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Society Guidelines

Canadian Cardiovascular Society Atrial Fibrillation Guidelines 2010: Catheter Ablation for Atrial Fibrillation/Atrial Flutter

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ABSTRACT

Catheter ablation of atrial fibrillation (AF) offers a promising treatment for the maintenance of sinus rhythm in patients for whom a rhythm control strategy is desired. While the precise mechanisms of AF are incompletely understood, there is substantial evidence that in many cases (particularly for paroxysmal AF), ectopic activity most commonly located in and around the pulmonary veins of the left atrium plays a central role in triggering and/or maintaining arrhythmic episodes. Catheter ablation involves electrically disconnecting the pulmonary veins from the rest of the left atrium to prevent AF from being triggered. Further substrate modification may be required in patients with more persistent AF. Successful ablation of AF has never been shown to alter mortality or obviate the need for oral anticoagulation; thus, the primary indication for this procedure should be improvement of symptoms caused by AF. The success rate of catheter ablation for AF is superior to the efficacy of antiarrhythmic drugs, but success is still in the range of 75%-90% after 2 procedures. Ablation is also associated

RÉSUMÉ

L'ablation par cathéter est un traitement reconnu visant le maintien du rythme sinusal chez les patients atteints de fibrillation auriculaire (FA) ou de flutter auriculaire. Il a été démontré que dans la majorité des cas de FA (et particulièrement sa forme paroxystique), cette arythmie est déclenchée par des salves d'extrasystoles qui prennent origine dans les veines pulmonaires. L'ablation par cathéter, réalisée par cautérisations à la jonction des veines pulmonaires et de l'oreillette gauche, isole les foyers initiateurs de l'arythmie. Lors de l'intervention, d'autres cautérisations peuvent être effectuées dans les oreillettes, pour tenter d'éliminer le substrat de l'arythmie, notamment dans les cas de FA persistante. Il n'est pas encore démontré que cette procédure est associée à une réduction de la mortalité ou du risque thrombo-embolique. Son indication actuelle est essentiellement d'améliorer les symptômes de la FA. L'ablation par cathéter est plus efficace que les médicaments antiarythmiques pour le maintien du rythme sinusal chez les patients avec FA. Son taux de succès (absence de récidive d'arythmie) est de 75-90 % après 1-2 procédures. Par contre, le taux

As discussed in detail by Gillis et al,[1] studies have failed to show that a rhythm control strategy improves mortality or reduces the incidence of thromboembolic complications in atrial fibrillation (AF) compared to the use of rate control alone. Thus, the decision to pursue rhythm control should be directed to patients who are symptomatic with their AF despite rate control,

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This statement was developed following a thorough consideration of medical literature and the best available evidence and clinical experience. It represents the consensus of a Canadian panel comprised of multidisciplinary experts on this topic with a mandate to formulate disease-specific recommendations. These recommendations are aimed to provide a reasonable and practical approach to care for specialists and allied health professionals obliged with the duty of bestowing optimal care to patients and families, and can be subject to change as scientific knowledge and technology advance and as practice patterns evolve. The statement is not intended to be a substitute for physicians using their individual judgment in managing clinical care in consultation with the patient, with appropriate regard to all the individual circumstances of the patient, diagnostic and treatment options available and available resources. Adherence to these recommendations will not necessarily produce successful outcomes in every case.

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with a complication rate of 2%-3%. Thus, ablation should primarily be used as a second-line therapy after failure of antiarrhythmic drugs. In contrast to AF, catheter ablation of atrial flutter has a higher success rate with a smaller incidence of complications. Thus, catheter ablation for atrial flutter may be considered a first-line alternative to antiarrhythmic drugs.

de complications majeures est important, de l'ordre de 2-3 %. Aussi, l'ablation par cathéter ne doit elle être considérée que chez les patients avec FA symptomatique et qui ne répondent pas au traitement pharmacologique. L'ablation par cathéter du flutter auriculaire est encore plus efficace et comporte moins de risques. Elle peut donc être considérée en première intention, comme alternative aux médicaments antiarythmiques.

with the aim of improving quality of life. Many of these symptomatic patients, such as younger patients with "lone" AF, were underrepresented in trials comparing rate and rhythm control. Furthermore, in all of these trials, antiarrhythmic drug therapy was used for the rhythm control strategy. Antiarrhythmic drugs remain "first-line" therapy for the maintenance of sinus rhythm, but these medications have only modest efficacy at maintaining sinus rhythm over the long term. They are also associated with side effects, in particular proarrhythmia, which limit their long-term use, especially in younger patients. Catheter ablation offers an alternative to maintaining sinus rhythm when drugs have been ineffective or cannot be tolerated. Data have shown that the success rate of catheter ablation in maintaining sinus rhythm is superior to that of drug therapy and is associated with improved quality of life (see later). While there are clearly upfront risks associated with this invasive procedure, the risks have decreased substantially over time and, if successful, the procedure obviates the long-term risks of antiarrhythmic drugs. Thus, for many highly symptomatic patients who cannot be pharmacologically controlled, catheter ablation offers a promising alternative.

