New frontiers of supraventricular tachycardia and atrial flutter evaluation and catheter ablation

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Abstract
Radiofrequency catheter ablation (RFCA) has revolutionized treatment for tachyarrhythmias and has become first-line therapy for some tachycardias. Although developed in the 1980s and widely applied in the 1990s, the technique is still in development. Transesophageal atrial pacing (TAP) can be used for initiation and termination of supraventricular tachycardia (SVT).

Methods: The paroxysmal SVT include a wide spectrum of disorders including, in descending order of frequency, atrial flutter, atrioventricular (AV) nodal reentry, Wolff-Parkinson-White syndrome, and atrial tachycardia. While not life-threatening in most cases, they may cause important symptoms, such as palpitations, chest discomfort, breathlessness, anxiety, and syncope, which significantly impair quality of life. Medical therapy has variable efficacy, and most patients are not rendered free of symptoms. Research over the past several decades has revealed fundamental mechanisms involved in the initiation and maintenance of all of these arrhythmias. Knowledge of mechanisms has in turn led to highly effective surgical and catheter-based treatments. The supraventricular arrhythmias and their treatment are described in this report. SVT initiation was analyzed with programmed TAP in 49 patients with palpitations (age 47 ± 17 years, 24 females, 25 males).

Results: In comparison to antiarrhythmic drug therapy the radiofrequency catheter ablation in patients suffering from atrial flutter, atrioventricular nodal reentry, atrioventricular reentry and atrial tachycardia is the better choice in most cases. TAP SVT initiation was possible in 23 patients before RFCA. Atrial cycle length of SVT was 320 ± 59 ms. We initiated AV nodal reentrant tachycardia (AVNRT, n=15), atrial tachycardia (AT, n=6) and AV reentrant tachycardia with Kent pathway conduction (AVRT, n=2) before RFCA.

Conclusions: Radiofrequency catheter ablation is a successful and safe method to cure most patients with paroxysmal supraventricular tachycardias. TAP allowed initiation and termination of SVT especially in outpatients.

1 Introduction
Radiofrequency catheter ablation (RFCA) has revolutionized treatment for tachyarrhythmias and has become first-line therapy for some tachycardias. Although developed in the 1980s and widely applied in the 1990s, the technique is still in development. The paroxysmal supraventricular tachycardia (SVT) include a wide spectrum of disorders including, in descending order of frequency, atrial flutter, atrioventricular nodal reentry, Wolff-Parkinson-White syndrome, and atrial tachycardia. While not life-threatening in most cases, they may cause important symptoms, such as palpitations, chest discomfort, breathlessness, anxiety, and syncope, which significantly impair quality of life. [1-8].

2 Methods
Medical therapy has variable efficacy, and most patients are not rendered free of symptoms. Research over the past several decades has revealed fundamental mechanisms involved in the initiation and maintenance of all of these arrhythmias. Knowledge of mechanisms has in turn led to highly effective surgical and catheter-based treatments. The supraventricular arrhythmias and their treatment are described in this report.

2.1 Indications to radiofrequency catheter ablation
There are 3 Class I indications for catheter ablation. The first is symptomatic SVT due to atrioventricular nodal reentrant tachycardia (AVNRT), Wolff-Parkinson-White syndrome, unifocal atrial tachycardia, or atrial flutter (especially common right atrial forms). For these conditions, catheter ablation is first-line therapy if that is the patient’s preference. The second indication is atrial fibrillation with lifestyle-imparing symptoms and inefficacy or intolerance of at least 1 antiarrhythmic agent. Both left atrial ablation for restoration of sinus rhythm and AV junction ablation
for rate control are Class I indications, depending on the circumstance. The third indication is symptomatic ventricular tachycardia (VT). Catheter ablation is first-line therapy in idiopathic VT, if that is the patient’s preference. In structural heart disease, catheter ablation is generally performed for drug inefficacy or intolerance, or as adjunctive therapy in patients with an implantable cardioverter-defibrillator (ICD) who are experiencing frequent ICD discharges.

Uncommon indications for catheter ablation include the following:
- Symptomatic drug-refractory (inefficacy or intolerance) idiopathic sinus tachycardia
- Lifestyle-impairing ectopic beats
- Symptomatic junctional ectopic tachycardia

RFCA has been applied to most clinical tachycardias, even to polymorphic ventricular tachycardia and ventricular fibrillation in preliminary studies. Success rates are highest in patients with common forms of SVT, namely AVNRT and orthodromic reciprocating tachycardia (ORT).

2.2 Contraindications to radiofrequency catheter ablation

Few absolute contraindications to RFCA exist. Left atrial ablation and ablation for persistent atrial flutter should not be performed in the presence of known atrial thrombus. Similarly, mobile left ventricular thrombus would be a contraindication to left ventricular ablation. Mechanical prosthetic heart valves are generally not crossed with ablation catheters. Reproductive-aged women should not be exposed to fluoroscopy if any possibility exists that they are pregnant.

3 Results

Transesophageal atrial pacing (TAP) can be used for initiation and termination of SVT in emergency situations or in patients with atypically symptoms.

