Thoracoscopic epicardial ablation of atrial fibrillation: Safety, efficacy, single center experience

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Aims. Atrial fibrillation (AF) is associated with reduced quality of life and increased risk of ischaemic cerebrovascular events. The left atrial epicardial ablation procedures have evolved towards a successful and safe rhythm control strategy for patients with symptomatic drug-refractory paroxysmal, persistent or post-ablation AF or with a high risk of catheter ablation failure. The aim was to evaluate the efficacy and safety of thoracoscopic ablation at our instituiton.
Methods. We observed 81 patients undergoing thoracoscopic ablation from January 2015 to December 2019.
Results. The mean age was 61.3±8.5 years and the average duration of AF was 3.1±2.6 years. The cohort consisted of 16.5% of paroxysmal AF, 36.7% persistent, and 46.8% of long-standing AF. The procedure was completed in 79 patients; during follow-up, 15 patients (19%) received radiofrequency ablation. Freedom from atrial arrhythmia recurrence was 55.7% after a follow-up (FUP) period of 3.1±1.4 years. At the follow-up visit, sinus rhythm was present in 81% of patients. No relationships between arrhythmia recurrence and BMI, LVEF, left atrial dimension, gender, and AF duration were found. Major complications were noticed in 4 patients (5.0%); 2 had peripheral embolisation, 2 patients were converted to a sternotomy. At the time of the FUP visit, 25.3% of patients were using antiarrhythmic and 74.7% were still using anticoagulants.
Conclusion. In the majority of patients, sinus rhythm remained despite a considerable atrial tachycardia recurrence rate, with a relatively low percentage of patients on antiarrythmic drugs.

Key words: atrial fibrillation, thoracoscopic ablation, rhythm

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INTRODUCTION

Atrial fibrillation (AF) is the most common cardiac arrhythmia and is associated with reduced quality of life due to several adverse consequences related to decreased cardiac output, increased risk of ischaemic cerebrovascular events, or peripheral embolization due to left atrial thrombus formation[1,2]. AF is a progressive disease; paroxysmal AF (PAF) can transform into persistent AF, long-standing persistent, and finally to permanent AF. Thus, therapeutic approaches aim to maintain or restore sinus rhythm either using antiarrhythmic drugs (AAD) or using an invasive approach. The efficacy of pharmacological treatment can have variable results with potential side-effects and is no definitive curative treatment. The main goal of treatment is to remove or reduce symptoms and to prevent disabling complications. The treatment includes antithrombotic, rhythm, and/or rate control medication. Non-pharmacological interventions include catheter ablation (CA), thoracoscopic ablation procedures (TA), and surgical Maze procedures. With the advance of catheter ablation techniques, an increasing number of patients are treated invasively as first-line therapy, where catheter ablation is the most common invasive procedure performed. With the development of new ablation tools and techniques for surgical access, left atrial epicardial ablation procedures have evolved towards a successful and safe rhythm control strategy, with a Class 2A indication, for patients with symptomatic drug-refractory paroxysmal or (long-standing) persistent or post-ablation AF or with a high risk of CA failure[3]. A recent meta-analysis comparing CA and TA showed better efficacy of the latter at the cost of a higher rate of severe adverse events (SAEs) compared to CA (ref.[4]). The aim of this study was to evaluate the efficacy and safety of TA in our institution.

MATERIALS AND METHODS

Study design

A cohort of consecutive patients who underwent the TA procedure at our institution, between January 2015 and December 2019, for either paroxysmal AF or persistent AF or AAD refractory AF with a high propensity for CA failure, were analysed. Oral consent for data analysis and publication was obtained from each patient. A follow-up (FUP) visit was performed between October to December 2020, via phone contact with patients, attending cardiologists, and/or general practitioners to assess the subjective condition of the patient and current rhythm, recurrence of AF, and current use of AAD and antithrombotic medication.

The patients who were in sinus rhythm at the time of the FUP visit were scheduled for a 7-day Holter ECG monitoring or data from an implanted device capable of continuous ECG monitoring (i.e. pacemaker, cardioverter-defibrillator, or implantable ECG-recorder were used to assess the presence of atrial tachycardia (ATA). Recurrence of ATA was considered the presence of any atrial arrhythmia lasting ≥ 30 s during follow-up. We also assessed for procedural complications, death, MI, or cerebrovascular events during the follow-up period.

