

## Summary of Expert Consensus Statement for CLINICIANS

# 2017 HRS/EHRA/ECAS/APHRS/SOLAECE Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation

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This is a summary of the Heart Rhythm Society Expert Consensus Statement *2017 HRS/EHRA/ECAS/APHRS/SOLAECE Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation*, which was released during the 2017 HRS Scientific Sessions. Please refer to the full statement for more information.

The 2017 Expert Consensus Statement represents a complete rewrite of the 2012 HRS/EHRA/ECAS Expert Consensus Statement. This document provides updated definitions, mechanisms, and rationale for atrial fibrillation (AF) ablation and consensus recommendations concerning indications, strategies, techniques, and endpoints, technology and tools, and follow-up considerations for AF ablation. The document also provides definitions to be used in clinical trials and recommendations that will impact clinical trial design. The statement summarizes the opinion of the Task Force members on the basis of an extensive literature review and their own experience in treating patients.

Key points of this document are as follows:

1. Catheter and surgical ablation of AF are well established and important treatment options for patients with AF in whom a rhythm control strategy is chosen.
2. A decision to perform catheter or surgical ablation of AF should be made after a careful consideration of the efficacy, risks, and alternatives to undergoing the ablation procedure. Patient preferences and values are important consideration. This document provides indications for both catheter and surgical AF ablation.
3. The primary indication for performance of AF ablation is the presence of symptoms associated with AF. AF ablation is generally considered after at least one antiarrhythmic medication has been tried and proven to be ineffective or poorly tolerated.
4. A desire to stop anticoagulation is not an appropriate indication for AF ablation. For most patients with AF who have a high stroke risk profile, anticoagulation should be continued following their ablation procedure.
5. Catheter ablation of AF is associated with a risk of complications, including development of a stroke or transient ischemic attack. Careful attention to anticoagulation prior to, during, and following the ablation procedure minimizes these risks.
6. Multiple tools and strategies are available to perform both catheter and surgical ablation of AF. This document provides a detailed review of each of the available options, and the recommendations are made.

## Indications for Catheter Ablation of Atrial Fibrillation

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| <i>Symptomatic AF refractory or intolerant to at least one Class I or III antiarrhythmic medication</i>             |
| Paroxysmal: Catheter ablation is recommended. (COR I; LOE A)  |
| Persistent: Catheter ablation is reasonable. (COR IIa; LOE B-NR)  |
| Long-standing persistent: Catheter ablation may be considered. (COR IIb; C-LD)                                      |
| <i>Symptomatic AF prior to initiation of antiarrhythmic therapy with a Class I or III antiarrhythmic medication</i> |
| Paroxysmal: Catheter ablation is reasonable. (COR IIa; LOE B-R)   |
| Persistent: Catheter ablation is reasonable. (COR IIa; LOE C-EO)  |
| Long-standing persistent: Catheter ablation may be considered. (COR IIb; LOE C-EO)                                  |

## Indications for Catheter Atrial Fibrillation Ablation in Populations of Patients Not Well Represented in Clinical Trials

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| Congestive heart failure: It is reasonable to use similar indications for AF ablation in selected patients with heart failure as in patients without heart failure. (COR IIa; LOE B-R) |
| Older patients (>75 years of age): It is reasonable to use similar indications for AF ablation in selected older patients with AF as in younger patients. (COR IIa; B-NR)              |
| Hypertrophic cardiomyopathy: It is reasonable to use similar indications for AF ablation in selected patients with HCM as in patients without HCM. (COR IIa; LOE B-NR)                 |
| Young patients (<45 years of age): It is reasonable to use similar indications for AF ablation in young patients with AF (<45 years of age) as in older patients. (COR IIa; LOE B-NR)  |
| Tachy-brady syndrome: It is reasonable to offer AF ablation as an alternative to pacemaker implantation in patients with tachy-brady syndrome. (COR IIa; LOE B-NR)                     |
| Athletes with AF: It is reasonable to offer high-level athletes AF as first-line therapy due to the negative effects of medications on athletic performance. (COR IIa; LOE C-LD)       |
| Asymptomatic AF, Paroxysmal: Catheter ablation may be considered in select patients. (COR IIb; LOE C-EO)   |
| Asymptomatic AF, Persistent: Catheter ablation may be considered in select patients. (COR IIb; LOE C-EO)   |

## Indications for Concomitant Open (Such as Mitral Valve) Surgical Ablation of Atrial Fibrillation

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| <i>Symptomatic AF refractory or intolerant to at least one Class I or III antiarrhythmic medication</i>             |
| Paroxysmal: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Persistent: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Long-standing persistent: Surgical ablation is recommended. (COR I; LOE B-NR)                                       |
| <i>Symptomatic AF prior to initiation of antiarrhythmic therapy with a Class I or III antiarrhythmic medication</i> |
| Paroxysmal: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Persistent: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Long-standing persistent: Surgical ablation is recommended. (COR I; LOE B-NR)                                       |

## Indications for Concomitant Closed (Such as CABG and AVR) Surgical Ablation of Atrial Fibrillation

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| <i>Symptomatic AF refractory or intolerant to at least one Class I or III antiarrhythmic medication</i>             |
| Paroxysmal: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Persistent: Surgical ablation is recommended. (COR I; LOE B-NR)   |
| Long-standing persistent: Surgical ablation is reasonable. (COR I; LOE B-NR)  |
| <i>Symptomatic AF prior to initiation of antiarrhythmic therapy with a Class I or III antiarrhythmic medication</i> |
| Paroxysmal: Surgical ablation is reasonable. (COR IIa; LOE B-NR)  |
| Persistent: Surgical ablation is reasonable. (COR IIa; LOE B-NR)  |
| Long-standing persistent: Surgical ablation is reasonable. (COR IIa; LOE B-NR)                                      |