3.1 Programmed transesophageal atrial pacing

SVT initiation in patients with palpitations (n=49, age 47 ± 17 years) was analysed with programmed TAP during spontaneous rhythm and 600ms, 500ms, 400ms and 330ms TAP basic cycle length. In comparison to antiarrhythmic drug therapy the radiofrequency catheter ablation in patients suffering from atrial flutter, atrioventricular nodal reentry, atrioventricular reentry and atrial tachycardia is the better choice in most cases. TAP SVT initiation was possible in 23 patients before RFCA. Atrial cycle length of SVT was 320 ± 59 ms. We initiated AV nodal reentrant tachycardia (AVNRT, n=15), atrial tachycardia (AT, n=6) and AV reentrant tachycardia with Kent pathway conduction (AVRT, n=2) before RFCA (Fig. 1).

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atrialnodal input serves as the retrograde limb (the fast pathway). Typically, AVNRT can be cured by targeting the slow pathway near the inferior tricuspid valve annulus at the level of the coronary sinus or somewhat higher. The risk of iatrogenic heart block with ablation in this region is quite low (1-2%). Targeting the slow pathway is safer than targeting the fast pathway, which is located closer to the compact AV node (Fig. 2).

3.4 Orthodromic reciprocating tachycardia

In orthodromic reciprocating tachycardia (ORT) the AV node serves as the anterograde limb and an accessory AV connection (the accessory pathway) serves as the retrograde limb (Fig. 1). Typically, ORT can be cured by targeting the accessory pathway as it crosses the mitral or tricuspid valve annulus. Typically, a transition from ORT to atrial fibrillation can be the cause of rapid preexcited tachycardia in Wolff-Parkinson-White syndrome. Ablation of the accessory pathway cures the syndrome, eliminating ORT and atrial fibrillation in most instances.

3.5 Unifocal atrial tachycardia

Unifocal atrial tachycardia, which can arise from either atrium, is somewhat more challenging to ablate than the more common forms of generic SVT. For those tachycardias originating from the left atrium, transseptal catheterization via a patent foramen ovale or transseptal puncture is usually required.

3.6 Atrial flutter

Atrial flutter is most commonly due to a large reentrant circuit in the right atrium, involving an isthmus of tissue between the tricuspid valve annulus and the inferior vena cava. Most commonly, reentry proceeds counterclockwise up the atrial septum and down the lateral right atrium, inscribing inverted ("sawtooth") flutter waves in the inferior leads and upright P waves in V1. Clockwise reentry using this same circuit can also occur, giving upright P waves inferiorly and inverted P waves in V1. Linear ablation of the cavotricuspid isthmus cures these common forms of atrial flutter. Non–isthmus-dependent flutters can occur elsewhere in the right atrium as well as in the left atrium. Left atrial flutters are uncommon, may be difficult to ablate, and generally require a 3-dimensional mapping system to facilitate the procedure.

3.7 Catheter ablation procedure success rates

The common forms of SVT (atrioventricular nodal reentrant tachycardia and SVT associated with Wolff-Parkinson-White syndrome) are usually curable with a single procedure; the success rate is typically 90-95%. AVNRT is usually amenable to cure with a slow pathway ablation near the inferior atrial septum, where the risk of heart block is 1-2%. In the uncommon circumstances in which ablation near the compact AV node is required (fast pathway for AVNRT, or an accessory pathway in a parahisian location), the risk of heart block may approach 5% or a little higher. Cure rates for unifocal atrial tachycardia and common right atrial flutter are somewhat lower but still approach 90%. Recurrent tachyarrhythmias typically occur in the first few months after ablation and may be amenable to cure with a second procedure (Fig. 3).

3.8 Complications of catheter ablation

Major complications occur in approximately 3% of patients who have ablation procedures, including thromboembolism in less than 1% (higher in some atrial fibrillation ablation series) and death in 0.1-0.2% of all proce-
dures. The incidence of cardiac complications varies, based on the site and type of ablation.

**Cardiac complications include the following:**
- High-grade AV block
- Cardiac tamponade (highest in atrial fibrillation ablation, up to 6%)
- Coronary artery spasm/thrombosis
- Pericarditis
- Valve trauma.

**Vascular complications, which occur in approximately 2-4% of procedures, include the following:**
- Retroperitoneal bleeding
- Hematoma
- Vascular Injury
- Transient ischemic attack/stroke
- Thromboembolism or air embolism.

**Miscellaneous complications include the following:**
- Pneumothorax
- Left atrial-esophageal fistula
- Acute pyloric spasm/gastric hypomotility
- Phrenic nerve paralysis
- Infection at access site
- Inappropriate sinus tachycardia
- Proarrhythmia.

**Figure 3** Demonstration of termination of atrial flutter during ablation procedure. V1, V5 – surface ECG, RA3-4, RA5-6, RA7-8, RA9-10, RA11-12, RA13-14, RA15-16, RA17-18, RA19-20 - bipolar right atrial ECG, CS - bipolar left atrial ECG recorded with coronary sinus electrode catheter, HBE ds – bipolar distal His bundle ECG, ABL 1-2 – distal catheter ablation electrodes, ABL 3-4 – bipolar proximal ablation catheter ECG.

### 4 Conclusions

Radiofrequency catheter ablation is a successful and safe method to cure most patients with paroxysmal supraventricular tachycardias. Transesophageal atrial pacing allowed initiation and termination of supraventricular tachycardias especially in outpatients.

### 5 References