Surgical procedure

All surgical procedures were performed under general anaesthesia with double-lumen endotracheal intubation for selective lung ventilation, on the beating heart without the use of extracorporeal circulation. Surgical table positioning in 2-axis was used for best endoscopic view. For the ablation, Medtronic Gemini–s device was used (Medtronic, Inc., Minneapolis, USA). The procedure commenced inside the right pleural cavity – after right lung deflation and carbon dioxide insufflation for lung collapse facilitation. Three thoracoscopic ports were introduced (a camera into the fifth intercostal space at the mid-axillary line, the second working port into the fourth intercostal space in the anterior axillary line, and the third working port into the sixth intercostal space in the anterior axillary line). Visualization was accomplished with a 10.0 mm 0-degree endoscope. On the right side, the pericardium was opened widely at 1.5–2.0 cm, anterior to the phrenic nerve. Pericardial retraction sutures were used to aid visualization. Blunt dissection was performed to open the oblique and transverse sinuses and flexible guides were passed through. After that, three ports were introduced into the left pleural cavity in a similar fashion to the right pleural cavity. The pericardium on the left side was opened just below the phrenic nerve. The flexible guides were retrieved out of the left thorax and ablation clamps were attached to the end of the guides outside the left chest. Using the guides, the Gemini-s clamps were inserted to provide left-sided pulmonary veins isolation and left atrium box lesions. The RF energy for ablation was applied 5–6 times, each time the clamps were positioned slightly sideways to ensure a complete non-conductive line (duration of each application was long enough for transmurality to be reached). Ablation of right pulmonary veins and finalization of right atrial box lesion was performed similarly from the right pleural space. The pericardium was then approximated on the right side. A single chest drain was inserted through the scope site on each side of the chest and the wounds were closed and dressed in the standard way. If the patient was in AF and did not convert to SR during the ablation procedure, an attempt was made to restore sinus rhythm using external cardioversion.

Statistical analysis

Categoric data are reported as numbers and percentages. Descriptive statistics are given as percentages, means and standard deviation. Continuous data are reported as average, mean ± standard deviation. Categorical data were analysed with Fischer´s exact test. Freedom from AF recurrence was demonstrated using the Kaplan-Meier method. Outcomes during follow-up were analysed using a Cox multivariate regression model and Mann-Whitney U-test. Data were analysed using SPSS (Version 23.0. Armonk, NY: IBM Corp.).

RESULTS

The TA was attempted in 81 patients and completed in 79 patients during the study period from January 2015 to December 2019. The procedure was not completed in 2 patients; the first was because of diaphragm injury due to its elevation and the second due to pleural obliteration.

Baseline patient characteristics are shown in Table 1, the mean age was 61.3±8.5, most of them were men (76.5%), and the time since the first diagnosis of AF was

Table 1. Baseline patients' characteristics (n=79).

BMI	30.2±4.2
LVEF (%)	50.6±10.2
LAD (PLAX) (mm)	45.6±5.2
CHA_2DS_2-VAS score	2.1±1.1
Age	61.3±8.5
Sex, Men	76.5%
Arterial hypertension	92.8%
Diabetes mellitus	10.2%
AF duration (y)	3.1±2.6
Type of AF	
Paroxysmal	16.5%
Persistent	36.7%
Long-standing	46.8%

BMI, body mass index; LVEF, left ventricle ejection fraction; LAD, left atrium diameter; PLAX, parasternal long-axis projection.

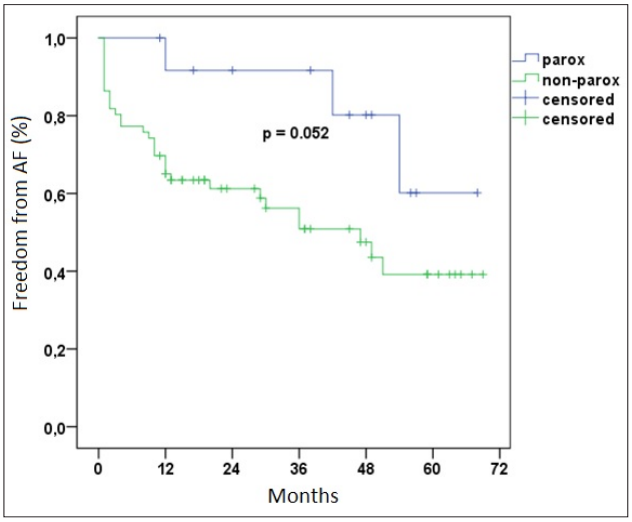

Fig. 1. Kaplan-Meier plots of freedom from AF recurrence for patients per subgroup of paroxysmal (parox) and non-paroxysmal (non-parox) atrial fibrillation.