## Indications for Stand-Alone and Hybrid Surgical Ablation of Atrial Fibrillation

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| <i>Symptomatic AF refractory or intolerant to at least one Class I or III antiarrhythmic medication</i>   |
| Paroxysmal: Stand-alone surgical ablation can be considered for patients who have failed one or more attempts at catheter ablation and also for those who are intolerant or refractory to antiarrhythmic drug therapy and prefer a surgical approach, after review of the relative safety and efficacy of catheter ablation versus a stand-alone surgical approach. (COR IIb; LOE B-NR) |
| Persistent: Stand-alone surgical ablation is reasonable for patients who have failed one or more attempts at catheter ablation and also for those patients who prefer a surgical approach after review of the relative safety and efficacy of catheter ablation versus a stand-alone surgical approach. (COR IIa; LOE B-NR)   |
| Long-standing persistent: Stand-alone surgical ablation is reasonable for patients who have failed one or more attempts at catheter ablation and also for those patients who prefer a surgical approach after review of the relative safety and efficacy of catheter ablation versus a stand-alone surgical approach. (COR IIa; LOE B-NR)   |
| It might be reasonable to apply the indications for stand-alone surgical ablation described above to patients being considered for hybrid surgical AF ablation. (COR IIb; LOE C-EO)   |

## Atrial Fibrillation Ablation: Strategies, Techniques, and Endpoints

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| <i>PV isolation by catheter ablation</i>   |
| Electrical isolation of the PVs is recommended during all AF ablation procedures. (COR I; LOE A)   |
| Achievement of electrical isolation requires, at a minimum, assessment and demonstration of entrance block into the PV. (COR I; LOE B-R)   |
| Monitoring for PV reconnection for 20 minutes following initial PV isolation is reasonable. (COR IIa; LOE B-R)   |
| Administration of adenosine 20 minutes following initial PV isolation using RF energy with reablation if PV reconnection might be considered. (COR IIb; LOE B-R)   |
| Use of a pace-capture (pacing along the ablation line) ablation strategy may be considered. (COR IIb; LOE B-R)   |
| Demonstration of exit block may be considered. (COR IIb; LOE B-NR)   |
| <i>Ablation strategies to be considered for use in conjunction with PV isolation</i>   |
| If a patient has a history of typical atrial flutter or typical atrial flutter is induced at the time of AF ablation, delivery of a cavotricuspid isthmus linear lesion is recommended. (COR I; LOE B-R)   |
| If linear ablation lesions are applied, operators should use mapping and pacing maneuvers to assess for line completeness. (COR I; LOE C-LD)   |
| If a reproducible focal trigger that initiates AF is identified outside the PV ostia at the time of an AF ablation procedure, ablation of the focal trigger should be considered. (COR IIa; LOE C-LD)  |
| When performing AF ablation with a force-sensing RF ablation catheter, a minimal targeted contact force of 5 to 10 grams is reasonable. (COR IIa; LOE C-LD)  |
| Posterior wall isolation might be considered for initial or repeat ablation of persistent or long-standing persistent AF. (COR IIb; LOE C-LD)  |
| Administration of high-dose isoproterenol to screen for and then ablate non-PV triggers may be considered during initial or repeat AF ablation procedures in patients with paroxysmal, persistent, or long-standing persistent AF. (COR IIb; LOE C-LD)   |
| DF-based ablation strategy is of unknown usefulness for AF ablation. (COR IIb; LOE C-LD)   |
| The usefulness of creating linear ablation lesions in the right or left atrium as an initial or repeat ablation strategy for persistent or long-standing persistent AF is not well established. (COR IIb; LOE B-NR)                                      |
| The usefulness of linear ablation lesions in the absence of macroreentrant atrial flutter is not well established. (COR IIB; LOE C-LD)   |
| The usefulness of mapping and ablation of areas of abnormal myocardial tissue identified with voltage mapping or MRI as an initial or repeat ablation strategy for persistent or long-standing persistent AF is not well established. (COR IIB; LOE B-R) |
| The usefulness of ablation of complex fractionated atrial electrograms as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established. (COR IIb; LOE B-R)  |
| The usefulness of ablation of rotational activity as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established. (COR IIb; LOE B-NR)  |
| The usefulness of ablation of autonomic ganglia as an initial or repeat ablation strategy for paroxysmal, persistent, and long-standing persistent AF is not well established. (COR IIb; LOE B-NR)   |

### *Nonablation strategies to improve outcomes*

Weight loss can be useful for patients with AF, including those who are being evaluated to undergo an AF ablation procedure, as part of a comprehensive risk factor management strategy. (COR IIa; LOE B-R)

It is reasonable to consider a patient's BMI when discussing the risks, benefits, and outcomes of AF ablation with a patient being evaluated for an AF ablation procedure. (COR IIa; LOE B-R)

It is reasonable to screen for signs and symptoms of sleep apnea when evaluating a patient for an AF ablation procedure and to recommend a sleep evaluation if sleep apnea is suspected. (COR IIa; LOE B-R)

Treatment of sleep apnea can be useful for patients with AF, including those who are being evaluated to undergo an AF ablation procedure. (COR IIa; LOE B-R)

The usefulness of discontinuation of antiarrhythmic drug therapy prior to AF ablation in an effort to improve long-term outcomes is unclear. (COR IIb; LOE C-LD)

The usefulness of initiation or continuation of antiarrhythmic drug therapy during the postablation healing phase in an effort to improve long-term outcomes is unclear. (COR IIb; LOE C-LD)

### *Strategies to reduce the risks of AF ablation*

Careful identification of the PV ostia is mandatory to avoid ablation within the PVs. (COR I; LOE B-NR)

It is recommended that RF power be reduced when creating lesions along the posterior wall near the esophagus. (COR I; LOE C-LD)

It is reasonable to use an esophageal temperature probe during AF ablation procedures to monitor esophageal temperature and help guide energy delivery. (COR IIa; LOE C-EO)

## **Anticoagulation Strategies: Pre-, During, and Postcatheter Ablation of AF**

### *Preablation*

For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with warfarin or dabigatran, performance of the ablation procedure without interruption of warfarin or dabigatran is recommended. (COR I; LOE A)

For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with rivaroxaban, performance of the ablation procedure without interruption of rivaroxaban is recommended. (COR I; LOE B-R)

For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with a NOAC other than dabigatran or rivaroxaban, performance of the ablation procedure without withholding a NOAC dose is reasonable. (COR IIa; LOE B-NR)

Anticoagulation guidelines that pertain to cardioversion of AF should be adhered to in patients who present for an AF catheter ablation procedure. (COR I; LOE B-NR)

