

Supraventricular tachycardia

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Supraventricular tachycardia (SVT) is a generic title for any form of tachycardia whose circuit lies wholly or partly within the atria. Thus sinus tachycardia or focal atrial tachycardia are causes of SVT. So too are atrioventricular (AV) nodal re-entrant tachycardia and the accessory pathway-mediated tachycardias associated with the Wolff-Parkinson-White (WPW) syndrome. Atrial flutter and atrial fibrillation are also forms of SVT.

Finally, there are rare examples such as junctional tachycardias and incisional re-entry tachycardias seen after surgery for congenital heart disease. As atrial fibrillation has been dealt with in a previous article it shall not be discussed further here.

Heart racing

The most common presenting symptom of SVT is palpitations, usually described as 'heart racing'. Associated symptoms such as weakness, breathlessness, chest tightness and light-headedness occur frequently also. Syncope is rare and when it does occur it is usually at the onset of the tachycardia.

A small number of patients may be unaware of their tachycardia and may present after a variable period with symptoms and signs of heart failure. These patients have incessant tachycardias which are not too fast, usually in the region of 120-140bpm, and which lead to a tachycardia-induced cardiomyopathy. This is an important condition to recognise as it is completely reversible following successful treatment of the underlying arrhythmia. It may be missed however as the underlying tachycardia causing the problem may be mistaken for a sinus tachycardia occurring as a result of the congestive failure.

The ECG most commonly shows a regular narrow complex tachycardia. Sometimes the rhythm is irregular as in atrial flutter or atrial tachycardia with varying AV block. Of course, an SVT may cause a broad complex tachycardia due to bundle branch aberrancy (functional or rate-related) or underlying bundle branch block. There are a number of features which can be used to distinguish this from ventricular tachycardia.

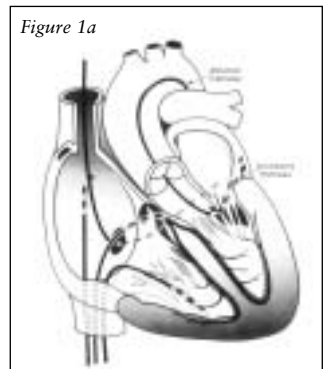
Management

Management of SVTs has changed greatly over the last decade or so, since the introduction of radio frequency ablation which now offers permanent cure rates of up to 98% for the most common forms of SVT. Patients with troublesome recurrent tachycardias previously required long-term

antiarrhythmic drug therapy while those with more serious arrhythmias required AV node ablation and permanent pacing or open heart surgical intervention.

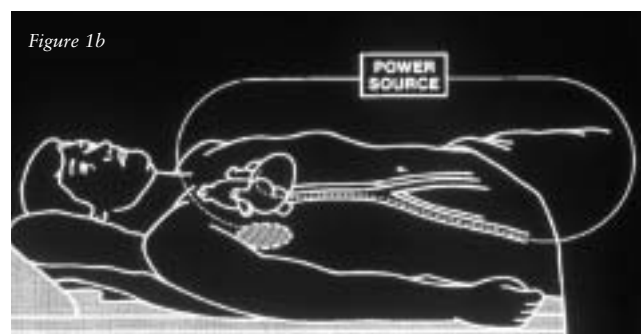
EP study

A diagnostic electrophysiological (EP) study and radio frequency ablation can be done as a single procedure requiring an overnight admission with patients able to return to full normal activities the following day. Figure 1a shows the four catheters used during a full EP study. They are passed via the femoral vein(s) and the jugular or subclavian vein and positioned one each in the right atrium, right ventricle, in the region of the AV node and in the coronary sinus. These permit external pacing and recording of intrinsic electrical signals from each of these sites.



The patient's tachycardia can be induced and the mechanism/tachycardia circuit is deduced from the recordings obtained. The critical point of the circuit (see discussion below) is then targeted by the radio frequency ablation catheter. Radio frequency energy is very high frequency energy (above ultrasound on the spectrum) and it is delivered between the catheter tip and a large patch on the patient's back (Figure 1b). This leads to a very localised (approximately 5mm diameter area) and finely controlled heating effect where the catheter is in contact with the myocardium.

When a target temperature of about 55°C is reached, the accessory pathway or tachycardia circuit is interrupted permanently. This is usually performed under conscious sedation with general anaesthesia an option in selected cases and



is almost always well tolerated (Figure 1c). It is a safe procedure with a risk of any significant complication of 1-2%. These usually resolve spontaneously (e.g. access site haematoma) or can be treated (e.g. tamponade which occurs very rarely). The most significant is complete heart block requiring pacemaker which may occur when the target area or pathway lies close to the AV node.