3.1±2.6 years. The cohort consisted of 16.5% paroxysmal AF, 36.7% persistent, and 46.8% of long-standing AF.

Freedom from atrial arrhythmia recurrence was 55.7% after a mean follow-up period of 3.1±1.4 years (Fig. 1) based on 98.6% 7-day ambulatory ECG or device-based monitoring (1 patient refused due to lack of AF-related symptoms). During follow-up, 15 patients (19%) received radiofrequency ablation for atrial arrhythmia recurrence, most of them (14 patients) were from the non-paroxysmal subgroup of AF. In multivariate analysis, no significant relationships between arrhythmia recurrence and BMI, LVEF, left atrial dimension, sex, and AF duration were found. Subanalysis showed that 76.9% of the patients in the paroxysmal AF group were free from recurrence compared to 51.5% of patients within the non-paroxysmal group (*P*=0.052). Major procedural complications occurred in 4 patients (5.0%); 1 patient experienced a cerebellar stroke (1.2%), 1 peripheral embolisation to the left leg requiring embolectomy (1.2%), 2 patients were converted to a full sternotomy due to major bleeding (2.5%). 4 patients (5.0%) suffered minor adverse events; 2 patients (2.5%) experienced minor bleeding from the port wound, and 2 patients (2.5%) had a small asymptomatic pneumothorax on postoperative X-ray requiring no treatment.

During the follow-up period, the overal mortality was 11.4%, all non-cardiac related (8 patients died from malignancy, 1 from suicide). 1 patient required PM implantation for sick sinus syndrome. 2 patients suffered a stroke during follow-up; the first one suffered a stroke due to low compliance with taking apixaban and the second one suffered stroke 6 months after the operation, due to rivaroxaban discontinuation by a local doctor. At the FUP visit, the sinus rhythm was present in 81%, 25.5% of patients were using antiarrhythmic drugs, and 74.7% were still on anticoagulants.

DISCUSSION

Surgical ablation (SA) is considered as an alternative to a catheter ablation (CA) in persistent and long-term persistent AF and more often as a part of a hybrid concept of invasive AF treatment. Several recent reports on its efficacy and safety are being published[5-8]. On the contrary, for patients with paroxysmal AF (PAF), in agreement with current guidelines, SA should be considered only in patients in whom CA has failed or in a patient with a high risk of CA failure. Some studies have reported good efficacy in PAF, such as in the series of Van Laar et al., where 12-months freedom from AF recurrence ranged between 70–90% with regard the patients were on or off AADs (ref.[9]). Some data suggest SA may be superior to CA for first-line treatment in PAF, however, at the cost of a higher rate of complications and longer hospitalization[4,6,8,10,11]. In contrast, in the review of Yi et al. SA did not show better efficacy results as the first invasive procedure in the subgroup of patients with paroxysmal AF or early persistent AF (ref.[4]). In our series, the comparison of PAF and non-PAF group revealed a difference in ATA recurrence; in the PAF freedom from ATA was 76.9% compared to 51.5% in the non-paroxysmal group, (*P*=0.052). Hence, the decision to choose SA or CA in PAF must be supported by an experienced team of electrophysiologists and surgeons[3].

Our study demonstrates an overall freedom from ATA in 55.7% of patients after a mean follow-up of 3.1±1.4 years. Moreover, 81% of patients were in sinus rhythm at the follow-up visit, 75% were off AAD´s and 75% remained on oral anticoagulants (OAC). Comparably with Vos et al., who performed SA in 82 patients (50% had PAF) and reported freedom from ATA 60% after a mean follow-up of 4±0.6 years, freedom from cerebrovascular events (CVE) 98.8%, 86% was off AAD´s and 55% on OAC (ref.[12]). In a systematic outcome analysis of a multicentre cohort of 475 patients published by Van Laar there was overall freedom from ATA 68.8% after a mean follow-up period of 20±9 months; in the subgroup it was 72.7% for paroxysmal, 68.9% for persistent and 54.2% for longstanding persistent AF. A risk factor for ATA recurrency was in-hospital AF, longer duration of preoperative AF, and mitral regurgitation[12]. Slightly lower efficacy rate in our series could be due to the left atrial appendage (LAA) which was not addressed. Previous studies have also reported LAA as a trigger site for 27% of AF patients presenting for repeat procedures, and thus LAA exclusion may also contribute to achieving freedom from AF (ref.[14]). Thus, there were some opinions that LAA management may play a role in surgical AF treatment, both to the potential benefit on stroke rate[15] and also regarding electrical isolation of LAA, preventing triggering from LAA, which can improve long-term success rate[16].