For patients anticoagulated with a NOAC prior to AF catheter ablation, it is reasonable to hold one to two doses of the NOAC prior to AF ablation with reinitiation postablation. (COR IIa; LOE B-NR)

Performance of a TEE in patients who are in AF on presentation for AF catheter ablation and who have been receiving anticoagulation therapeutically for 3 weeks or longer is reasonable. (COR IIa; LOE C-EO)

Performance of a TEE in patients who present for ablation in sinus rhythm and who have not been anticoagulated prior to catheter ablation is reasonable. (COR IIa; LOE C-EO)

Use of intracardiac echocardiography to screen for atrial thrombi in patients who cannot undergo TEE may be considered. (COR IIb; LOE C-EO)

#### *During ablation*

Heparin should be administered prior to or immediately following transseptal puncture during AF catheter ablation procedures and adjusted to achieve and maintain an ACT of at least 300 seconds. (COR I; LOE B-NR)

Administration of protamine following AF catheter ablation to reverse heparin is reasonable. (COR IIa; LOE B-NR)

#### *Postablation*

In patients who are not therapeutically anticoagulated prior to catheter ablation of AF and in whom warfarin will be used for anticoagulation postablation, low molecular weight heparin or intravenous heparin should be used as a bridge for initiation of systemic anticoagulation with warfarin following AF ablation.\* (COR I; LOE C-EO)

Systemic anticoagulation with warfarin\* or a NOAC is recommended for at least 2 months postcatheter ablation of AF. (COR I; LOE C-EO)

Adherence to AF anticoagulation guidelines is recommended for patients who have undergone an AF ablation procedure, regardless of the apparent success or failure of the procedure. (COR I; LOE C-EO)

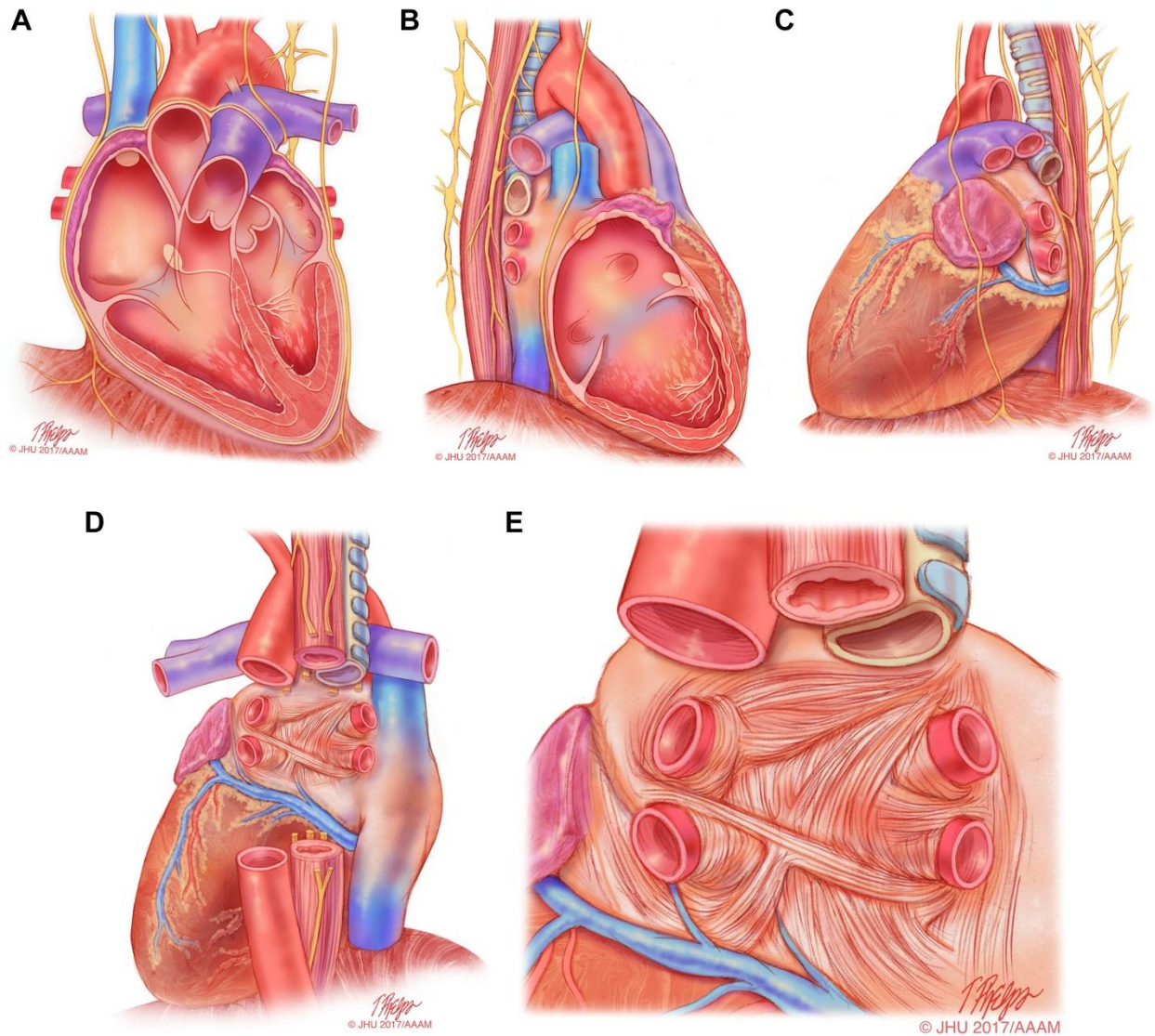
Decisions regarding continuation of systemic anticoagulation more than 2 months post ablation should be based on the patient's stroke risk profile and not on the perceived success or failure of the ablation procedure. (COR I; LOE C-EO)

In patients who have not been anticoagulated prior to catheter ablation of AF or in whom anticoagulation with a NOAC or warfarin has been interrupted prior to ablation, administration of a NOAC 3 to 5 hours after achievement of hemostasis is reasonable postablation. (COR IIa; LOE C-EO)

