

# Simultaneous Surgical Ablation of Atrial Fibrillation with Cardiac Surgery: A Review

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## Abstract

Atrial fibrillation (AF) is the most common cardiac arrhythmia with the rate of 1-2% in general population. It is characterized by the absence of coordinated pulses in the atrium and micro-re-entry. Increasing age, coronary artery disease and valve pathologies are the risk factors for the development of AF. It can be seen both non-cardiac surgery (10-20%) and cardiac surgery (20-40%). This disease is

expected to double in the next 25 years. Despite current drug and electrophysiological treatments, death and functional limitations related to AF are still common. In this paper we present the current status of simultaneous surgical ablation for AF in the light of current literature.

**Keywords:** Atrial fibrillation, atrial fibrillation surgery, cryoablation, surgical ablation

## Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia. It is characterized by chaotic electrical activity and related arrhythmic contractions in the atrium. It is an important risk factor for increased morbidity and mortality. Currently, 5 million individuals have AF in the United States<sup>(1)</sup>. The prevalence of AF increases with age (0.7%

between the ages of 55-59 and 17.8% between the ages of 85-89); and it is more prevalent among male population. Hypertension, obesity, alcohol consumption, diabetes mellitus and structural heart disease are the risk factors for the development of AF<sup>(2)</sup>. Patients with AF have a 5-fold increased risk of stroke, a 3-fold increased risk of heart failure and a 2-fold greater risk of death<sup>(1,3,4)</sup>. AF decreases



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cardiac output as a result of increased ventricular response and decreased ventricular filling time. Stasis might lead to clot formation and thromboembolism<sup>(5)</sup>.

It has been shown that morbidity and mortality risks are increased in cardiac surgery patients with untreated AF<sup>(6)</sup>. Pre-operative AF is seen in 11% of patients undergoing cardiac surgery according to the Society of Thoracic Surgeons (STS) database. This rate varies according to cardiac procedure. AF is most common in patients undergoing mitral valve surgery (30%). The rate was 14% for aortic valve surgery and 6.5% for isolated coronary bypass surgery<sup>(7)</sup>. To improve postoperative outcomes of the patients with AF, concomitant treatment of AF was emerged. AF ablation during the cardiac surgery was increased from 28.1 to 40.2 between the years 2004 to 2016<sup>(8)</sup>.

Surgical ablation of AF is based on two principles: to isolate pathologic triggers [pulmonary veins, posterior left atrium (LA), atrial appendix etc.] from the atria and to leave a large atrial area to support electrical macro-re-entry<sup>(2)</sup>. Surgical treatment of AF was first performed experimentally by Williams et al. and was reported at the American Association of Thoracic Surgeons annual meeting in 1980<sup>(9)</sup>. Then, Cox completed the first clinical procedure called Maze for AF treatment and reported 22 successful cases in 1991<sup>(10)</sup>. In the following years, the operation developed into the Maze III or “cut and sew” Maze procedure. Damiano and colleagues replaced Maze III procedure using a combination of radio frequency energy and cryoablation which is called as Cox-Maze IV<sup>(2)</sup>. In this article we have analyzed a systematic review of surgical treatment of AF and evaluated its long-term results.

## Materials and Methods

In this review, we analyzed English-language literature for reported surgical treatment of AF. We searched using the terms of “AF, surgical ablation, maze procedure” in PubMed®. We, also, included reference lists of original articles and excluded case reports and congress presentations.

## Results

AF is a marker of high risk in patients undergoing coronary surgery. Presence of pre-operative AF reduces long term survival in both valve disease and coronary artery bypass grafting<sup>(11-13)</sup>. In the evaluation of 15,000 patients with AF who had undergone cardiac surgery, Attaran et al. reported that intensive care, in-hospital and 10-year follow up mortality were significantly higher in patients with AF than the patients with sinus rhythm<sup>(11)</sup>.

Atrial enlargement, which might cause micro-re-entry, usually associated with mitral valve disease. In addition to the atrial enlargement, structural abnormalities such as fibrosis, dilatation, ischemia, and hypertrophy might cause AF<sup>(14)</sup>. Increased diameter of LA and longer duration of AF is associated of the failure of the procedure<sup>(15)</sup>. It was reported that the success of the ablation procedure was significantly reduced in patients over 75 years of age and if the left atrium size was greater than 5 cm<sup>(16)</sup>.

Surgical ablation of AF is not a concomitant surgical approach specific for the mitral valve disease. It can be performed during the aortic valve surgery and coronary artery bypass grafting concurrently. In the evaluation of 47,000 patients undergoing coronary artery bypass grafting (CABG); it was revealed that patients with pre-operative AF were older, had more left ventricular dysfunction and were more hypertensive, but the rate of anginal complaints were lower. In follow up mean survival was 8.7% and 14% in the patients with and without AF, respectively<sup>(12)</sup>. It is easy during the mitral valve surgery since cardiac chambers are opened and surgeons usually perform AF ablation concurrently with the mitral valve surgery. However, with the increased awareness of the AF on the long-term mortality might encourage surgeons to do epicardial ablation during the aortic valve surgery and coronary artery bypass grafting.

According to the STS guidelines for the surgical treatment of AF; surgical ablation of AF can be performed without additional operative mortality or major morbidity risk, and was also recommended as Class I, Level A during

the accompanying mitral valve operations to regain sinus rhythm. Surgical ablation was recommended as Class I, Level B during isolated aortic valve replacement (AVR) and isolated coronary artery bypass graft surgery to regain sinus rhythm<sup>(2)</sup>.

