TACHY ARRHYTHMIAS constitute a major cause of mortality and morbidity. The most serious manifestation of cardiac arrhythmia is sudden cardiac death where the underlying rhythm is ventricular tachycardia-ventricular fibrillation (VT - VF) in the vast majority of patients. Other symptoms produced by cardiac arrhythmias are syncope, near syncope, lightheadedness, and palpitations. Although supraventricular tachycardia seldom causes cardiac arrest it can, nonetheless, result in recurrent disabling symptoms. A variety of therapeutic modalities have emerged over the years to control tachycardias. These include antiarrhythmic drugs, implantable anti tachycardiacardioverter defibrillators, arrhythmia surgery, and catheter ablation. While implantable antitachycardia devices have evolved as the major nonpharmacologic treatment for VT - VF, the catheter ablation technique is now the choice therapy for many forms of supraventricular tachycardias.

**Methodology**

A precise diagnosis of the arrhythmic origin is critical for catheter ablative therapy to work. Thorough familiarity of both physiology and anatomy are, therefore, important to achieve a high level of success rate. An electrophysiologic study is performed initially to diagnose and localize the problem area. Although right heart catheterization is adequate for a routine electrophysiologic study, a coronary sinus catheter is important to rule out left-sided accessory pathways (Figure 1). Left heart catheterization is essential for mapping and ablation of left ventricular tachycardia.

![Figure 1](image-url) - This figure shows the usual catheter position, i.e., the right atrium, His bundle region, right ventricular apex, and coronary sinus. These catheters are used for supraventricular tachycardia induction and mapping of the reentry circuit. This schema shows a left free-wall AP. Once the location is identified, the ablating catheter is positioned adjacent to that (see ablation catheter via retrograde transaortic approach) and radiofrequency energy is applied.

Once the precise diagnosis is made, catheter ablation can be carried out with positioning of the ablating catheter near the target area. Although

**From the Wisconsin Electrophysiology Group. University of Wisconsin - Milwaukee Clinical Campus. Milwaukee Heart Institute of Sinai Samaritan Medical Center and St. Lukes Medical Center, Milwaukee, Wisconsin, USA.**

**Address reprint requests and correspondence to Dr. Akhtar: Milwaukee Heart Institute, Sinai Samaritan Medical Center, 960 N. 12th Street. Milwaukee. WI 53233. USA.**
electric energy (DC) had been used in the past to cause the local damage, the current choice of energy source is radiofrequency (RF). Radiofrequency is an unmodulated alternating current with a frequency range of 30 to 750 kHz. At such frequencies, there is little electrical stimulation of the local tissue and there is heat build at the catheter tip - tissue interface. The entire circuit for the flow of the current is completed by the application of a chest pad, usually in a posterior location (Figure 2). Ablative procedures are typically done with heparinization while the patient is either heavily sedated or under light general anesthesia.4-9

**Table 1. Catheter ablation in supraventricular tachycardia.**

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Ablation site</th>
<th>Cure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A V reentry</td>
<td>Accessory pathway</td>
<td>&gt;95%</td>
</tr>
<tr>
<td>(WPW syndrome)</td>
<td>A V nodal reentry</td>
<td>&gt;95%</td>
</tr>
<tr>
<td>A V nodal pathway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial tachycardia</td>
<td>Atrial focus</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Common atrial flutter</td>
<td>Atrial focus</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>A V junctional</td>
<td>100%</td>
</tr>
</tbody>
</table>

WPW = Wolff-Parkinson-White; A V = atrioventricular.

With the help of pacing and mapping, the critical zone for tachycardia is identified and the RF energy can be targeted at the area of interest. Once a lesion is produced, tachycardia induction is repeatedly tried to assess the effectiveness of RF ablation. Several lesions may be necessary to ultimately achieve a successful outcome. Typical RF application is for 15 to 60 seconds with an energy range of 15 to 50 watts. A brief synopsis of various arrhythmias in which RF ablation is helpful, along with a relative degree of success achieved in these settings, is outlined below.