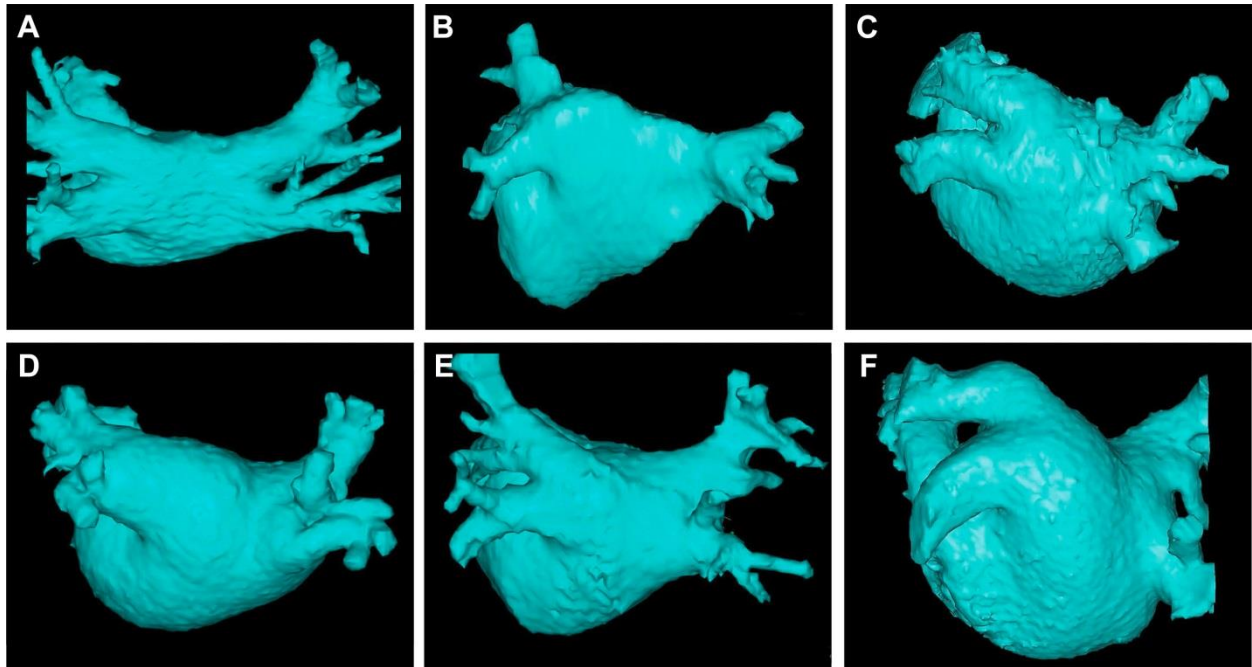
Patients in whom discontinuation of anticoagulation is being considered based on patient values and preferences should consider undergoing continuous or frequent ECG monitoring to screen for AF recurrence. (COR IIb; LOE C-EO)

\*Time in therapeutic range (TTR) should be > 65% – 70% on warfarin.



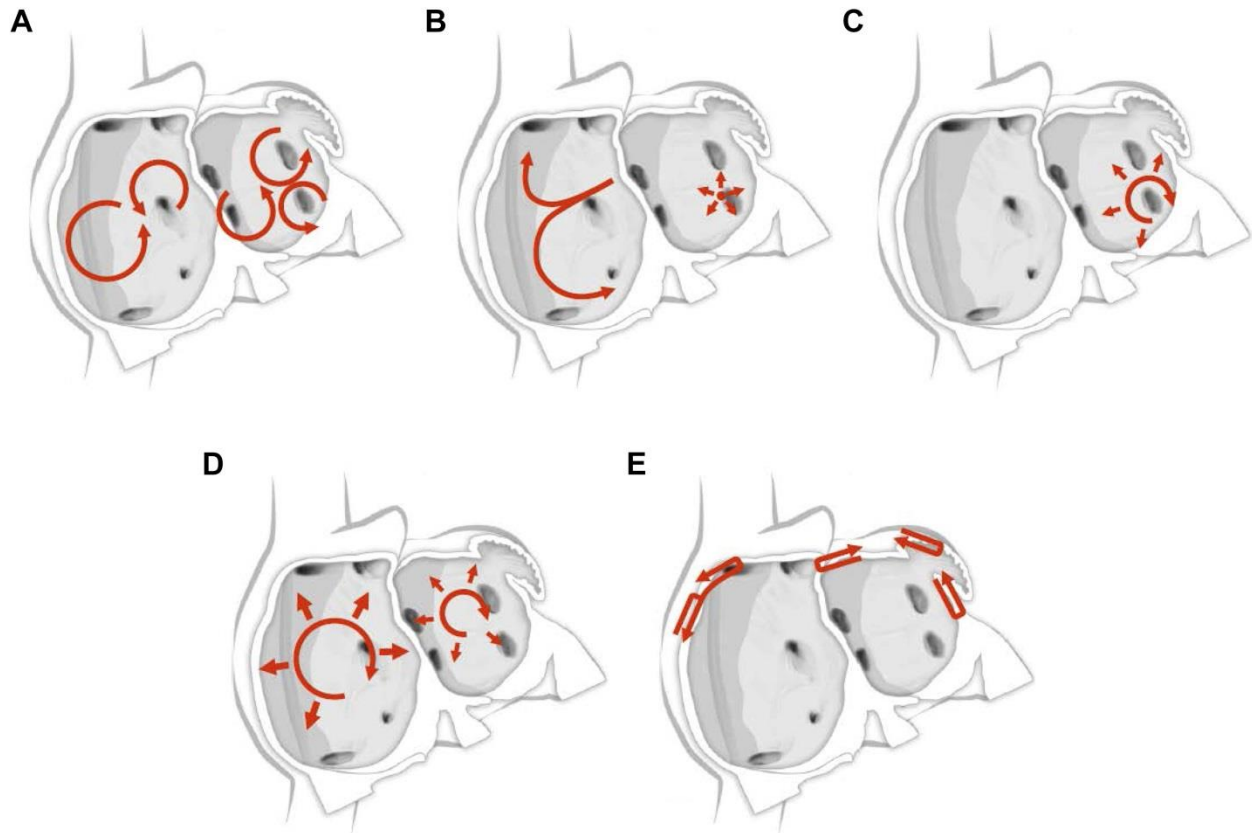


**Figure 1.** Anatomical drawings of the heart relevant to AF ablation. This series of drawings shows the heart and associated relevant structures from four different perspectives relevant to AF ablation. This drawing includes the phrenic nerves and the esophagus. **A:** The heart viewed from the anterior perspective. **B:** The heart viewed from the right lateral perspective. **C:** The heart viewed from the left lateral perspective. **D:** The heart viewed from the posterior perspective. **E:** The left atrium viewed from the posterior perspective. *Illustration: Tim Phelps © 2017 Johns Hopkins University, AAM.*

