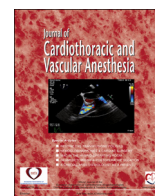




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Expert Review

Catheter Versus Surgical Ablation of Atrial Fibrillation: An Analysis of Outcomes

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ATRIAL FIBRILLATION (AF), an abnormal atrial rhythm due to uncoordinated atrial activation resulting in ineffective atrial contraction, is the most common sustained arrhythmia encountered in clinical practice and is increasing in prevalence and incidence worldwide.¹ In 2010, worldwide estimates for the number of individuals with AF were 20.9 million men and 12.6 million women.² The lifetime risk for development of AF is 1-in-4 for individuals ≥ 40 years of age.³ Direct costs of AF amounted to between \$6 billion and \$26 billion in the United States in 2008, driven by AF-related complications and treatment costs.⁴ AF is associated with a 2-fold increased risk for all-cause mortality in women and 1.5-fold increased risk in men. Approximately 20% to 30% of ischemic strokes are attributable to AF and 10% to 40% of patients with AF are hospitalized each year.⁵ Clinical risk factors associated with

AF include age, hypertension, diabetes mellitus, myocardial infarction, valvular heart disease, heart failure, obesity, obstructive sleep apnea, cardiothoracic surgery, smoking, exercise, alcohol use, hyperthyroidism, increased pulse pressure, European ancestry, family history, and genetic variants. Echocardiographic risk markers include left ventricular hypertrophy, decreased left ventricular fractional shortening, and increased left ventricular wall thickness.⁶ This expert review discusses the mechanisms of and current outcomes for non-invasive and invasive options for the treatment of AF.

Mechanisms and Pathophysiology

AF occurs when there are electrical and structural abnormalities in the atria that favor abnormal impulse formation and propagation. Multiple mechanisms likely coexist in a single patient. Intra- and extracardiac factors that alter atrial architecture by causing dilation, infiltration, ischemia, or hypertrophy eventually lead to myocardial fibrosis, which increases the susceptibility to AF.⁷ Several atrial electrical abnormalities,

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including increased automaticity, shortening of action potential duration and refractoriness, and abnormal intracellular calcium handling, play a role in initiation and maintenance of AF. The seminal observation by Haïssaguerre et al⁸ that ectopic focal discharges from left atrial (LA) myocardial sleeves that extend into the pulmonary veins often initiate AF, has led to the development of pulmonary vein isolation as a cornerstone for catheter-based treatment of AF. Three different theories have been proposed to explain the maintenance of AF. These include multiple random re-entrant wavelets, rapidly discharging ectopic foci, and localized spiral re-entrant sites with fibrillatory conduction, also known as rotors.⁹ All of these mechanisms have been targeted for the treatment of AF.

Classification of Atrial Fibrillation

In most patients, AF progresses from brief, occasional episodes to longer and more frequent events.⁵ Over time, many patients will develop sustained forms of AF. In a small proportion of patients, AF will remain paroxysmal over several decades (2%–3% of AF patients).⁵ Based on these characteristics, several types of AF are traditionally distinguished:

- ✦ Paroxysmal AF: AF that terminates spontaneously or with intervention within 7 days of onset. Episodes may recur with variable frequency.
- ✦ Persistent AF: Continuous AF that is sustained > 7 days.
- ✦ Long-standing persistent AF: Continuous AF of > 12 months duration.
- ✦ Permanent AF: Used when there has been a joint decision by the patient and clinician to cease further attempts to restore and/or maintain sinus rhythm.

The term *lone AF* is a historical descriptor that has been variably applied to younger individuals without structural heart disease, without evidence of clinical or echocardiographic evidence of cardiopulmonary disease, hypertension, or diabetes mellitus. Because definitions are variable, the term *lone AF* is potentially confusing and should not be used to guide therapeutic decisions.⁵

AF classifications have been variable and adjusted throughout the years due mostly to the evolution of the pathophysiologic mechanisms and therapeutic strategies. Additionally, the classification has been consistently different between US and European Union guidelines.^{5,6,10} Despite these differences, guidelines coincide in a common point: Catheter ablation (CA) is better for paroxysmal AF than for nonparoxysmal AF.