Recently, two systematic reviews and meta-analysis of randomized controlled trials comparing CA and SA were published[4,6]. In Wang's review, the pooled rates of AF recurrences at 6 months were 38% in CA vs 19% in SA in three studies; AF recurrences at 1-year were 46% in CA vs 26% in SA, in six studies. In the review of Yi, SA was also associated with better efficacy and a higher rate of SAEs compared to CA. Freedom from ATA was 75% in the SA group compared to 57.1% in the CA group. However, SA did not show better efficacy results as the first invasive procedure in the subanalysis of patients with paroxysmal AF or early persistent AF (ref.[4]). The published systematic review of Phan showed freedom from ATA was significantly higher in SA than in CA at 12-month off-AAD (78.4 vs 53%; RR, 1.54; *P*<0.0001) (ref.[11]). In our series, there was no in-hospital mortality and regarding procedural complications, our rate was 5% for major and 5% for minor complications, hence slightly more than the large series of Van Laar, where the overall rate was 7.5%; major 2.1% and minor 5.5%. The conversion to sternotomy rate was 2.5%, which is considered acceptable and similar to specialized referring centers[13]. Similarly, a systematic review of Yi et al. showed that larger numbers of serious adverse events (SAEs) were observed in the TA group than in the CA group (odds ratio 0.16; 95% confidence interval 0.006–0.46; *P*=0.0006; I2=44%) (ref.[4]). In Wangs review, total adverse events in the CA group were 10% vs SA where it was 25%, particularly thoracic complications[6]. In Phan‘s review, major complications were significantly

higher in the SA group – 28.2% vs 7.8%, driven by pleural effusion and pneumothorax[11]. We noticed perioperative embolic events in 2 patients (2.5%). Both of them were thoroughly anticoagulated until the operation. The first patient was at a high thromboembolic risk, with generalized atherosclerosis and a history of pulmonary embolism. He suffered peripheral embolization in the left leg on the third post-operative day, and required a thrombectomy. In this case, a reduced dose of heparin was given which could lead to thrombus formation in this high-risk patient. The second patient has a recent history of transient ischemic attack (2 months before the operation) and post-operatively has cerebellar symptomatology with posture instability but with no findings on brain MRI. During the follow-up period, one patient required PM implantation for sick sinus syndrome. Freedom from cardiovascular events (CVE) during follow-up was 97.5%; 2 patients suffered a stroke (2.5%) – first month after the operation due to low adherence to taking apixaban. The second patient suffered a stroke 6 months after the operation, because of rivaroxaban discontinuation by a local doctor.

Study limitations

Our study has its limitations due to its observational character and the absence of a control group. Additionally, the relatively small sample size and the single-centre design does not allow us to generalize our results. Moreover, in our study, the left atrial appendage was not addressed.

CONCLUSION

Despite a considerable AF recurrence rate, the majority of patients remained in sinus rhythm with a relatively low percentage of patients on AADs. Surgical ablation may have greater efficacy but also higher adverse event rates than catheter ablation, hence it should be reserved for selected patients, particularly those planned for a hybrid approach.

ABBREVIATIONS

AADs, Antiarrhythmic drugs; AF, Atrial fibrilation; ATA, Atrial tachycardia; BMI, Body mass index; CA, Catheter ablation; CVE, Cerebrovascular events; FUP, Follow-up; LVEF, Left ventricle ejection fraction; MI, Myocardial infacrtion; OAC, Oral anticoagulants; PAF, Paroxysmal atrial fibrillation; RF, Radio frequency; SA, Surgical ablation; SAEs, Severe adverse events; SR, Sinus rhythm; TA, Thoracoscopic ablation.

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Conflict of interest statement: None declared.

Ethics statement: Oral consent for data analysis and publication was obtained from each patient.

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