

Initial Experience of Radiofrequency Catheter Ablation of Supraventricular Tachycardia in Paediatric Patients

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Abstract

Introduction: The management of supraventricular tachycardia (SVT) in paediatric patients until recently has frequently been pharmacologic therapy, but this approach suffers from the drawbacks of treatment failure, development of drug intolerance and/or side-effects. **Aim:** In keeping with recent advances in paediatric cardiology, we share our experience with radiofrequency catheter ablation as an alternative and definitive modality of therapy. **Materials and Method:** 4 young patients with recurrent SVT underwent electrophysiologic study followed by radiofrequency ablation of the accessory pathways. **Results:** Resolution of symptoms was achieved in all patients and no major complication was encountered. **Conclusions:** The ability to ablate permanently the reentrant circuit responsible for SVT has now permitted cure by non-surgical means, and is an important alternative to drug therapy in the management of SVT in children.

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Introduction

Paroxysmal supraventricular tachycardia (SVT) is well-recognised as one of the commonest rhythm disorders in children. There may be few symptoms, but many experience palpitations, or some other less specific complaints such as nausea, pallor and sweatiness. Occasionally, there can be significant haemodynamic compromise resulting in heart failure. While the acute episode may be aborted^{1,2} with vagotonic manoeuvres and/or medication (for example adenosine, verapamil), the decision to treat recurrent paroxysmal SVT, and with which modality, is less often as straightforward.

Pharmacologic agents have been used in the treatment of recurrent, symptomatic SVT. Although effective, there is the limitation of treatment failure and breakthrough SVT. Drug intolerance and side-effects of taking medication in the long term has to be borne in mind as well. In fact, many of the anti-arrhythmics used in the treatment of SVT are themselves potentially proarrhythmogenic or may depress myocardial function. Added to these is the need for indefinite

long-term medication and the associated follow up and costs involved.

Surgical³ or catheter ablation⁴⁻⁶ of accessory pathways using high-energy shocks have been used as treatment modalities. The former constitutes fairly major (open-heart) surgery, requires specific high-level skills and has inherent risks. The latter, although a novel method, uses high-energy shocks, and complications⁷ such as cardiac perforation, cardiogenic shock, coronary artery spasm, atrioventricular block and late occurrence of ventricular fibrillation have been reported.

More recently, an alternative energy source of radiofrequency current has been employed to produce discrete lesions without causing haemodynamic embarrassment. Delivery of this current is carried out using percutaneous techniques, avoiding the need for surgery and general anaesthesia. Indeed, reports from adult series^{8,9} have validated RF catheter ablation both in terms of efficacy and safety.

With these encouraging results, the technique is now

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being modified and adapted for use in children.¹⁰ In the series by Dick et al,¹⁰ an overall success rate of 74% was achieved. Major advances in diagnosis facilitate treatment strategies, and the definitive cure of SVT with RF ablation is now possible in children with a low complication rate.¹¹ Indeed, the technique is used to treat tachyarrhythmias from underlying structurally normal as well as abnormal/operated hearts. The indications are also expanding beyond SVT to other rhythm disorders,¹² including the ventricular tachyarrhythmias. The aim of this report was to evaluate our preliminary experience of this technique in our local paediatric population.

Patients and Methods

Four patients (2 males, 2 females) underwent RF ablation for troublesome SVT refractory to conventional drug therapy. The age range of these children was 12 to 15 years (mean 13 ± 1 year). The nature of procedure, indications, and the concept of RF ablation of accessory pathways were explained to the patients and their parents. Written consent was obtained from parents.

All children were subjected to a full electrophysiologic (EP) study to identify the cause of the SVT. This was carried out using a local anaesthetic and a small dose of anxiolytic such as intravenous midazolam with or without fentanyl. This rendered a semi-conscious state in the patients, so that they could still feedback any experience of symptoms, if any, during the procedure.