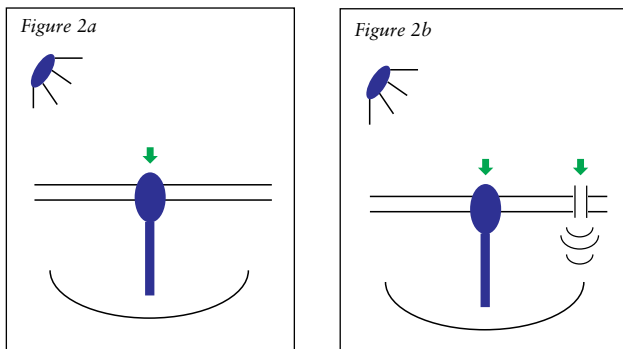


Forms of SVT

There follows a brief description of each of the most common forms of SVT, focusing on the tachycardia mechanism and treatment target.

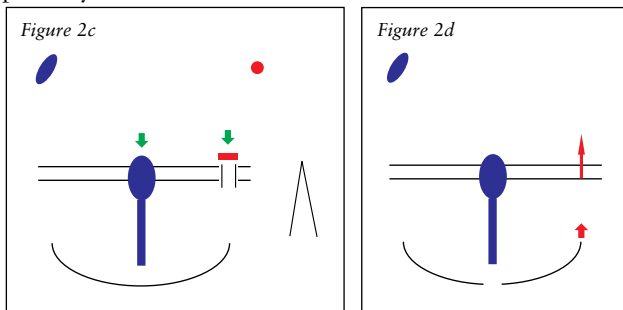
Accessory pathway-mediated tachycardias and WPW syndrome

This is the classical example of a so-called re-entrant tachycardia which is the most common mechanism for all forms of tachycardia. The origin of this tachycardia is shown in

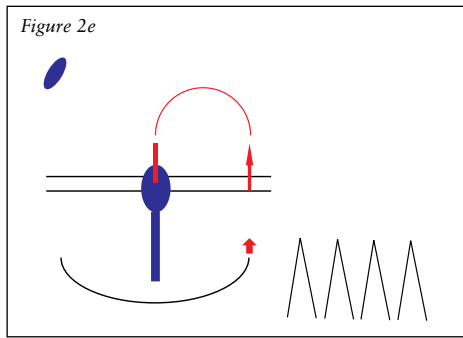


Figures 2a-e. Figure 2a demonstrates the normal situation with conduction of the sinus impulse through the atrium, down the AV node and then through the His-Purkinje system to the ventricles.

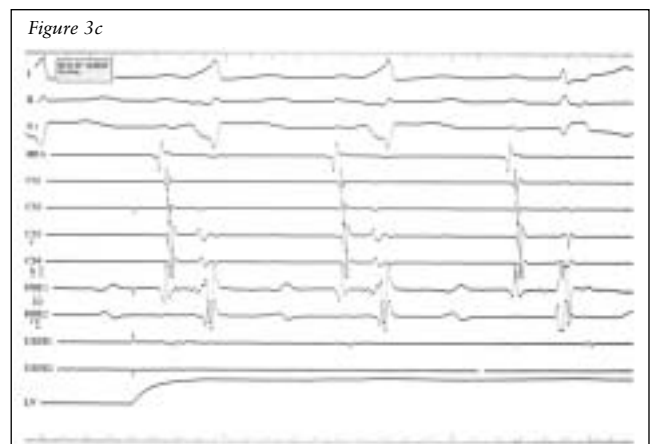
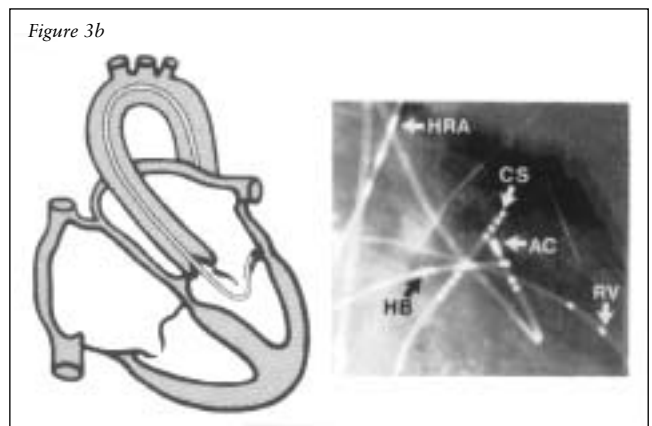
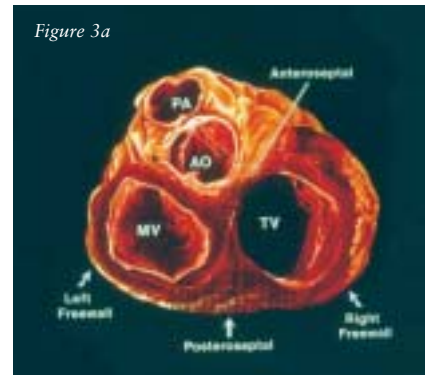
Figure 2b illustrates the situation in the WPW syndrome where patients have an additional or accessory pathway (AP) connecting the atria and ventricles. The sinus impulse passes down both pathways with the AP conduction leading to the characteristic delta wave on the ECG. Tachycardia is initiated by an ectopic beat which blocks in one of the two pathways.