Mechanism of Action of Catheter Ablation of AF

Catheter ablation for AF should be distinguished from atrioventricular (AV) junction ablation and pacemaker implantation, which is used for rate control but for not maintenance of sinus rhythm. It should also be distinguished from catheter ablation of typical right atrial flutter, which is a distinct procedure (described later in this article). Catheter ablation of AF aims to eliminate both the triggers of AF and the substrate that maintains AF, to achieve long-term sinus rhythm.

While the mechanism of AF is very complex, rapid ectopic activity from the pulmonary veins (PVs) may be responsible for both triggering and maintaining AF, in particular paroxysmal AF.[2] Scherf and colleagues[3] first described how rapidly firing ectopic foci within the atria could degenerate the atria into a fibrillatory rhythm. It was the seminal report by Haissaguerre and colleagues,[4] however, that first applied this principle in clinical practice. In their report, they described how most of the triggering foci for AF in the human originated in or around the PVs of the left atrium (LA). More than 90% of the foci originate in this region, with 10% originating in other areas such as the LA posterior wall, interatrial septum, coronary sinus, superior vena cava, and crista terminalis in the right atrium (RA).[4] By ablating around the PVs and electrically isolating them from the rest of the atria, the triggering foci can be eliminated and AF prevented (Fig. 1). The procedure is sometimes referred to as a "pulmonary vein isolation" procedure for this reason. Over time, this technique has proved to be widely effective at maintaining sinus rhythm, particularly in patients with paroxysmal AF, and has evolved to become the cornerstone of AF catheter ablation procedures.[5]

In patients with more persistent AF, electrical and structural remodelling of the atria occur, creating an abnormal atrial substrate that tends to perpetuate AF.[6] Changes include a decrease in atrial refractoriness, atrial fibrosis, and atrial stretch.[7] Thus, while PV isolation remains the primary AF ablation approach in persistent AF, it is believed that further ablation of the substrate is required to treat AF in this population. The most common forms of substrate modification are linear ablation and electrogram-guided ablation. Linear ablation involves creating lines of block along the LA roof and the mitral annulus and occasionally in the RA, mimicking the original surgical maze procedure.[8] Electrogram-guided ablation involves targeting specific electrical signals (eg, complex "fractionated" signals) that may represent critical areas of AF perpetuation.[9] The optimal strategy of substrate modification remains an area of active investigation.

Procedural Considerations

AF ablation is a complex procedure, requiring a high degree of operator expertise and advanced technological support.

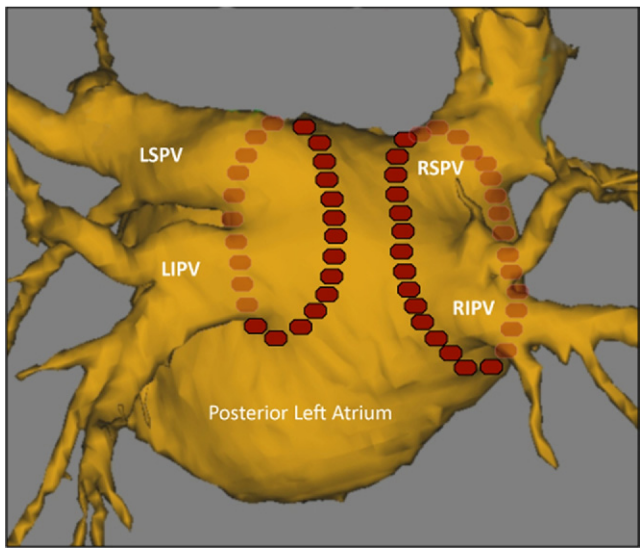

Figure 1. Ablation lesion set for pulmonary vein isolation. Computed tomography scan of the posterior view of the left atrium including the pulmonary veins. Veins are labelled as follows: LSPV, left superior; LIPV, left inferior; RSPV, right superior; RIPV, right inferior pulmonary vein. The *red dots* represent point-by-point ablation lesions created by radiofrequency energy in the left atrium surrounding the pulmonary veins, thus electrically disconnecting them from the rest of the atrium. The *darker dots* represent lesions on the posterior wall of the left atrium, and the *lighter dots* represent circumferential lesions along the anterior aspect of the left atrium.

