal and hepatic injuries, and device-related complications.

Statistical Analysis

SPSS 22.0 software was used for the statistical analysis. Estimated frequencies of event occurrences are expressed as percentages or rates. Continuous variables are summarized as the mean and SD.

Results

Baseline Characteristics

The average age of patients in this group, including 10 males and 9 females, was 62.3±6.7 years. Eight patients had hypertension before the operation, 12 patients had the syndrome of cardiac dysfunction, 2 patients had a history of cerebral infarction, 2 patients had diabetes, and none of the patients had valve disease. The average CHA2DS2VASc score was 2.6±0.8 and the average HASBLED score was 2.9±0.8 (Table 1).

Primary End Points

All of the surgical LAA occlusion were performed successfully. The mean LAA width was 23.3 ±3.1mm (Table 2) and the mean LAA work length was 26.0±5.4mm. The mean diameter of the seal plate of the devices was 25.1±3.3mm. All of the devices were implanted successfully. Because the procedures were combined with bilateral pulmonary veins isolation, the plugging time alone could not be calculated accurately. But it could usually be done in 10 minutes.

Secondary End Point

No complications that seriously affected a patient's life occurred during the perioperative period. During the operation, there was one case of bleeding of about 100mL in the LAA through the intercostal pathway, and one patient developed a reaction to the anesthesia (nausea and vomiting after surgery) (Table 3). The endotracheal tube was removed within 6 hours after the completion of surgery. Postoperative and half-year follow-up TEE reexamination showed successful closure of the LAA in all patients with no flow or minimal residual flow of 2mm in two patients.

The results of half-year follow-up showed that sinus rhythm without recurrences of AF is 68.8%. Endocardial electrophysiologic examination and radiofrequency ablation were performed in recurrent patients.

Discussion

Patients with atrial fibrillation (AF), which is the most common arrhythmia, have an increased risk for stroke (9) ranging from 2% to >10% per year, depending on additional risk factors (10). As a result, AF is responsible for 15% to 20% of all ischemic strokes (11).

The mortality and disability rates of atrial fibrillation are high, which seriously threatens the life and quality of life of patients. Anticoagulation or NOACs is the choice of therapy, but due to the existence of anticoagulant contraindications and other factors, some patients refuse or are not allowed drug treatment.

The Cox maze procedure is now a routine surgical procedure for AF, whether combined with other surgical procedures or lone AF. For nonvalvular atrial fibrillation, thoracoscopic PVI with bipolar radiofrequency prevents recurrence of paroxysmal AF (69%-91% freedom from arrhythmias at 1 year) (12-14). Sinus rhythm without severely symptomatic recurrences of AF is found in up to 70% of patients with paroxysmal AF, and around 50% in persistent AF (15). Therefore, neither surgery nor catheter ablation can completely cure atrial fibrillation, and patients are still at risk of embolization complications. Long-term oral anticoagulants can also lead to uncontrolled bleeding complications.

According to the statistics, more than 90% of thrombi of patients with non-valvular atrial fibrillation originate in the left atrial appendage. In recent years, many clinical studies home and abroad have shown that LAAO can reduce the risk of stroke in patients with atrial fibrillation. A multicenter clinical study of 110 patients showed that treatment with LAAO can reduce the risk of stroke, major bleeding, and death compared with other therapeutic strategies (16).

The regular 2D transesophageal echocardiogram can show each side of the LAA, enabling observation of the presence of a thrombus and measurement of its largest and least diameters and the depth of the LAA. However, there is no imaging advantage for an LAA with a complex structure or different opening forms.

Three-dimensional TEE can be used to quickly obtain a perpendicular LAA section, and the multi-section surface can display the diameter of the LAA opening in real time, reduce the steps required during surgery, and shorten the measurement time. It can directly image the complex anatomical structure of the LAA and display its shape, internal structure, and thrombus (17) in 3D images. Therefore, it plays an important role in screening patients, selecting a suitable plugging device, and ensuring the sealing effect.

After the successful release of the plugging device, TEE can evaluate its position and residual shunt at multiple angles and on multiple planes. More importantly, TEE can dynamically display the changes in the above observation indexes during the pushing and pulling experiment in real time.

In order to make full use of the advantages of TEE, we have been able to complete percutaneous endocardial LAA occlusion under the guidance of TEE alone, avoiding the radiation of doctors and patients (18). In the cases of thoracoscopic radiofrequency ablation, we also performed percutaneous LAA occlusion guided by TEE. However, there was still a risk of cardiac injury or even pericardial tamponade due to the long operation path of atrial septal puncturing and occluder releasing. Therefore, we improved the method of the LAA occlusion. The left pulmonary vein ablation incision was used to implant the device of LAA occlusion through the epicardial membrane under the guidance of thoracoscopy and TEE. The improvement is more intuitive, of which the path is shorter, and the risk of bleeding is significantly reduced.

Although the left atrial appendage can be treated through ligation, resection and suture, and even auricular clamp, the left atrial appendage has various structural variations and is not completely isolated from the type of broad substrates, which makes the surgical approach unable to completely isolate the left atrial appendage. Moreover there was evidence to suggest that residual LAA flow or incomplete LAA exclusion could increase stroke risk (19).