In Figure 2c, a premature atrial ectopic arrives at the AP before it has recovered from the previous sinus beat and is blocked there but conducted through the AV node to the ventricles. By the time it reaches the ventricular aspect of the AP, it has recovered fully and permits retrograde conduction back to the atria (Figure 2d). The circuit is then completed when the impulse passes back down through the AV node (Figure 2e) and the tachycardia persists until the circulating impulse blocks in one or other limb, restoring sinus rhythm.



Accessory pathways may be located along the AV ring in any of the four regions illustrated in Figure 3a. Having determined the target site, the radio frequency ablation catheter is manipulated into place (Figure 3b) and the pathway is ablated. In Figure 3c, the energy is switched on (bottom record-



ing line) and after two beats the AP is ablated. The third QRS complex changes as the PR interval normalises. Thus the patient is cured, permanently.

AV nodal re-entrant tachycardia

This tachycardia is actually the most common cause of recurrent SVTs. Along with the AP-mediated tachycardias they account for up to 95% of SVTs (excluding atrial fibrillation, of course).

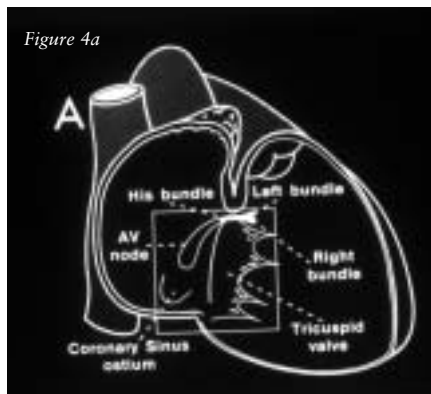


Figure 4a

Figure 4b shows a blown-up section highlighting the AV nodal region. In this tachycardia, there are two inputs into the AV node termed the fast and slow pathways because of their conduction properties.

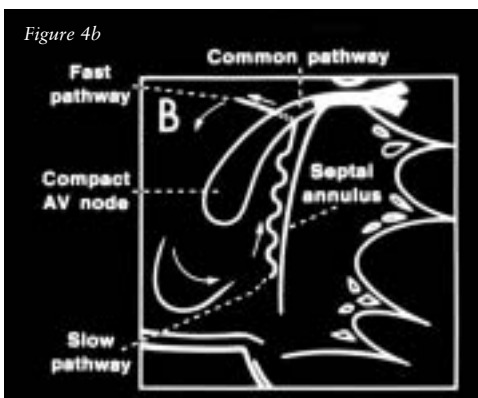


Figure 4b

The impulse passes down the slow pathway and back up the fast pathway as demonstrated in Figure 4c. Each time it passes through the lower turnaround point, it also passes down to the ventricles giving heart rates usually in the region of 180-220bpm.



Figure 4c

Atrial tachycardia

Focal atrial tachycardias are relatively uncommon and may have origin in either the right or left atrium (Figure 5). Automatic atrial tachycardias occur mainly in children and may cause a tachycardia-induced cardiomyopathy as described above. In adults, they may occur in the presence of some underlying cardiac disease.

Figure 5



Figure 6



While experience has shown that there are certain areas where the foci are more likely to be found, tracking these down can be difficult using traditional catheter-based approaches. Newer computer-assisted mapping systems help greatly but are expensive and so are still not widely available. Once the focus of the tachycardia is localised, it can be ablated giving a cure.

Atrial flutter

The mechanism of this interesting but relatively less common arrhythmia has been elucidated over the last few years. The circuit is located within the right atrium and this gives rise to the tachycardia (Figure 6). The atrial rate is in the region of 300bpm but there is usually at least 2:1 AV block and the most common presentation is with a ventricular rate of 150bpm. The circuit can be interrupted by creating a line of conduction block across the isthmus between the lower tricuspid valve and the inferior vena cava.

Summary

Radio frequency ablation offers a safe, highly successful and cost-effective way of curing patients with recurrent SVTs. It must now be considered the treatment of choice for these patients. The emergence of this technique has truly transformed the management of supraventricular arrhythmias (Figure 7).



The First Electrophysiologist

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