While AF ablation is performed as an outpatient, day procedure, the intervention often takes about 3-5 hours or longer to complete. Patients need to be orally anticoagulated with warfarin for at least 1-2 months prior to the procedure and at least 3-6 months postablation to minimize the risk of a thromboembolic complication. Some centres will routinely perform preprocedural transesophageal echocardiography to rule out atrial thrombus prior to performing the ablation.[10]

The procedure itself may be performed under general anaesthesia or heavy conscious sedation using benzodiazepines and/or opiates.[11,12] The entire procedure is performed through systemic venous access via the femoral and/or subclavian or internal jugular veins. Access to the LA is achieved by performing a transseptal puncture across the interatrial septum to cross from the RA to the LA. Because the major focus for ablation is in the LA, the patient is systemically anticoagulated to minimize thromboemboic events. In general, the procedure is performed with the patient adequately anticoagulated, either by sustaining the preprocedure warfarin (usually allowing the INR to fall to the lower end of the therapeutic range) or with use of bridging low-molecular-weight heparin both before and after the procedure. In the latter case, unfractionated heparin is administered with access to the LA. Likewise, bridging low-molecular-weight heparin is reinitiated within hours of the sheath removal and continued until a therapeutic INR is reestablished with oral anticoagulant therapy. The anatomy and electrical activity of the LA are often reconstructed using a 3-dimensional mapping system that then guides the rest of the procedure. Ablation is most commonly performed with radiofrequency energy delivered from a catheter tip. Technologies are evolving, however, to use different catheter designs and energy sources to maximize energy delivery while minimizing the risks, such as perforation.

Following ablation, patients are evaluated at regular intervals with electrocardiograms and Holter monitoring to determine the success of the procedure. Early recurrences of AF may occur within the first 3 months postablation due to acute inflammation in the LA but do not necessarily indicate long-term failure of the procedure; at least 50% of these recurrences will resolve spontaneously after 3 months.[13,14]

Efficacy of Catheter Ablation for AF

Since AF ablation was first described >10 years ago, the technique and technology have evolved such that fairly consistent success rates can be achieved for patients with paroxysmal AF and minimal associated structural heart disease.[15] In these patients, the success rate of maintaining sinus rhythm off antiarrhythmic drug therapy is 60%-75% after 1 procedure and 75%-90% after 2 procedures.[12] In a recent meta-analysis of 6 clinical trials that compared ablation with antiarrhythmic drug therapy in a total of 693 patients, ablation was associated with a significantly increased odds of freedom from AF at 12 months (odds ratio [OR] 9.74; 95% confidence interval [CI] 3.98-23.87).[16] Ablation was also associated with a decreased rate of cardiovascular hospitalization (OR 0.15; 95% CI 0.10-0.23). These results were achieved with a repeat ablation rate of 17%. The results were also quite consistent between trials.[17] In a recent multicenter, randomized trial comparing catheter ablation with antiarrhythmic drug therapy, 66% of patients maintained sinus rhythm off drugs after a single ablation of paroxysmal AF compared with only 16% with antiarrhythmic drug therapy alone.[18] Ablation also resulted in a significant improvement in quality of life. Another trial has demonstrated similar results.[19] Failures most commonly occur as a result of electrical reconnection between the PVs and the LA due to recovery of previous ablation sites.[20] Improved outcomes have been demonstrated with repeat procedures to isolate electrically reconnected PVs. Technologies that will help create more permanent lesions during the first ablation may improve long-term success rates and decrease the need for repeat procedures.

In patients with persistent AF, the success rates are 10%-15% lower than those described for paroxysmal AF with a higher need for repeat procedures.[21] This lower success rate is predominantly due to the fact that the substrate has to be targeted and ablated in addition to PV isolation, meaning more complex and lengthy procedures. Furthermore, the optimal lesion set to target the substrate has yet to be fully determined, although there are data to suggest that hybrid techniques targeting more than just PV isolation may be required.[22] With 2 procedures, the success rate of ablation for persistent AF may approach the success rates for paroxysmal AF.[21] Lower success rates (by 5%-10% compared with paroxysmal AF) have also been reported in patients with structural heart disease, such as cardiomyopathy,[23] although the benefit in this population may still be significant. The PABA-CHF trial, for example, reported improvements in ejection fraction in patients with congestive heart failure despite the lower overall procedural success rate.[24]

In patients who do not have a successful outcome postablation, some may become responsive to antiarrhythmic drug therapy that was previously ineffective. While many patients undergoing ablation wish to discontinue antiarrhythmic drugs, those who cannot maintain sinus rhythm postablation may achieve good rhythm control with adjuvant antiarrhythmic drug therapy.