**Supraventricular Tachycardia**

Among the supraventricular tachycardias (Table 1), paroxysmal reentrant forms are the most common clinically significant arrhythmias (Figure 3). Atrioventricular (A V) reentry using an accessory pathway and A V nodal reentry are the two tachycardias most amenable to curative therapy. The target in A V reentry and ventricular pre-excitation in association with Wolff-Parkinson-White syndrome is the accessory pathway. Accessory pathway localization is accomplished by either identifying the earliest ventricular activation during ventricular pre-excitation (Figure 4) or earlier atrial activation during orthodromic A V reentry. In patients with A V nodal reentry, either fast or slow pathway ablation can be tried. The lesion site is often guided by the anatomic location of these pathways. However, fast pathway ablation carries a much higher likelihood of A V block and uniformly causes prolongation of the PR interval. Atrial tachycardias are also amenable to ablative therapy when they are unifocal and the origin can be precisely mapped. More recently,
control of atrial flutter has also been achieved with ablation of a critical area within the reentrant circuit.11

Figure 4. The electrograms from the high right atrium (HRA), coronary sinus (CS) and His bundle (HBE) along with surface ECG are displayed. Note that there is pre-excitation during sinus rhythm (first four QRS complexes). The RF energy is applied (see the onset of impedance rise) and within three sinus cycles the pre-excitation is abolished and QRS becomes narrow (see arrow). When ventricular pre-excitation is present during sinus rhythm, the earliest ventricular activation can be used as the target site.

A V junctional ablation has been carried out for control of rapid ventricular rates in atrial arrhythmias as a palliative procedure when a cure cannot be accomplished.5 The most common underlying rhythm in these patients is atrial fibrillation. Implantation of permanent pacemakers constitutes an essential part of this procedure to support the resultant bradycardia as a consequence of catheter-induced third-degree A V block.

Ventricular Tachycardia

Catheter ablation for ventricular tachycardia (VT) is primarily restricted to the monomorphic forms. Clinically significant forms of monomorphic VT that are suited for catheter ablative methods are listed in Table 2. The most common form of VT encountered in clinical practice is due to chronic coronary artery disease, and prior myocardial infarction is the most common anatomic substrate.12 In this type of VT an area of slow conduction is the best site for ablative therapy. Endocardial mapping, pace mapping, and entrainment are the various methods used for circuit localization. When the area of slow conduction can be delineated, the success rate is high. VT in the absence of any definable structural heart disease can also be cured with ablative therapy.13 This is true of VT from either right and left ventricular origins. Simulation of VT morphology on a 12-lead ECG with pacing of the ventricle provides an excellent marker to target therapy, although mapping with the earliest site of ventricular activation is also useful.

TABLE 2. Catheter ablation in ventricular tachycardia.

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Ablation site</th>
<th>Cure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial VT due to prior MI</td>
<td>Area of slow condition</td>
<td>&gt;70%</td>
</tr>
<tr>
<td>Myocardial VT in the absence of structural heart disease</td>
<td>Area near myocardial breakthrough</td>
<td>&gt;70%</td>
</tr>
<tr>
<td>Bundle-branch reentry</td>
<td>Right or left bundle branch</td>
<td>100%</td>
</tr>
</tbody>
</table>

VT = ventricular tachycardia; MI = myocardial infarction.

Figure 5. Sustained ventricular tachycardia (VT) due to bundle reentry with a QRS morphology of left bundle-branch block can be appreciated in Panel B. Panel A shows a reference sinus beat and QRS configuration similar to what is seen during VT. The RB-V interval is prolonged during sinus rhythm and VT. Radiofrequency energy application to the right bundle (Panel C) terminates the VT and the next sinus beat now shows a right bundle-branch block (last beat in Panel C).


VT due to bundle-branch reentry is often seen in patients with dilated cardiomyopathy regardless of the cause.14-16 However, in patients with idiopathic dilated cardiomyopathy, bundlebranch reentry accounts for up to 40% The success rate in many forms of SVT and some types of VT approaches 100% and the procedure can be carried out with minimal complications in experienced hands. Catheter ablation using radiofrequency as the energy source should be considered as the therapy of first choice for several of the tachycardias described here.
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sustained monomorphic VT. In this arrhythmia, the reentry utilizes both the His bundle and bundle branch to complete the circuit. Interruption of conduction in either the right bundle or main left bundle will interrupt the tachycardia (Figure 5). In our experience, bundle branch reentry has been curable in 100% of the cases who underwent right or left bundle-branch ablation.16

Complications

In experienced hands, the rate of serious complications is relatively low. The main complications include pulmonary or systemic thromboembolism, bleeding, pericardial effusion, and tamponade.s Inadvertent A V block can occur during ablation of the fast A V nodal pathway requiring permanent pacing.s At our center, the incidence of serious complications as a part of catheter ablation procedures has been less than 2% among our initial 650 cases and there has been no mortalities. We have also not encountered any instance of permanent second- or third-degree A V block among more than 270 patients undergoing slow A V nodal pathway ablations.

Conclusion

For most reentrant tachycardias with a definable circuit, catheter ablation therapy provides a viable therapeutic option. The success rate in many forms of SVT and some types of VT approaches 100% and the procedure can be carried out with minimal complications in experienced hands. Catheter ablation using radiofrequency as the energy source should be considered as the therapy of first choice for several of the tachycardias described here.

References