Four catheters were inserted through the right femoral and right internal jugular vessels. These catheter electrodes were positioned in the high right atrium (HRA), the bundle of His (His), the coronary sinus (CS, through right internal jugular approach) and the right ventricular apex (RVA).¹³ In addition, a 5F catheter was left in the right femoral artery for continuous pressure monitoring throughout the whole procedure. An EP study was performed to elicit the following information—baseline intracardiac conduction intervals and tissue refractory periods, with programmed electrical stimulation to define and initiate tachycardias, thereby confirming the mechanism operative in the patient. In radiofrequency ablation of the accessory pathways, the retrograde transaortic ventricular approach was used. Ablation was performed at sites that demonstrated one or more of the following criteria: (1) presence of an accessory pathway potential; (2) local ventriculogram preceded onset of the delta wave [in Wolff-Parkinson-White (WPW) syndrome]; (3) tightest interval between the local atrial and ventricular electrogram during sinus rhythm (in WPW syndrome) or vice versa during orthodromic atrioventricular reciprocating tachycardia. Twenty-five to 30 W of RF energy was applied for the initial 10 seconds, and continued for a further 30 seconds if loss of delta wave (during sinus

rhythm) or loss of the tightest interval (during ventricular pacing) was seen. An additional application was applied in the same site for a similar duration to ensure adequacy of burn. With atrioventricular nodal reentrant tachycardia, radiofrequency modification was performed by selective ablation of the slow pathway, utilizing the (posterior) anatomic-cum-electrogram-guided approach. The tip of the ablation catheter was placed on the tricuspid annulus between the coronary sinus os and His bundle. Beginning posteriorly, the ablation site was identified as a stable bipolar recording from the distal electrode showing an A/V electrogram ratio of 0.2 to 0.5 in sinus rhythm. Occasionally the slow pathway potential could be identified. Correctness of position was vindicated by the observation of junctional rhythm during radiofrequency energy application. At least 2 pulses were delivered at each site. If the tachycardia remained inducible, the catheter tip was advanced anteriorly toward the His bundle while maintaining the A/V ratio and the energy application repeated. Care was taken to avoid sites where the His bundle potential was evident.

One patient had WPW syndrome (Fig. 1a) with inducible orthodromic atrioventricular reciprocating tachycardia (AVRT). A second patient had a single concealed accessory pathway while the third patient had 2 concealed accessory pathways. The fourth patient had dual AV nodal pathway with inducible atrioventricular nodal reentrant tachycardia (AVNRT).

Results

Having identified these aberrant conduction pathways during EPS, RF ablation was applied within the same session. The ablation procedure was completely successful in all cases with the mean fluoroscopic time being 32.3 ± 24.9 minutes. The patient with WPW syndrome displayed a normal ECG (Fig. 1b) with disappearance of the delta wave immediately after RF ablation. No major complication was observed. In one of the patients, there was transient complaint of claudication presumably related to cannulation of the artery. This resolved spontaneously without a need for treatment. Subsequent Doppler study of the femoral and lower limb pulses reported normal flow patterns. The average hospitalisation duration was 2 days, with the patients being observed overnight following the procedure, and discharged the next morning.

In the follow-up at the outpatient clinic, patients were reviewed carefully for a history of palpitations. ECG and 24-hour ambulatory Holter monitoring were carried out as part of our complete protocol in the evaluation of these patients. Thus far, after a follow-up period of 18 ± 15 months, there has been no symptomatic or documented arrhythmic recurrence.

Fig. 1a. 12-lead ECG of a 13-year-old patient with Wolff-Parkinson-White syndrome.

Fig. 1b. ECG of same patient following RF catheter ablation of accessory pathway. Note disappearance of the delta wave compared to earlier ECG.

The clinical profile of our patients and results of the RF ablation are summarised in Table I.

