Catheter Ablation Techniques in Patients with Supraventricular Tachycardia

Melvin M. Scheinman, M.D.

Catheter ablation is an experimental procedure that may prove useful for patients with drug-refractory supraventricular tachycardia. Current techniques involve the use of high-energy direct-current shocks, delivered via electrode catheters. These techniques have been used most commonly for ablating the atrioventricular (AV) junction in patients with supraventricular tachycardia. Such ablation may be of value in a subset of patients with the Wolff-Parkinson-White syndrome. In addition, limited data suggest that direct catheter ablation of postero-septal accessory pathways may prove safe and effective when shocks are applied just outside the ost of the coronary sinus. Catheter ablation has also been used in small numbers of patients with ectopic atrial tachycardia. The chief limitation of catheter ablation of the AV junction is the induction of pacemaker dependency. Successful ablation of an accessory pathway or of an ectopic atrial tachycardia focus obviates the need for long-term pacing. For many reasons, catheter ablation represents an exciting approach to the management of patients with drug-refractory supraventricular tachycardia. (Texas Heart Institute Journal 1986; 13:427-432)

Key words: Catheter ablation; supraventricular tachycardia; interventional electrophysiology

The use of electrode catheters to ablate cardiac tissue has been termed interventional electrophysiology. Since the publication of early reports describing electrode catheter ablation of the atrioventricular (AV) junction, this technique has been extended to include ablation of accessory pathways and of foci for ectopic atrial, junctional, fascicular, and ventricular tachycardia. This article reviews the clinical role of electrode catheter ablation in a variety of patients with supraventricular arrhythmias.

Ablation of the Atrioventricular Junction

Catheter electrocoagulation of the bundle of His has been described in detail. In brief, a standard USCI electrode catheter is positioned across the tricuspid valve, to allow registration of the greatest unipolar His bundle potential (Fig. 1). The electrode that shows the greatest potential is used as the cathode, while a patch positioned over the left scapula serves as the anode. One or more direct-current shocks are

From the Department of Medicine and the Cardiovascular Research Institute, University of California, San Francisco, California.

Address for reprints: Melvin Scheinman, M.D., Room 312 Moffitt Hospital, University of California, San Francisco, California 94143-0214.
Catheter ablation of the AV junction: The catheter is positioned so as to record the greatest degree of unipolar His and atrial deflection (see insert of electrograms, upper right). Shocks are delivered via a direct-current defibrillator from the electrode catheter to a patch placed over the left scapula.

Key: RA = right atrium; RV = right ventricle; H = His.

delivered from the electrode to the patch with a standard direct-current defibrillator. If stable, complete AV block is present for at least 24 hours, and a permanent pacemaker is implanted.

The catheter technique for His bundle ablation has most commonly been used in patients with atrial flutter or fibrillation who prove resistant to medical therapy. In addition, this technique may be applied to patients with intractable atrial tachycardia or AV nodal reentrant tachycardia. The basic goal is to destroy the AV junction, which funnels the atrial impulses into the ventricle. The chief disadvantage of the catheter ablation technique is that the patient is rendered pacemaker-dependent, since normal AV conduction is either modified or completely blocked.

Atrioventricular junctional ablation has also been applied to patients with the Wolff-Parkinson-White (WPW) syndrome. In these cases, the usual tachycardia circuit involves antegrade conduction via the normal AV node-His axis and retrograde conduction via the accessory pathway (Fig. 2). In patients with the WPW syndrome who are refractory to medical therapy, surgical division of the accessory pathway has proved both safe and effective.10 His bundle ablation has been used in patients who either refuse surgery or are at increased risk for surgery. The rationale for using catheter electrocoagulation of the His bundle in
Fig. 2 Rationale for the use of catheter electrode ablation procedures in patients with the Wolff-Parkinson-White syndrome: The left panel illustrates the typical circuit of orthodromic AV reciprocating tachycardia. The impulse proceeds antegrade over the AV node-His axis and retrograde over the accessory pathway. The right panel shows that ablative procedures may be aimed at destroying either the AV junction (left flash mark) or the accessory pathway (right flash mark). Because both of these structures are critical for the maintenance of tachycardia, ablation of either one will allow tachycardia to be controlled.

these patients stems from the fact that the AV junction is a critical component of the reentrant circuit. Successful ablation of the AV junction would thus render the tachycardia circuit inoperative. Because patients with the WPW syndrome have dual conduction pathways into the ventricle, disruption of the AV node-His axis leaves the accessory pathway intact. Therefore, these patients are not left pacemaker-dependent, since AV conduction is still possible over the accessory pathway. We believe that it is advisable, however, to insert a permanent back-up pacemaker, since the long-term natural history of conduction over accessory pathways has not yet been defined. One important precaution should be emphasized: AV junctional ablation is not indicated for patients who have accessory pathways with short effective refractory periods (i.e., those capable of rapid conduction during atrial fibrillation). Whereas AV junctional ablation frees patients from circus movement tachycardia, it nevertheless leaves them unprotected from atrial fibrillation and the possible consequences of rapid, potentially malignant arrhythmias. Patients whose accessory pathways have short effective refractory periods should, therefore, be treated with direct surgical or catheter ablation.

The largest series of patients undergoing AV junctional ablation has been recorded by the Percutaneous Cardiac Mapping and Ablation Registry. To date, almost 400 cases have been reported to the Registry, and approximately 60% of these have involved drug-refractory chronic or paroxysmal atrial fibrillation or flutter. The response was deemed excellent in approximately 80% of the patients, in that arrhythmias were controlled without antiarrhythmic drugs. In 10% of the responders, AV conduction resumed but was sufficiently modified so that no drugs were needed. Of the remaining 20% of the patients, 10% required antiarrhythmic drugs and the other 10% did not respond to the procedure at all.