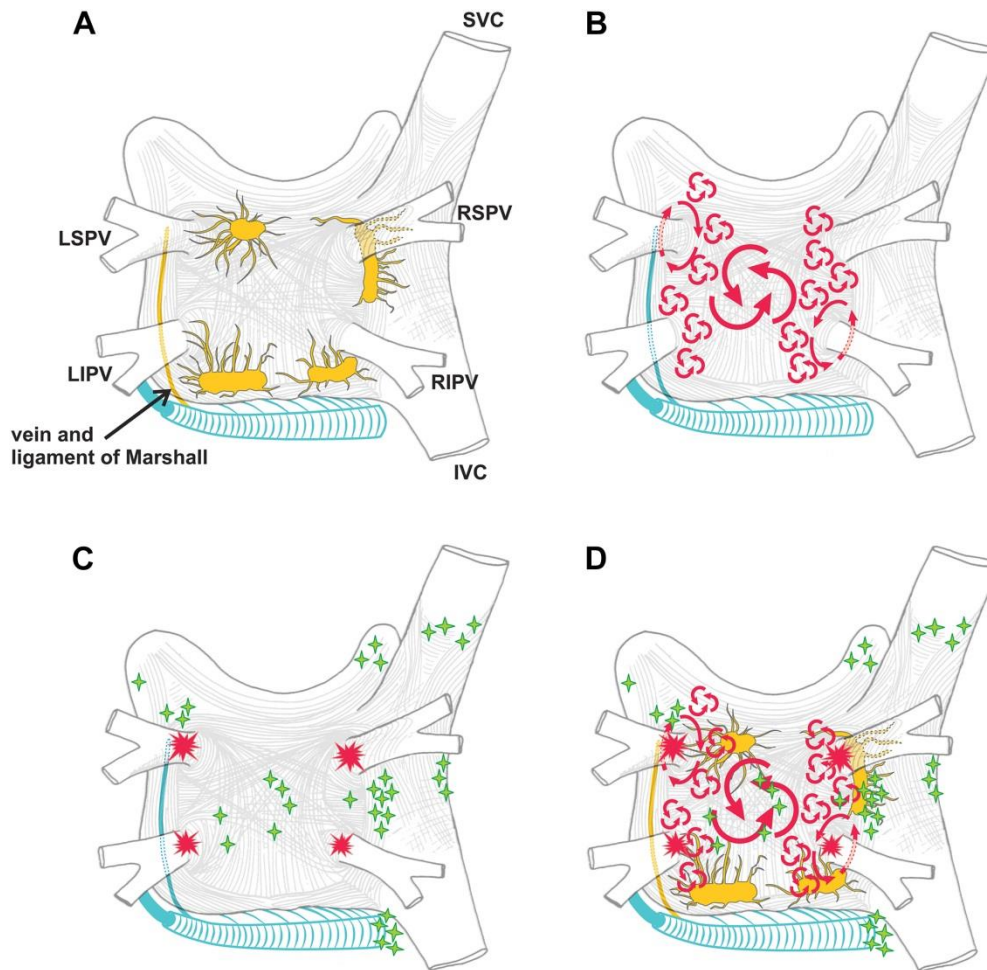


**Figure 2.** This figure includes six CT or MR images of the left atrium and pulmonary veins viewed from the posterior perspective. Common and uncommon variations in PV anatomy are shown. **A:** Standard PV anatomy with 4 distinct PV ostia. **B:** Variant PV anatomy with a right common and a left common PV. **C:** Variant PV anatomy with a left common PV with a short trunk and an anomalous PV arising from the right posterior left atrial wall. **D and E:** Variant PV anatomy with a common left PV with a long trunk. **F:** Variant PV anatomy with a massive left common PV.

