Catheter Ablation of Cardiac Arrhythmias : Usually Cure, but Complications May Occur

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Editorial

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In cardiology, our ability to cure is rare. When cardiac disease is diagnosed, most of our treatments are palliative. They may remove or diminish complaints and prolong life but usually will not be able to stop the disease process. Cure is possible, however, in the patient suffering from a tachycardia in an otherwise normal heart. In that patient, we can locate the site of abnormal impulse formation or a critical part of the tachycardia pathway by cardiac activation mapping during the arrhythmia. Through the same or another catheter, radiofrequency (RF) energy can be applied to that area, resulting in destruction of a few millimeters of critical tissue and cure of the patient. That technique has been with us now for a decade.[1–4] During that decade, RF energy applied through a catheter has been shown to be very effective in different types of supraventricular tachycardia.

See p 262

A method can be effective, but its use may be limited because of complications. The key question, therefore, is, how safe is RF catheter ablation in the treatment of patients with arrhythmias? Certain risks are associated with RF ablation. They include the general risks of any cardiac catheterization, such as thromboembolic complications, infection, bleeding, cardiac perforation with or without cardiac tamponade, valvular damage, and radiation damage. In addition, specific risks are related to the ablation procedure itself.

To abolish the substrate of an arrhythmia, a small area of myocardial necrosis is necessary. It is difficult, however, to assess in vivo the amount of tissue destroyed by RF ablation. Several investigators have looked at the value of biochemical markers to estimate the amount of myocardial necrosis after ablation. Haines et al[5] showed that measurement of the creatine activity significantly underestimated the volume of myocardial injury because creatine kinase (CK) activity is not stable at temperatures >65°C, which are routinely attained within the central zone of RF ablation. A better marker to assess the size of necrosis seems to be the release of cardiac troponin I. Madrid et al[6] found elevated values in 44 of 46 patients after RF ablation. In their studies, cardiac troponin I release varied according to the site in the heart (atrium, AV node, accessory pathway, ventricle) at which the RF ablation was applied, was moderately related to the number of RF pulses, and reached a peak value 8 hours after ablation. Madrid et al found that cardiac troponin I had the greatest sensitivity (better than that of CK and CK-MB) for detecting minor myocardial damage. It is important to know that in vivo studies could not demonstrate a good correlation between lesion size as found at autopsy and the amount of energy delivered during ablation, the duration of RF application, and the degree of catheter contact.[7–9] More information about the value of cardiac troponin I to estimate cardiac damage after RF ablation is needed to obtain a better idea about the size of the area of necrosis, especially after multiple RF applications or the drawing of long ablation lines, as in atrial fibrillation.

When myocardial necrosis occurs during application of RF energy in a specific area like the atrioventricular (AV) node, complete AV block may occur. This has occurred more commonly in the so-called anterior approach to AV nodal tachycardia ablation, in which the AV nodal fast pathway is ablated rather than slow pathway ablation.[10] In patients with accessory AV pathways (APs), the risk of catheter ablation is related to the location of the accessory pathway. Ablation of a para-Hisian accessory pathway carries the risk of complete AV block. In epicardially located posteroseptal or left posterior bypasses, in which ablation has to be performed from the coronary venous system, there is the risk of damage to the coronary artery or perforation of the venous system, leading to cardiac tamponade. Also, in right free wall accessory pathways, the right coronary artery may be damaged.

How dangerous, therefore, is the application of a catheter ablative procedure in patients with a cardiac arrhythmia?

That question was addressed in the prospective multicenter study by Calkins et al[11] in this issue of *Circulation*. A total of 1050 consecutive patients participating in the clinical evaluation of a new RF catheter ablation system were included in the study. Ablation was performed in ≈50% of the patients because of an accessory AP, in 33% of the patients because of AV nodal reentrant tachycardia (AVRNT), and in 121 patients to interrupt conduction in the AV junction. Catheter ablation was successful in 95% of patients (100% in AV junction ablation, 97% in AVRNT, and 93% in APs). Within 1 month of the ablation, 3% of patients developed a major complication (such as

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death, stroke, myocardial infarction, complete AV block), and 8.2% a minor complication.