Most studies have looked at 1-year outcomes for AF ablation. Very few longer-term data are available. It appears that after 12-18 months, most patients will continue to do well, but 5%-10% of patients will have late recurrences beyond that time period.[25-28] Further data are required to understand better the long-term durability of the results of AF ablation.

Risks of Catheter Ablation of AF

As with any invasive procedure, catheter ablation of AF is associated with procedural risk. While the risk of any complication was reported to be 6%-8% in early experiences,[29] these risks have decreased appreciably in the past 5 years[30] and are currently in the range of 2%-3%. The most common risk is a vascular access complication such as hematoma, pseudoaneurysm, and AV fistula, occurring in 1%-2% of cases. Less common but more serious risks include those of cardiac perforation (0.5%-1%) and thromboembolism (0.5%-1%). Cardiac perforation can often be managed by percutaneous drainage (pericardiocentesis), although surgical repair is rarely required. Acute thromboembolic stroke results in transient deficits in most affected patients. Pulmonary vein stenosis used to be a more common complication when ablation was initially performed by ablation within the PVs. However, current ablation techniques deliver energy outside of the PVs within the LA, thus avoiding the stenosis hazard and making this complication quite uncommon today (<0.5%).

Fatal complications are quite rare, occurring in approximately 1:1000 cases. However, because of the proximity of the esophagus to the posterior LA wall, the esophagus may be damaged as a result of ablation in the LA. Rarely, this damage can result in a fistula forming between the LA and esophagus, which most often presents 2-4 weeks postablation as an unexplained fever with or without chest pain and unexplained neurologic events.[31] Because this complication often goes unrecognized, it leads to sepsis and death. Use of lower power outputs during ablation, esophageal monitoring, and postprocedural proton pump inhibition may all reduce the already small risk of this complication.

Candidates for Catheter Ablation of AF

The decision to pursue a strategy of maintaining sinus rhythm should be aimed at reduction of patient symptoms.[1] To date, there are no clinical trial data available demonstrating a reduction in mortality or stroke through maintenance of sinus rhythm, including through the use of catheter ablation. Thus, the primary indication for catheter ablation is in patients with symptomatic AF for whom the symptoms are adversely affecting quality of life. Patients with totally asymptomatic AF are not candidates for ablation, with the possible exception of patients in whom AF is thought to be adversely affecting left ventricular function (such as with tachycardia-induced cardiomyopathy). Antiarrhythmic drug therapy is still considered first-line therapy for maintenance of sinus rhythm,[5] while catheter ablation should only be considered for patients for whom adequate trials of drug therapy fail. This hierarchy generally means a trial of ≥2 drugs in most patients. More recent clinical trials have demonstrated superiority of ablation in patients for whom ≥1 antiarrhythmic drugs have failed, and these trials form the basis for a conditional recommendation for select patients to be considered for catheter ablation as the initial treatment of AF. Younger patients, for example, may want to avoid long-term amiodarone treatment use given the drug's accompanying (or cumulative) risks. Patients may also have cardiac or noncardiac absolute or relative contraindications to certain drugs[1] (see Table 3 in Gillis et al[1] in this issue). Also, patients are unlikely to benefit from specific medications if 1 medication in the same class has already failed.

RECOMMENDATION

We recommend catheter ablation of AF in patients who remain symptomatic following adequate trials of anti-arrhythmic drug therapy and in whom a rhythm control strategy remains desired (Strong Recommendation, Moderate-Quality Evidence).

Values and preferences. This recommendation recognizes that failure of multiple antiarrhythmic drugs results in few alternative strategies if maintenance of sinus rhythm is preferred based on symptom burden reduction and quality of life improvement.

We suggest catheter ablation to maintain sinus rhythm in select patients with symptomatic atrial fibrillation and mild-moderate structural heart disease who are refractory or intolerant to ≥1 antiarrhythmic medication (Conditional Recommendation, Moderate-Quality Evidence).