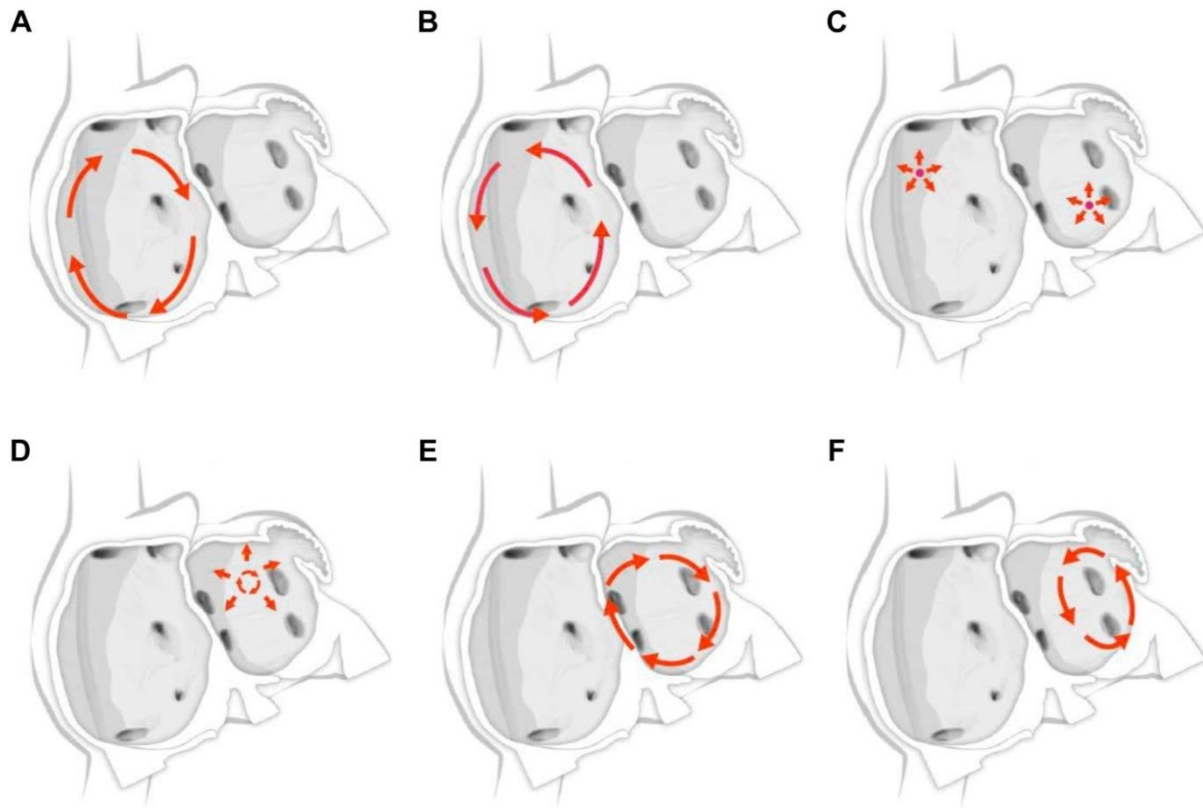




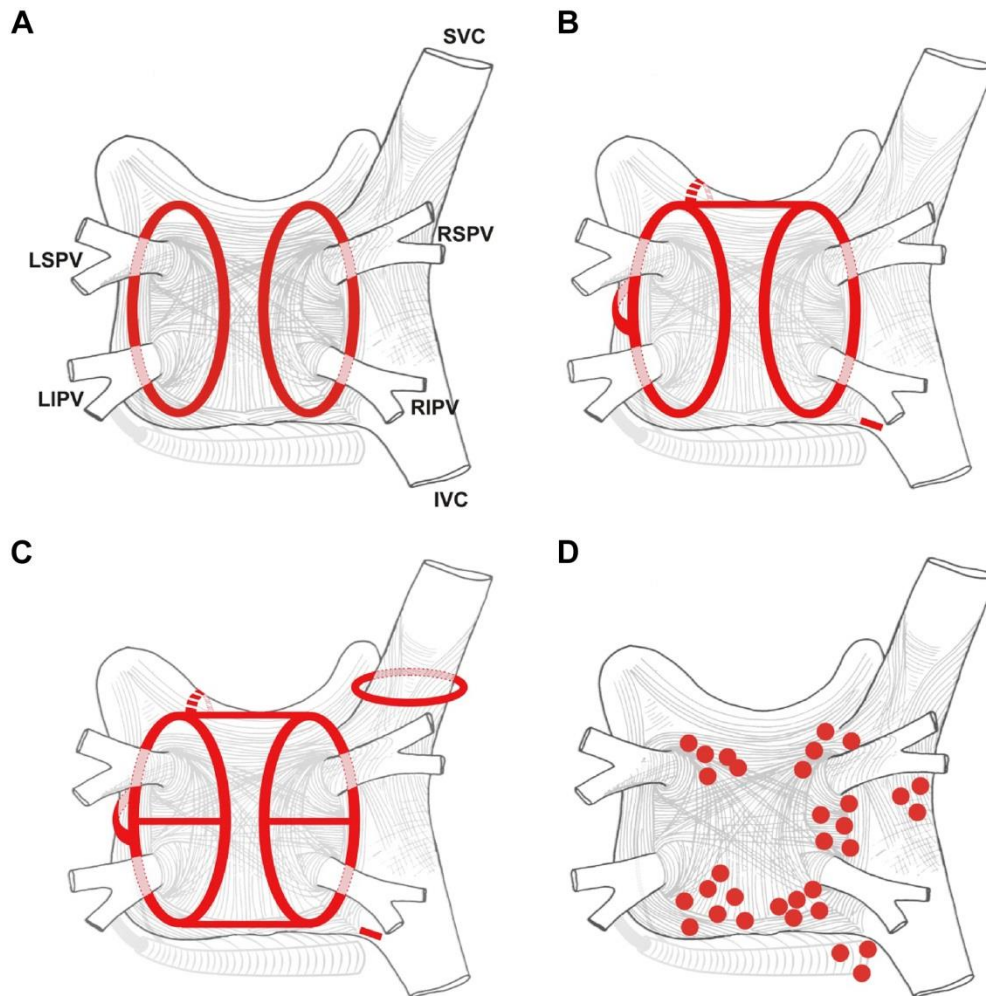
**Figure 3.** Schematic drawing showing various hypotheses and proposals concerning the mechanisms of atrial fibrillation. **A:** Multiple wavelets hypothesis. **B:** Rapidly discharging automatic foci. **C:** Single reentrant circuit with fibrillatory conduction. **D:** Functional reentry resulting from rotors or spiral waves. **E:** AF maintenance resulting from dissociation between epicardial and endocardial layers, with mutual interaction producing multiplying activity that maintains the arrhythmia.



**Figure 4.** Structure and mechanisms of atrial fibrillation. **A:** Schematic drawing of the left and right atria as viewed from the posterior perspective. The extension of muscular fibers onto the PVs can be appreciated. Shown in yellow are the five major left atrial autonomic ganglionic plexi (GP) and axons (superior left GP, inferior left GP, anterior right GP, inferior right GP, and ligament of Marshall). Shown in blue is the coronary sinus, which is enveloped by muscular fibers that have connections to the atria. Also shown in blue is the vein and ligament of Marshall, which travels from the coronary sinus to the region between the left superior PV and the left atrial appendage. **B:** The large and small reentrant wavelets that play a role in initiating and sustaining AF. **C:** The common locations of PV (red) and also the common sites of origin of non-PV triggers (shown in green). **D:** Composite of the anatomic and arrhythmic mechanisms of AF. Adapted with permission from Calkins et al. *Heart Rhythm* 2012;9:632–696.e21.