Discussion

The usual mechanisms^{14,15} underlying SVT in children are due to reentry or enhanced automaticity.^{16,17} Reentry is by far the commoner of the two mechanisms, and frequently arises from the presence of accessory pathways or dual AV nodal pathway. These additional pathways have specific conduction characteristics, which allow an accelerated transmission of electrical cardiac impulses to reenter the circuit and manifest as a SVT.

The performance of an EPS is becoming increasingly valuable in demonstrating the abnormal rhythm and diagnosing the underlying mechanism that is responsible. This has contributed significantly to our understanding of the pathophysiology of many cardiac rhythm disorders. In tandem with recent advances and knowledge in this field, electrophysiologists are now in a better position to find a cure for such disorders.

RF ablation of accessory pathways has now become an accepted modality of treatment for recurrent paroxysmal SVT in adults. Reports involving large number of patients have confirmed its efficacy and safety. Over and above long-term pharmacologic therapy is the fact that RF ablation provides for a definitive cure. There is no need to worry about daily medication, side-effects of long-term medication and breakthrough episodes. All these would translate to minimal medical follow-up, improved quality of life and reduction in costs in the long run.

Percutaneous catheter ablation has even more distinct advantages over surgical ablation. Apart from major concerns over risks associated with the surgery itself, RF ablation leaves behind no scars and less pain. General anaesthesia is also not required. The duration of hospitalisation and period of recuperation is far shorter in a case of RF ablation.

From our experience, it is evident that EPS and RF catheter ablation have a pivotal role in the management of children with SVT. Our results compare favourably with

TABLE I: CLINICAL PROFILE OF PATIENTS AND RESULTS OF RF ABLATION

Patient	Age/Sex	Diagnosis	Presenting symptoms	Medication	Duration of symptoms before RF ablation	Results of RF ablation	Symptoms after RF ablation	Duration of follow-up (months)
1	12 y/F	WPW	palpitations	verapamil	6 y	successful	Nil	6
2	15 y/M	AVRT single-concealed accessory pathway	palpitations, near syncope, chest tightness	-	1 y	successful	Nil	30
3	12 y/F	AVRT 2-concealed accessory pathways	palpitations	-	2 y	successful	Nil	30
4	13 y/M	AVNRT tachycardia	palpitations, near syncope	verapamil	1½ y	successful	Nil	30

AVRT: atrioventricular reentrant tachycardia; AVNRT: atrioventricular nodal reentrant tachycardia; WPW: Wolff-Parkinson-White syndrome

those of others. In an earlier series of 20 children by Dick et al¹⁰ an overall success rate of 74% was obtained for ablation of accessory connections which caused SVT in their patients. In the report of the Pediatric Ablation Registry, the overall success rate was 91% for accessory pathways and 96% for AVNRT.¹¹ Another large series which combined adult and paediatric patients (mean age 32.2 ± 15.7 years), accessory pathway conduction was eliminated in 99% of their patients with Wolff-Parkinson-White syndrome.⁸

With increasing expertise, it is expected that this procedure will be adapted for use in younger children^{18,19} in future. Thus far, we have selected our patients carefully to those who were symptomatic and/or refractory to conventional medical treatment. The results, so far, have proved encouraging and EPS/RF ablation may possibly be a first-line treatment modality for symptomatic, recurrent paroxysmal SVT.

The patients reported had structurally normal hearts demonstrated on echocardiography. However, it is likely that EPS/RF ablation will benefit those patients with rhythm disorders and underlying structural cardiac anomaly,²⁰⁻²² whether operated or not, as well. Indeed, these are patients who frequently have low reserves, making them more readily compromised from a haemodynamic standpoint.

Conclusion

Recurrent paroxysmal SVT is a well-recognised entity in children and may cause significant morbidity. Management is not always straightforward and there are different therapeutic strategies. Of these, EPS/RF catheter ablation appears to be an effective, and relatively safe alternative, which is curative, and would be an acceptable option in paediatric patients as it is in adults.

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