The reported major risks include ventricular arrhythmias after shock (2.0%), cardiac tamponade (0.5%), and transient hypotension (1.5%). Other reported risks, which are those associated with catheterization procedure, include phlebitis, local hematoma, and sepsis. The most worrisome potential risk is the possibility of sudden death (1.9%) one to six
months after AV junctional ablation. To date, six of the seven patients who died suddenly had organic cardiac disease. It is unclear whether their demise was related to the procedure or whether it was part of the natural history of their disease.

**CATHETER ABLATION OF ACCESSORY BYPASS CONNECTIONS**

More recently, direct catheter electrocoagulation of accessory pathways has been attempted. Initial efforts involved attempted catheter ablation of left free wall pathways by means of high-energy direct-current shocks in the coronary sinus. This technique proved to be of limited efficacy and was associated with pericardial tamponade owing to rupture of the coronary sinus. Other authors have demonstrated successful ablation of posteroseptal accessory pathways with a catheter technique. In this procedure, an end-hole catheter is inserted into a peripheral vein and is positioned at the root of the coronary sinus (Fig. 3). The os and the coronary sinus are outlined by injecting contrast material into the coronary sinus. After the os has been precisely delineated, an electrode catheter is positioned so that the distal electrodes are within the os and the proximal electrodes are just outside it. One or more high-energy direct-current shocks are delivered from the proximal elec-

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**Catheter Ablation of Posteroseptal Accessory Pathway**

![Diagram of catheter ablation](Fig. 3) Catheter ablation of a posteroseptal accessory pathway: The catheter is positioned so that the distal electrodes are within the coronary sinus and the proximal electrodes are just outside the os of the coronary sinus (dotted structure). The proximal electrodes are positioned so as to record the earliest atrial activity during orthodromic tachycardia (see insert of electrograms, upper right). Shocks are delivered from the proximal electrodes to a patch on the chest wall.
trodes (cathode) to a patch on the chest wall (anode). To date, out of a combined series of 19 patients who underwent this procedure either at the University of California, San Francisco, or at the University of Michigan, arrhythmias were controlled in 15 cases (75%) without the need for drug therapy. Of the four patients who failed to respond, two required drug therapy and two subsequently underwent cardiac surgery for interruption of the pathway. Two major complications of the catheter procedure have been observed: One patient developed cardiac tamponade and required emergency pericardiocentesis, and one patient with the permanent form of junctional reentrant tachycardia developed permanent AV block after successful ablation of the posteroseptal pathway.

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**ABLAION OF ECTOPIC SUPRAVENTRICULAR TACHYCARDIA FOCI**

Successful ablation of ectopic supraventricular tachycardia foci was first reported by Gillette and associates for patients with automatic atrial or junctional tachycardia. There are few data concerning the use of this technique in adults. We have applied it in treating six patients with ectopic supraventricular arrhythmias. The technique involves endocardial mapping of the right atrium and coronary sinus with standard electrode catheters. The earliest atrial activity relative to multiple-surface P waves is taken as the exit point of the automatic focus. One or more shocks are delivered from the electrode catheter that shows the earliest activity to a patch on the chest wall. In view of the small diameter of the atrial wall, special care must be taken to avoid administering high-energy shocks.

We have applied this technique to two patients with automatic junctional tachycardia. After ablation of the AV junction, complete AV block ensued, and permanent cardiac pacing was required. Two additional patients had automatic atrial tachycardia foci localized to the region of the coronary sinus os. Shocks delivered in this region, as described above (for patients with posteroseptal accessory pathways), proved successful in terminating the arrhythmias. The procedure was unsuccessful in one patient with tachycardia localized to the right atrial appendage and in one patient with persistent inappropriate sinus tachycardia. These two patients subsequently underwent successful AV junctional ablation and cardiac pacemaker insertion.

Electrode catheter ablation procedures are beginning to assume an increasingly important clinical role in the management of patients with resistant supraventricular tachyarrhythmias, and catheter electrocoagulation of the AV junction has supplanted the need for surgical division of the His bundle in patients with drug-resistant supraventricular tachycardia. The chief drawback that limits the use of AV junctional ablation is the induction of pacemaker dependency. Thus, control of tachycardia is usually achieved at the expense of sacrificing the normal AV conduction centers. The technique may be used in selected patients with drug-refractory circus movement tachycardias incorporating a bypass tract. Control of tachycardia may be achieved, but a permanent pacemaker is still recommended as a back-up, since the natural history of AV conduction over a bypass tract is not known. This procedure may be of particular importance for patients who either decline surgery or are high-risk candidates for direct surgical ablation of the accessory pathway.

Newer, potentially more promising procedures involve direct catheter ablation of either the accessory pathway or discrete automatic atrial foci. If the procedure is successful, tachycardia can be controlled without permanent cardiac pacing. It should be stressed that very limited data are currently available concerning catheter ablation of accessory pathways or automatic atrial foci and that the risk/benefit ratios have not been clearly defined.

Although catheter ablation has had exciting new applications since its introduction in 1982, further technical advances are required: Specially designed catheters are needed to carry the enormous electrical energy delivered during these shocks. In addition, experience with alternative energy sources (radiofrequency, lasers, etc.) should be further explored. Finally, electrode catheters that allow for better intracardiac manipulation are
required in order to facilitate endocardial mapping and ablation.

Catheter ablation procedures should be performed only by medical teams that are experienced in invasive electrophysiology. Precise diagnosis of the arrhythmic mechanism, as well as consideration of alternative treatments, is essential before one can determine whether the patient is a potential candidate for catheter ablation.

REFERENCES