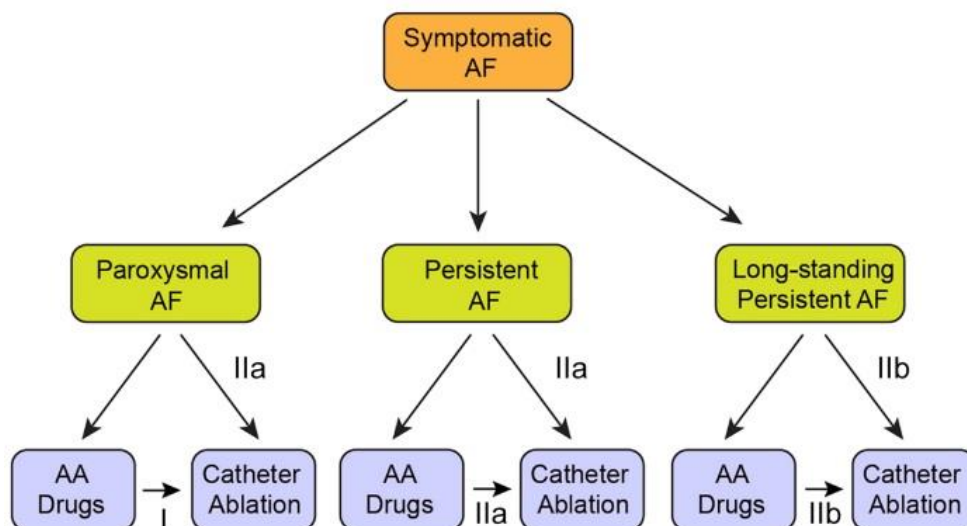


**Figure 5.** Schematic drawing showing mechanisms of atrial flutter and atrial tachycardia. **A:** Isthmus-dependent reverse common (clockwise) atrial flutter. **B:** Isthmus-dependent common (counter clockwise) atrial flutter. **C:** Focal atrial tachycardia with circumferential spread of activation of the atria (can arise from multiple sites within the left and right atrium). **D:** Microreentrant atrial tachycardia with circumferential spread of activation of the atria. **E:** Perimitral atrial flutter. **F:** Roof-dependent atrial flutter.



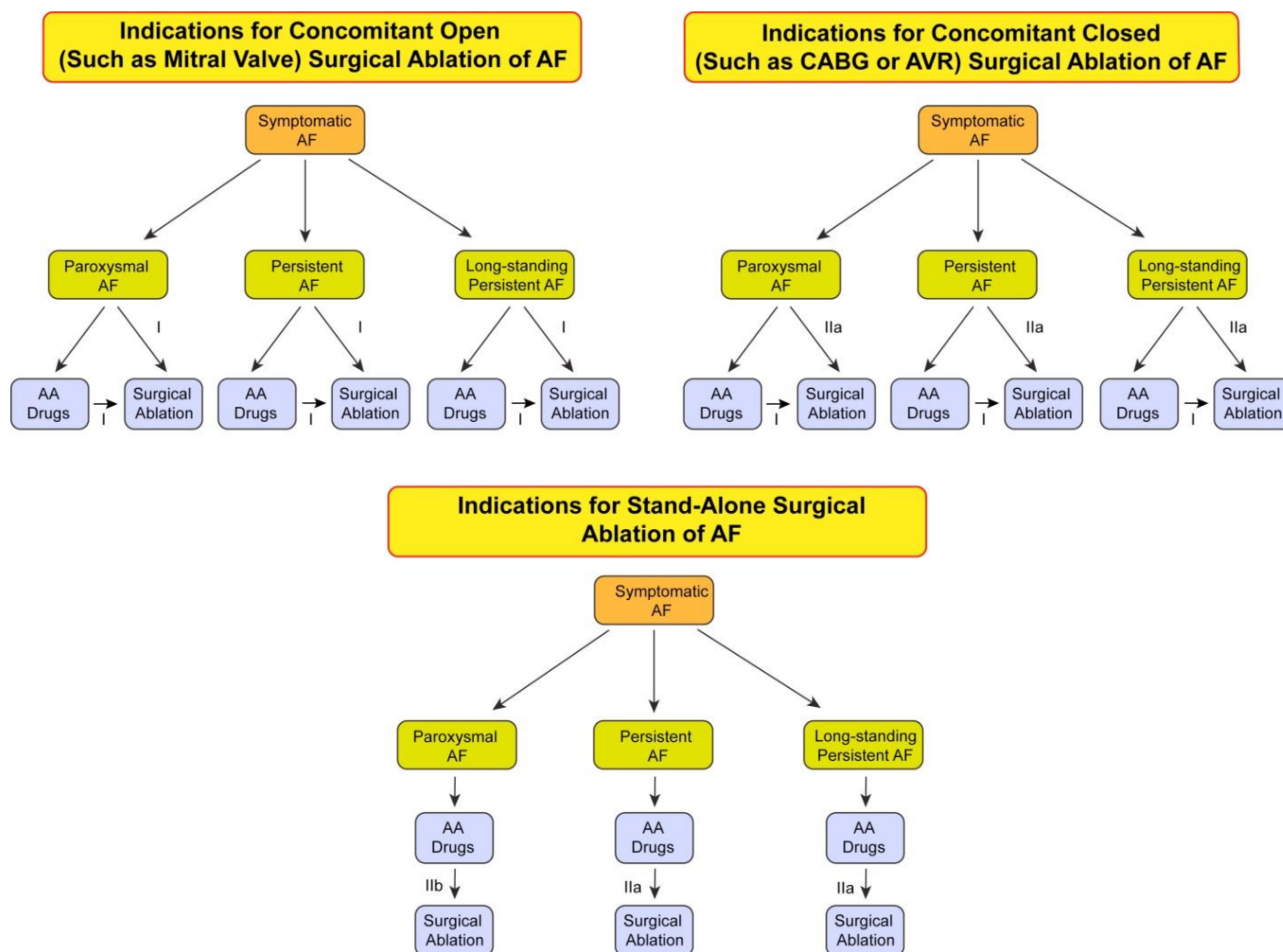
**Figure 6.** Schematic of common lesion sets employed in AF ablation. **A:** The circumferential ablation lesions that are created in a circumferential fashion around the right and the left PVs. The primary endpoint of this ablation strategy is the electrical isolation of the PV musculature. **B:** Some of the most common sites of linear ablation lesions. These include a “roof line” connecting the lesions encircling the left and/or right PVs, a “mitral isthmus” line connecting the mitral valve and the lesion encircling the left PVs at the end of the left inferior PV, and an anterior linear lesion connecting either the “roof line” or the left or right circumferential lesion to the mitral annulus anteriorly. A linear lesion created at the cavotricuspid isthmus is also shown. This lesion is generally placed in patients who have experienced cavotricuspid isthmus-dependent atrial flutter clinically or have it induced during EP testing. **C:** Similar to 6B, but also shows additional linear ablation lesions between the superior and inferior PVs resulting in a figure of eight lesion sets as well as a posterior inferior line allowing for electrical isolation of the posterior left atrial wall. An encircling lesion of the superior vena cava (SVC) directed at electrical isolation of the SVC is also shown. SVC isolation is performed if focal firing from the SVC can be demonstrated. A subset of operators empirically isolates the SVC. **D:** Representative sites for ablation when targeting rotational activity or CFAEs are targeted. Modified with permission from Calkins et al. *Heart Rhythm* 2012;9:632–696.e21.

