

# **Efficacy of Surgical Radiofrequency Ablation using the Left Modified Maze Procedure in the Treatment of Chronic Atrial Fibrillation during Mitral Valve Surgery**

*Thesis*

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## List of Abbreviations

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ABCs	:	Airway, breathing, and circulation
ACC	:	American College of Cardiology
ACLS	:	Advanced Cardiac Life Support
AF	:	Atrial fibrillation
AHA	:	American Heart Association
AP	:	Action potentials
APD	:	Action potential duration
BNP	:	B-type natriuretic peptide
cAMP	:	Cyclic adenosine monophosphate
CBC	:	Complete blood count
CHF	:	Congestive heart failure
COR	:	Classification of Recommendation
CRP	:	C-reactive protein
CVA	:	Cerebrovascular accident
DAD	:	Delayed afterdepolarization
DADs	:	Delayed afterdepolarizations
DC	:	Direct current
DECAAF	:	Determinant of Successful Catheter Ablation of Atrial Fibrillation
ECG	:	Electrocardiographic
ECM	:	Excess extracellular matrix
HF	:	Heart failure
HIFU	:	High-intensity focused ultrasound
HVA	:	High voltage-activated
ICaL	:	L-type calcium channel
ICVTS	:	Interactive cardiovascular and thoracic surgery
INR	:	International normalized ratio
IVC	:	Inferior vena cava
KV	:	Voltage-gated K <sup>+</sup>

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## List of Abbreviations (Cont.)

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LA	:	Left atrial
LAD	:	Left atrial diameter
LOE	:	Level of Evidence
LV	:	Left ventricular
LVA	:	Low voltage-activated
LVH	:	Left ventricular hypertrophy
MI	:	Myocardial infarction
NaV	:	Voltage-gated cardiac Na <sup>+</sup>
PTCA	:	Percutaneous transluminal coronary angioplasty
RP	:	Refractory period
RVR	:	Rapid ventricular response
SA	:	The sinoatrial
SD	:	Mean± standard deviation
SPSS	:	Statistical Program for Social Science
SR	:	Sinus rhythm
SICTRA	:	Saline-irrigated cooled tip RF ablation
TEE	:	Transesophageal echocardiography
TTE	:	Transthoracic echocardiography
VHD	:	Valvular heart disease

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## Introduction

Atrial fibrillation is a disorder of cardiac rhythm characterized by rapid (350-500/min), irregular disorganized atrial impulses and ineffective atrial contractions <sup>(1)</sup>.

Atrial fibrillation (AF) is characterized by rapid and irregular activation of the atria, leading to loss of normal sinus rhythm. In AF, various regions of the atrial wall pulse 400-600 times per minute and the ventricular rate is determined by the interaction between the atrial activity and the filtering function of the atrioventricular node. AF is the most common cardiac rhythm disturbance, affecting an estimated 2.2 million people within the United States <sup>(2)</sup>.

Atrial fibrillation (AF) is related to poor survival rates with respect to sinus rhythm (SR) both in the general population <sup>(3)</sup> and in patients undergoing heart surgery <sup>(4)</sup>.

The incidence of AF increases with age, with a prevalence of 0.5% of people in the fifth decade rising to 10% of people in the eighth decade. AF is associated with a number of predisposing cardiovascular disorders, including coronary artery disease, valvular heart disease, congestive heart failure, and hypertension. However, in up to 31% of cases AF is not associated with an underlying cardiovascular disorder <sup>(5)</sup>.

The prevalence of AF in patients scheduled for a mitral valve procedure is still between 30 and 84 % <sup>(6-8)</sup>. In the presence of permanent AF the likelihood of SR recovery after a conventional heart operation alone ranges from 4.5 to 36% and is even more unlikely in patients with left atrial megalia <sup>(4)</sup>.

Because of the loss of effective atrial contraction, stasis of blood in the atria predisposes affected patients to thromboembolism. Patients with AF have a five-fold increased risk for stroke compared to age-matched controls, and AF is responsible for as many as 15% of all strokes<sup>(9,10)</sup>.

The long-term medical treatment of AF with antiarrhythmic drug therapy is associated with a failure rate of 50% at one year and up to 84% at two years<sup>(10,11)</sup>. In addition, currently available antiarrhythmic agents are not specific for atrial activity and therefore can have profound effects on ventricular electrophysiology. The medical treatment for AF has therefore largely focused on ventricular rate control and management of thromboembolic risk with oral anticoagulants. While anti-coagulation therapy has been shown to have a decisive benefit in reducing thromboembolism in patients with chronic AF, this treatment is cumbersome and exposes patients to significant hemorrhagic risk<sup>(12)</sup>.

Although most symptoms of atrial fibrillation are controlled with medications, a small percentage of patients have drug intolerance or severe side effects, especially notable are the myriad effects of long term amiodarone use<sup>(13,14)</sup>. Most worrisome are proarrhythmic potential of most antiarrhythmic drugs. Although the symptoms of atrial fibrillation may be severe and even disabling in unusual patients, the most feared complication is thromboembolism. Patients with chronic atrial fibrillation had a significantly increased mortality especially if fibrillation was accompanied by mitral stenosis. The surgical attempts to cure atrial fibrillation can be justified from the previous studies with regard to stroke risk<sup>(15,16)</sup>, decreased life expectancy<sup>(16)</sup> and avoidance of toxic antiarrhythmic drugs<sup>(14,17)</sup>.

The pioneering work of Cox and colleagues has demonstrated the feasibility of treating AF surgically by interrupting the atrial pathways for multiple reentry circuits, which are necessary for the maintenance of AF<sup>(18)</sup>. The pioneering work of Cox and colleagues culminated in the development of the Cox-Maze III procedure, which remains the gold standard for the surgical treatment of AF<sup>(19)</sup>. The outstanding results of the Cox-Maze III procedure justify its status as the ‘gold standard’ surgical procedure for AF. Cox and colleagues report an overall success rate of 99% in curing patients of AF<sup>(20)</sup>.

The Cox-Maze procedure is the most effective surgical treatment for patients with chronic atrial fibrillation<sup>(19,21-23)</sup>. The method can be combined with an operation for organic heart disease or can be performed as an isolated surgical procedure for patients with lone atrial fibrillation refractory to medical therapy<sup>(19,21-23)</sup>. However from a surgical point of view, it is a demanding procedure that prolongs significantly the aortic cross-clamp and operating time. Therefore this procedure is not widely accepted.

Intraoperative radiofrequency ablation is a novel surgical principle for the treatment of atrial fibrillation in combination with a standard open-heart operation<sup>(24-31)</sup>. It is based on the original concept of the maze procedure developed and introduced by James Cox<sup>(21)</sup>. Application of radiofrequency current replaces the incisions and sutures of the standard maze technique. There is a spectrum of modifications regarding the types of surgical probe used for ablation, modes of application (endocardial or epicardial), and the direction of the maze lines<sup>(24-31)</sup>.

Radiofrequency energy uses an alternating current from 350 kHz to 1 MHz to heat tissue, resulting in thermal