Table 1. Risk/benefit ratio for ablation in patients with symptomatic AF

	Longstanding*	Persistent	Paroxysmal
First-line	—	–	+
Failed first-line drug	—	+	++
Failed second-line drug	+	++	+++
Failed multiple drugs	++	+++	+++

+, Balance of risk and benefit in favour of catheter ablation.
*Ongoing symptomatic AF for ≥1 year.

Values and preferences. This recommendation recognizes that the balance of risk with ablation and benefit in symptom relief and improvement in quality of life must be individualized. It also recognizes that patients may have relative or absolute cardiac or noncardiac contraindications to specific medications.

Because most of the patients included in clinical trials to date have been with paroxysmal AF and because the success rate is higher in this population, these patients are favoured for ablation therapy. However, patients with symptomatic persistent AF are increasingly undergoing ablation. The risk/benefit ratio of performing catheter ablation for AF in various subtypes of AF is detailed in Table 1.

Practical tip. There is no formal definition for "adequate trials of anti-arrhythmic drug therapy" mentioned in the first recommendation. Early studies assessing AF ablation required that patients have failed therapeutic doses of ≥2 different antiarrhythmics.

This "strong" recommendation stems from both the data and the belief of the consensus committee that AF ablation be reserved for patients who have had trials of therapeutic doses of ≥2 different antiarrhythmics drugs prior to being considered for catheter ablation. Electing to perform ablation after a trial of <2 drugs may be appropriate in carefully selected patients but meets only a "conditional" recommendation based on the more limited availability of data to support this approach.

In highly selected patients, AF ablation may be offered as first-line therapy. Data from 1 small pilot study of 70 patients showed a 63% recurrence rate in the antiarrhythmic arm versus only 13% in the ablation arm ($P < .001$) with a significant reduction in hospitalization and improvement in quality of life.[32] In addition, although this has not been studied in detail, some patients with tachybrady syndrome are unable to tolerate drug therapy because of bradyarrhythmic complications in the absence of a permanent pacemaker. If the AF can be successfully ablated, then antiarrhythmic therapy and the need for permanent pacing may be avoided, especially in younger patients.[33]

RECOMMENDATION

We suggest catheter ablation to maintain sinus rhythm as first-line therapy for relief of symptoms in highly selected patients with symptomatic, paroxysmal atrial fibrillation (Conditional Recommendation, Low-Quality Evidence).

Values and preferences. This recommendation recognizes that individual patients may have a strong intolerance or aversion to antiarrhythmic drugs such that the risk of ablation is deemed warranted.

While there is no absolute age limit for ablation, most clinical experiences have included few patients ≥75 years old and almost no patients ≥80 years old due to concern of increased complication rates.

Finally, if the LA size is too enlarged (typically >55-mm diameter in the parasternal long-axis view on standard echo), the success rate of catheter ablation is poor. Thus, if ablation is to be considered, it should be done prior to severe LA enlargement.

Practical tip. The following represents a typical, but not exclusive, profile of a patient who is referred for consideration of AF ablation today:

Age <80 years

Patients who are *symptomatic* with their AF

Patients who have tried but failed or are intolerant of antiarrhythmic drug therapy

Paroxysmal AF or short-standing persistent AF

Minimal to moderate structural heart disease (eg, LV dysfunction or valvular disease).

Need for Anticoagulation With Catheter Ablation of AF

To date, there is no clinical evidence to suggest that successful catheter ablation of AF affects long-term stroke risk. One major reason is that some asymptomatic AF may continue to occur postablation undetected by intermittent monitoring. Data show that more intensive or continuous monitoring may detect episodes of asymptomatic AF in patients who have had a "successful" outcome,[34] and this AF may contribute to ongoing thromboembolic risk. Even in patients in whom AF is eliminated, there is a lack of data to support anticoagulation withdrawal in patients with other risk factors for stroke. Trials to evaluate this question are currently under way, including the large-scale CABANA study. At present, if a patient has sufficient risk to warrant oral anticoagulation for their AF preablation (eg, a $CHADS_2$ [**C**ongestive Heart Failure, **H**ypertension, **A**ge, **D**iabetes, **S**troke/Transient Ischemic Attack] risk score of ≥2), then it is recommended that oral anticoagulation be continued indefinitely postablation regardless of apparent procedural success.[35,36] Furthermore, because the very long-term results of ablation have not been fully elucidated beyond 2-5 years, the very late recurrence rate may also warrant ongoing anticoagulation. Avoidance of oral anticoagulation is not an indication for catheter ablation of AF at present.