Indications for Catheter Ablation of Symptomatic Atrial Fibrillation

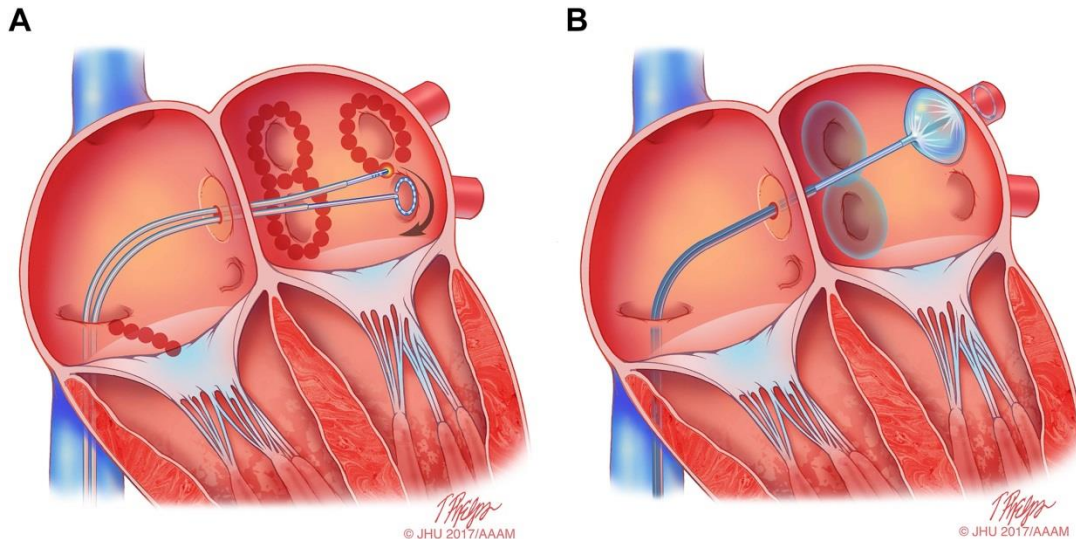


**Figure 7.** Indications for catheter ablation of symptomatic atrial fibrillation. Shown in this figure are the indications for catheter ablation of symptomatic paroxysmal, persistent, and long-standing persistent AF. The Class for each indication based on whether ablation is performed after failure of antiarrhythmic drug therapy or as first-line therapy is shown.





**Figure 8.** Indications for surgical ablation of atrial fibrillation. Shown in this figure are the indications for surgical ablation of paroxysmal, persistent, and longstanding persistent AF. The Class for each indication based on whether ablation is performed after failure of antiarrhythmic drug therapy or as first-line therapy is shown. The indications for surgical AF ablation are divided into whether the AF ablation procedure is performed concomitantly with an open surgical procedure (such as mitral valve replacement), a closed surgical procedure (such as coronary artery bypass graft surgery), or as a stand-alone surgical AF ablation procedure performed solely for treatment of atrial fibrillation.



**Figure 9.** Schematic drawing showing catheter ablation of atrial fibrillation using either RF energy or cryoballoon AF ablation. **A:** Shows a typical wide area lesion set created using RF energy. Ablation lesions are delivered in a figure of eight pattern around the left and right PV veins. Also shown is a linear cavotricuspid isthmus lesion created for ablation of typical atrial flutter in a patient with a prior history of typical atrial flutter or inducible isthmus-dependent typical atrial flutter at the time of ablation. A multi-electrode circular mapping catheter is positioned in the left inferior PV. **B:** Shows an ablation procedure using the cryoballoon system. Ablation lesions have been created surrounding the right PVs, and the cryoballoon ablation catheter is positioned in the left superior PV. A through the lumen multi-electrode circular mapping catheter is positioned in the left superior PV. *Illustration: Tim Phelps © 2017 Johns Hopkins University, AAM.*



This consensus statement was developed in partnership with and endorsed by the European Heart Rhythm Association (EHRA), the European Cardiac Arrhythmia Society (ECAS), the Asia Pacific Heart Rhythm Society (APHRS), and the Latin American Society of Cardiac Stimulation and Electrophysiology (Sociedad Latinoamericana de Estimulación Cardíaca y Electrofisiología [SOLAECE]) and was developed in collaboration with and endorsed by the Society of Thoracic Surgeons (STS), the American College of Cardiology (ACC), the American Heart Association (AHA), the Canadian Heart Rhythm Society (CHRS), the Japanese Heart Rhythm Society (JHRS), and the Brazilian Society of Cardiac Arrhythmias (Sociedade Brasileira de Arritmias Cardíacas [SOBRAC]).

This consensus statement is provided as an educational service of the Heart Rhythm Society (HRS). It is designed to provide the HRS members with expert consensus recommendations to assist the decision making in patient care. It is based on an assessment of current scientific and clinical information, which was interpreted by expert committee of physicians who specialize in electrophysiology and approved by the HRS Board of Trustees. It is not intended to include all possible proper methods of care for a particular cardiologic problem or all legitimate criteria for choosing to use a specific procedure. Neither is it intended to exclude any reasonable alternative methodologies. The HRS recognizes that specific patient care decisions are the prerogative of the patient and the physician caring for the patient and are based on all of the circumstances involved. Physicians are encouraged to carefully review the full statement published by the HRS so they understand all recommendations associated with care of these patients.

The HRS develops these summaries as educational tools for electrophysiologists, family members, caregivers, and the public. You may download and retain a single copy for your personal use. Please contact [clinicaldocs@hrsonline.org](mailto:clinicaldocs@hrsonline.org) to learn about options for sharing this content beyond your personal use.