Outcomes With Antiarrhythmics and Catheter Ablation

Patient selection is essential for appropriate therapeutic choice.¹¹ Rate control may be preferred in asymptomatic patients, whereas a rhythm control strategy may be the therapy of choice in symptomatic patients. Rhythm control can be achieved either with medications or CA. CA for the treatment of AF is currently recommended by guidelines as a second-line therapy in patients with paroxysmal and persistent AF after

treatment with ≥ 1 antiarrhythmic drug (AAD) has failed (Class I recommendation for paroxysmal AF, Class IIa for persistent AF, and Class IIb for long-standing persistent). Of note, guidelines give a Class III (causes harm) warning for pursuing AF ablation for the sole purpose of discontinuing anticoagulation.^{5,6}

Guidelines for catheter AF ablation from the European Society of Cardiology/European Heart Rhythm Association^{5,10,12} and the American Heart Association/American College of Cardiology/Heart Rhythm Society⁶ are summarized in Table 1.

Although pharmacologic therapy has been the mainstay of rhythm control in AF, currently available AADs have limited effectiveness and safety. Several randomized trials have compared the safety and efficacy of CA of AF versus AADs. The RAAFT (Radiofrequency Ablation v Antiarrhythmic Drugs as First-Line Treatment of Paroxysmal AF) trial was the first to suggest the benefit of CA as a first-line therapy for AF.¹³ This comprised a multicenter prospective randomized study conducted from December 31, 2001 to July 1, 2002, with 70 patients aged 18 to 75 years who experienced monthly symptomatic AF episodes for ≥ 3 months and had not been

Table 1
Society Guidelines for Catheter Ablation of Atrial Fibrillation

European Society of Cardiology/European Heart Rhythm Association	
●	Catheter ablation for symptomatic atrial fibrillation as an alternative to antiarrhythmic drug therapy in patients who are refractory or intolerant to ≥ 1 Class I or 3 antiarrhythmic medication with symptomatic recurrences and who desire a rhythm control strategy, provided that the procedure is performed by an expert operator at an experienced center: <ul style="list-style-type: none"> ○ is recommended for paroxysmal atrial fibrillation (Class I, Level A) ○ is reasonable for persistent atrial fibrillation (Class IIa, Level B) ○ may be considered for long-standing persistent atrial fibrillation (Class IIb, Level B)
●	Catheter ablation as an alternative first-line therapy in patients with symptomatic atrial fibrillation before initiating antiarrhythmic drug therapy, no structural heart disease, and with a low-risk profile for procedure-related complications: <ul style="list-style-type: none"> ○ is reasonable for paroxysmal atrial fibrillation (Class IIa, Level B) ○ may be considered for persistent atrial fibrillation (Class IIb, Level C) ○ may be considered for long-standing persistent atrial fibrillation (Class IIb, Level C)
American Heart Association/American College of Cardiology/Heart Rhythm Society	
●	Catheter ablation for symptomatic atrial fibrillation as an alternative to antiarrhythmic drug therapy in patients who are refractory or intolerant to ≥ 1 Class I or 3 antiarrhythmic medication with symptomatic recurrences and who desire a rhythm control strategy, provided that the procedure is performed by an expert operator at an experienced center: <ul style="list-style-type: none"> ○ is recommended for paroxysmal atrial fibrillation (Class I, Level A) ○ is reasonable for persistent atrial fibrillation (Class IIa, Level A) ○ may be considered for long-standing persistent atrial fibrillation (Class IIb, Level B)
●	Catheter ablation as an alternative first-line therapy in patients with symptomatic atrial fibrillation before initiating antiarrhythmic drug therapy, no structural heart disease, and with a low-risk profile for procedure-related complications: <ul style="list-style-type: none"> ○ is reasonable for paroxysmal atrial fibrillation (Class IIa, Level B) ○ may be considered for persistent atrial fibrillation (Class IIb, Level C)

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