### Should Concomitant Ablation Be Performed?

Several studies have shown that patients who have undergone coronary surgery or AVR require less surgical AF ablation procedures than patients undergoing mitral surgery<sup>(17)</sup>. Simultaneous ablation for AF with the cardiac surgery improves postoperative outcomes without any additional risk. Concomitant surgical ablation of AF with mitral valve surgery increase 4-year survival with similar perioperative morbidity<sup>(18)</sup>. Similarly, addition of the Cox-Maze procedure to CABG or AVR did not increase morbidity and perioperative risk<sup>(19)</sup>.

In a study 375 patients with AF were evaluated in terms of safety and efficacy of concomitant AF ablation in patients undergoing CABG or AVR. Forty-four percent underwent CABG operation, while 27% underwent AVR and 29% underwent CABG and AVR surgery. Cardiopulmonary bypass and cross-clamp times were significantly higher in the ablation group. The duration of intensive care and hospital stay were similar. Postoperative AF frequency was lower in the ablation group (27% vs 78%,  $p < 0.01$ ). Adjusted operative mortality was similar, and there was no difference in mid-term survival. They also observed that the accompanying AF ablation was effective in decreasing AF-induced work load and improved survival after the surgery<sup>(14)</sup>.

Ad et al. investigated left-sided surgical ablation after cardiac surgery<sup>(16)</sup>. Fifty-nine percent of the patients had CABG, 36% had aortic valve surgery and 25% had mitral valve surgery. Postoperative sinus rhythm without antiarrhythmic drug was remained in 82%, 87% and 79% of the patients at 6, 12 and 24 months, respectively. The only independent predictor was left atrial diameter. As a result, they concluded that left-sided surgical ablation

provided acceptable success only in patients with small LA size and short duration of AF<sup>(16)</sup>.

In a meta-analysis of sixteen randomized controlled trials, the clinical outcomes of medical ablation and surgical ablation were analyzed after cardiac surgery. There was no significant difference in mortality between patients with and without surgical ablation (OR: 1.05; 95% CI: 0.66 to 1.68;  $p = 0.83$ ). There was no significant difference in the need for pacemaker implantation (OR: 0.88; 95% CI: 0.51 to 1.51;  $p = 0.64$ ) and neurological event risk (OR: 0.86; 95% CI: 0.37 to 2.04;  $p = 0.74$ ). Sinus rhythm prevalence was higher in the surgical ablation group at  $\geq 12$  months follow-up (OR: 6.72; 95% CI: 4.88 to 9.25;  $p < 0.00001$ ). They recommended simultaneous surgical ablation as a first option in the treatment of AF in patients undergoing cardiac surgery<sup>(20)</sup>. In our department we routinely perform surgical ablation procedure, if AF persists. We performed surgical ablation of AF in 234 patients. Most of the patients had mitral valve disease (96.5%). We preferred radiofrequency ablation in 96.5% of our patients. Postoperative sinus rhythm was remained in 189 patients (80.7%) in the follow up period.

### What is the Optimal Ablation Approach?

International Association of Minimally Invasive Cardiothoracic Surgery recommended that patients undergoing cardiac surgery should undergo a surgical ablation procedure; to increase the frequency of sinus rhythm at short and long-term follow-up, to improve ejection fraction and exercise tolerance, to reduce the risk of stroke and thromboembolic event and to improve long-term survival<sup>(21)</sup>.

In the comparison of the new developed techniques and the classical Cox Maze III procedure Cox Maze III procedure resulted in a greater freedom from AF in each follow-up<sup>(22)</sup>. In multivariate analysis, the risk of recurrent AF was lower during 1 to 5-year follow-up period in the Cox Maze III procedure (hazard ratio: 0.4; 95% CI: 0.24-0.69;  $p < 0.001$ )<sup>(22)</sup>. Randomized controlled trials are

necessitated with alternative energy sources to provide effectiveness of the Cox Maze IV procedure.

## Conclusion

Gammie et al. declared that, although an increasing number of patients with AF were treated by surgical ablation, almost 60% of patients were still untreated<sup>(8,23)</sup>. Although 52% of patient undergoing mitral valve surgery underwent concomitant surgical correction of AF only 28% of patients with aortic valve surgery and 24% of patients with CABG had concomitant surgical ablation procedure. After adjustment for the differences in pre-operative characteristics, it was revealed that surgical ablation AF might be performed without increasing mortality and major morbidity<sup>(8)</sup>. In the evaluation of more than 85,000 patients, it was found that, as in other studies, early mortality, prolonged ventilation and stroke rate decreased in patients who underwent surgical ablation; however, there was increase in the development of renal failure and the need for pacemaker implantation<sup>(17)</sup>.

The number of patients with AF is increasing day by day and it is predicted that this number will be doubled in 25 years<sup>(1)</sup>. This situation is similar across the world and patient prevalence is similar in the USA and Europe. Patient with AF has increased risk for stroke, heart failure and mortality. As a consequence, treatment of the AF will be more popular in the following decades.

Surgical ablation of AF has been developing for more than three decades. Safety and efficiency with AF ablation are maintained with the new techniques. Currently only 40% of AF patients had undergone AF ablation<sup>(17)</sup>. Surgical ablation of AF improves quality of life, survival and patient satisfaction without increased risk of operative mortality or major morbidity. Considering the benefits to long-term rhythm control and quality of life, more frequently performed surgical ablation will improve patient outcomes.

## Ethics

**Peer-review:** Externally peer-reviewed.

## Authorship Contributions

Surgical and Medical Practices: E.D., Concept: E.D., Design: M.U., İ.D., Data Collection or Processing: M.U., İ.D., Analysis or Interpretation: E.D., M.U., Literature Search: E.D., M.U., İ.D., Writing: E.D., M.U., İ.D.

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