With the maturity of radiofrequency ablations of atrial fibrillation assisted by thoracoscopy, the success rate is also increasing. At present, Wolf surgery is performed in our center on the front line of the 4th intercostal axillary line on the right and the 3rd intercostal axillary line on the left. For patients with the need for closure of the LAA, ligation or clamping of the LAA performed through the epicardial membrane can be directly assisted by thoracoscopy. The advantage of this method is that it reduces the operating path and takes less time than the femoral vein route. Since the direction of the implanted closure is in the body to the opening of the left atrium appendage, the direction of releasing the occluder must also be in the reverse direction of the femoral vein pathway, and only the Amplatzer device currently has such characteristics. During the operation, special attention should be paid to placing the purse-string sutures as far as possible away from the base part to allow maximum space for the release of the two sealing plates. Otherwise, it will lead to the release of the fixed disc of the sealing device, part of which is outside the epicardial membrane, causing bleeding. A Prolene line can be put in place before the sealing device is implanted. The purpose of this line is to fix the sealing device to the outer cardiac membrane after its release, so as to prevent its displacement. A pericardial pad or felt pad can be added to the epicardial surface to prevent rupture of the heart due to tension of the occluder.

For this modified LAA occlusion, we encountered some initial difficulties. For example, the conveying and releasing system of the Amplatzer device were prepared for percutaneous LAA occlusion, but this method did not need too long conveying and releasing system, so we shortened the conveying sheath and releasing cable, so that it could adapt to this improved method. In addition, the choice of the sealing devices should not be too large, which can just block the opening of the left atrial appendage. Otherwise, bleeding may occur because the left atrial appendage is not deep enough to expose the oversized fixed disc to the outside of the purse.

Study Limitations

There were several limitations in our present study. This study was small and non-randomized. There was no control group.

Conclusions

It is safe and reliable to apply the sealing devices to perform epicardial LAA occlusion guided only by TEE which is radiation-free. And it can be performed simultaneously during the thoracoscopic radiofrequency ablation of atrial fibrillation.

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Conflict of interest statement

The authors declare that they have no competing financial interests.

Data Availability Statement

The data used to support the findings of this study are included within the tables of the article.

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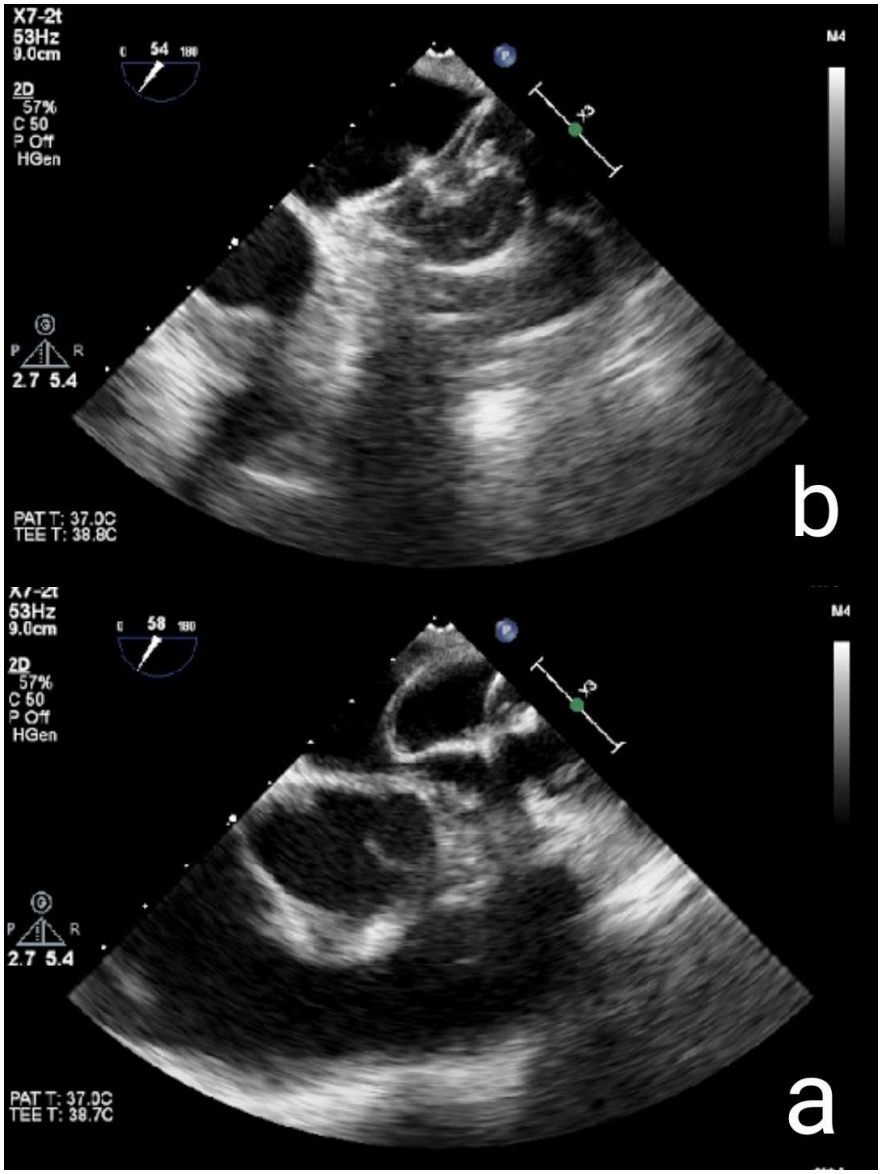
Figures

Figure 1 . Modified epicardial left atrial appendage occulusion .

Figure 1a . Firstly, the plugging plate of occluder device was released in the left atrium.

Figure 1b . Then the plugging plate was pulled back until the opening of the left atrial appendage was completely covered. At this time, the fixing plate of the occluder device was released.



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