Complications occurred in all 3 groups of patients (AVNRT, AP, and AV junction) and were more common in patients with structural heart disease and multiple ablation targets. That they were found in patients who underwent ablation of the AV junction is not surprising. These patients more often have associated cardiac disease with diminished cardiac function. But complications also occurred in the patients with AVNRT and accessory AV pathways. There was a 1.3% (5 of 373 patients) and 1% (5 of 500 patients) incidence of complete AV block in patients with AVNRT and accessory pathways, respectively. It is not clear whether all patients with AVNRT underwent ablation of the slow AV nodal pathway (the study was performed between 1992 and 1995). Of the minor complications listed in Table 4 of the article by Calkins et al,[11] no information is given as to their effect on length of hospital stay and the financial consequences. Recurrences of arrhythmias occurred primarily in the patients with right free wall, posteroseptal, septal, and multiple accessory pathways and were found in 6% of the patients. These locations of accessory pathways more likely to have arrhythmia recurrences are well known and are related to greater difficulty in obtaining correct catheter-tissue contact to achieve adequate tissue heating.

The findings on complications of RF ablation from the prospective multicenter study by Calkins et al are not very different from those found in the earlier Multicenter European Radiofrequency Survey reported by Hindricks.[12] In that retrospective study, in which 2222 patients with accessory APs were treated by catheter ablation in the years 1987 to 1992, 14 patients (0.63%) developed complete AV block, 16 patients (0.72%) cardiac perforation with or without tamponade, and 12 patients clinically significant pericardial effusion. In 3 patients, death was thought to be related to the procedure. Both Calkins et al and Hindricks indicate that patient load and the experience of the center at which the ablation is performed are important determinants of success and complication rate.

The study by Calkins et al[11] shows that RF catheter ablation can be performed with a high degree of success in patients with AVNRT and accessory APs. But in view of the sometimes serious complications, catheter ablation should be suggested only when the tachycardias are symptomatic and interfere with the well-being of the patient. The procedure should be performed in specialized centers by clinical electrophysiologists with extensive experience in the investigation of patients with AVNRT and accessory AV pathways. In patients with accessory pathways in the right free wall, epicardial posteroseptal, epicardial left posterior, and para-Hisian locations, the threshold to perform ablation should be higher, because of the higher incidence of complications. Rarely will there be an indication for catheter ablation in the asymptomatic patient with AV conduction over an accessory pathway, probably only in the case of an occupational hazard (airline pilot, bus driver, or athlete). In the patient with an accessory pathway who has rare and well-tolerated episodes of tachycardia, the value of vagal maneuvers should be explained and pharmacological treatment, either intravenous or oral, given only when the tachycardia cannot be terminated by a vagal maneuver. For intravenous use, adenosine or verapamil is preferred for an orthodromic circus movement tachycardia and procainamide for atrial fibrillation. For oral drug treatment, sotalol or class Ic drugs can be used.

In the patient with AVNRT, RF modification of AV nodal conduction carries the risk of AV block. Therefore, patients are instructed about vagal maneuvers, and long-term drug therapy is prescribed only when tachycardias are frequent and poorly tolerated. If therapy with drugs such as digoxin, calcium antagonists, or β-blockers is not succesful or not tolerated, RF catheter treatment is advised. As in the patient with an accessory pathway, in case of a rare and well-tolerated AVNRT, drug treatment is given only when a tachycardia occurs following an approach similar to that discussed under circus movement tachycardia.

It is important to note that in the study by Calkins et al,[11] no differences were found between children and adults with regard to success and complications. Previously, concern was expressed about RF ablation in the small child because of a possible increase in size of the RF lesion when the heart enlarges,[13] and it was considered prudent to abstain from an RF intervention until the child had reached the age of 10 years.[14] However, current information suggests that ablation should be postponed until the child weighs $>$15 kg.[15]

In conclusion, RF ablation usually results in cure in patients with supraventricular tachycardia. However, the possibility of complications should always be considered. The information from the study by Calkins et al[11] is helpful in making a risk profile for the individual patient.

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