Practical tip. AF ablation should not be considered as an alternative to oral anticoagulation. If a patient has a high thromboembolic risk profile (eg, $CHADS_2$ risk score of ≥2), then the patient should continue oral anticoagulation even after successful AF ablation. Studies of long-term monitoring have consistently shown asymptomatic episodes of AF both prior to and following ablation. Initiation of oral anticoagulation should also not be delayed when indicated in patients pending referral for AF ablation.

Catheter Ablation of AF

Typical right atrial flutter is a distinct arrhythmia from AF, although the 2 often coexist, occurring together in up to 40%-50% of patients with atrial flutter. Typical flutter is characterized by the classic "sawtooth" pattern on the electrocardiogram and often conducts 2:1 with a ventricular response of 150 beats per minute. Atrial flutter carries the same thromboembolic risk as AF and should be anticoagulated according to the same guidelines as AF. In contrast to AF, however, typical right atrial flutter involves a single reentrant circuit around the tricuspid annulus. By ablating a line along the isthmus that extends from the tricuspid annulus to the inferior vena cava, flutter can easily be eliminated in a single procedure with a success rate of >85%-90%.[37] Given the simplicity of this procedure (in contrast to AF ablation) with its accompanying low risk and given that atrial flutter is very hard to control pharmacologically, flutter ablation is recommended as an alternative first-line therapy to drugs. This has been supported by a number of clinical trials comparing atrial flutter ablation to drug therapy.[15,38] However, after elimination of AFL, over the next 5 years, approximately 60%-65% of patients will develop AF as a stand-alone problem.[39]

RECOMMENDATION

We recommend curative catheter ablation for symptomatic patients with typical atrial flutter as first line therapy or as a reasonable alternative to pharmacologic rhythm or rate control therapy (Strong Recommendation, Moderate-Quality Evidence).

Values and preferences. This recommendation recognizes the high efficacy, low complication rate of catheter ablation and low efficacy of pharmacologic therapy, whether rate or rhythm control.

Practical tip. Typical atrial flutter is more challenging to control medically with antiarrhythmic drugs than is AF and adequate rate control is more difficult to achieve. Given the high success rate and low complication rate of atrial flutter ablation, it is a strongly recommended as a first-line therapy in comparison to AF ablation.

Ablation of Accessory Pathways and Other Arrhythmias in AF

The presence of an accessory pathway (eg, Wolff-Parkinson-White syndrome) with evidence of preexcitation (delta wave) during AF presents a rare but potentially life-threatening situation.[40] If the pathway has a short refractory period, it may allow AF to conduct to the ventricles with a very high ventricular rate response. High ventricular rates can occasionally lead to degeneration into ventricular tachycardia or fibrillation, resulting in a cardiac arrest. Administration of an AV nodal blocking agent during preexcited AF can exacerbate this problem and should be avoided. In these cases, especially if the patient has a history of syncope or rapid AF, catheter ablation of the accessory pathway is strongly recommended to avoid any possibility of cardiac arrest.

RECOMMENDATION

In patients with evidence of ventricular preexcitation during AF, we recommend catheter ablation of the accessory pathway, especially if AF is associated with rapid ventricular rates, syncope, or a pathway with a short refractory period (Strong Recommendation, Low-Quality Evidence).

Values and preferences. This recommendation places a high value on the prevention of sudden cardiac death in patients at high risk and a low value on the small complication rate of catheter ablation of the accessory pathway.

RECOMMENDATION

In young patients with lone, paroxysmal AF, we suggest an electrophysiological study to exclude a reentrant tachycardia as a cause of AF; if present, we suggest curative ablation of the tachycardia (Conditional Recommendation, Very Low-Quality Evidence).

Values and preferences. This recommendation recognizes that supraventricular tachycardia can initiate AF when the substrate for AF is present and can be ablated with a high success rate and minimal risk.

In younger patients, other reentrant supraventricular tachycardias, such as AV nodal reentry or AV reentrant tachycardia using an accessory pathway, can degenerate into AF. Elimination of the reentrant tachycardia can therefore prevent episodes of AF. Thus, clear onset of AF resulting from another supraventricular tachycardia is an indication for seeking and eliminating the underlying tachycardia by ablation, if possible. If no such onset is clearly demonstrable, in younger patients it may be warranted to perform a general electrophysiological study prior to AF ablation, to look for and eliminate other underlying tachyarrhythmias, and assess the outcome prior to performing AF ablation.

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