

An avoidable antiarrhythmic side effect

A 65-year-old woman with a known history of arrhythmia, who was receiving regular oral flecainide, presented to the accident and emergency department with severe palpitations, shortness of breath and chest pain. She remained haemodynamically stable. Her electrocardiogram (ECG) is shown in *Figure 1*. What is the underlying initial arrhythmia and what is the explanation for the response to flecainide? How could it be avoided?

The electrocardiogram

Atrial flutter (AFL) is a rapid, regular atrial rhythm caused by a re-entrant circuit confined to the atria. The simplest and most logical classification of this arrhythmia is based upon whether or not the circuit involves the isthmus of atrial tissue between the tricuspid valve, coronary sinus and inferior vena cava (*Figure 2*) (Saoudi et al, 2001). The typical isthmus-dependent flutter circuit travels through a common narrow point – the isthmus on the floor of the right atrium – and then progresses anticlockwise up the inter-atrial septum and then laterally down the right atrial free wall. If the activation wavefront travels in the opposite direction it causes a less common clockwise isthmus-dependent flutter.

Around 90% of isthmus-dependent AFL is counterclockwise. However, flutter circuits can exist independent of the isthmus travelling around or through the crista terminalis or around scars in the left or right atrium, e.g. postoperative incisional flutter. Left AFL circuits can have the appearance of a positive P wave in lead VI more suggestive of a focal left atrial tachycardia. Left AFL circuits can involve the mitral valve annulus or travel around the pulmonary vein ostia (Garg and Feld, 2001; Cosio et al, 2003). These complex circuits have been defined and successfully ablated using advanced mapping systems.

Dr Bejal Pandya is Specialist Registrar in Cardiology and **Dr Pier D Lambiase** is Clinical Lecturer in Electrophysiology in the Cardiology Department, The Heart Hospital, University College London, London W1M 8PH

Correspondence to: Dr PD Lambiase

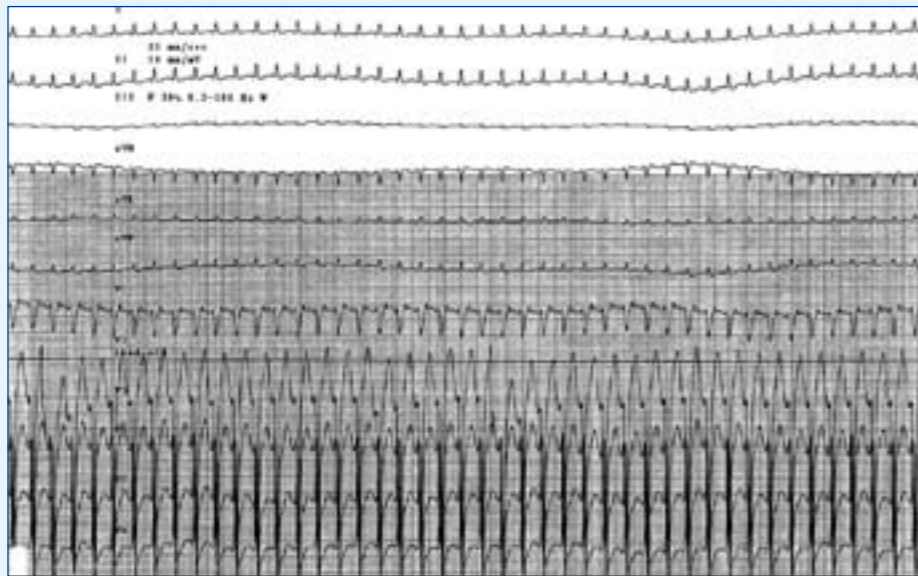
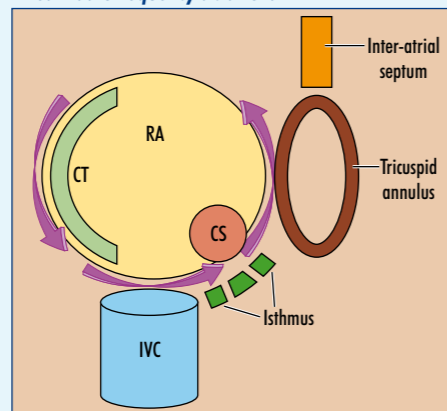


Figure 1. Electrocardiogram on presentation.

AFL causes a 'saw tooth' pattern of atrial activation. In isthmus-dependent counterclockwise flutter, the flutter waves are negative in leads II, III and aVF, and positive in V1 as the activation wavefront is predominantly travelling away from the inferior wall of the right atrium. The atrial activation rate is typically 240–340 beats per minute (bpm). The ventricular response

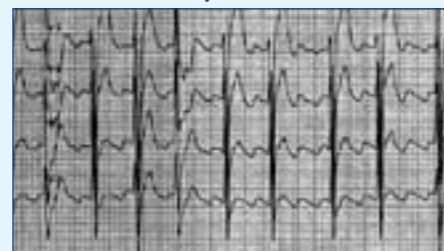
Figure 2. Typical isthmus-dependent atrial flutter circuit in the left anterior oblique projection. Counterclockwise activation of the right atrium (RA) is shown traveling medially along the inter-atrial septum over the roof of the RA and lateral to the crista terminalis (CT). Activation then proceeds through the isthmus region between the tricuspid annulus, coronary sinus os (CS) and the inferior vena cava (IVC). This is the narrowest common pathway of the circuit and is the site targeted for linear radiofrequency ablation.



depends upon the rate of conduction through the atrioventricular node (AVN). If 2:1 block occurs, the tachycardia is classically 150 bpm. However, 1:1 conduction can occur. This is most commonly seen in patients with Wolff–Parkinson–White syndrome or Lown–Ganong–Levine (short PR interval but no delta wave). Factors that improve AVN conduction such as exercise, catecholamines or phenytoin may also cause 1:1 conduction. Antiarrhythmic drugs can affect both the AFL rate and conduction through the AVN. Classically class Ic agents slow the atrial rate and enable the AVN to conduct 1:1 resulting in accelerated ventricular rates compared to before drug administration.

In the case described, the temporary block of the AVN with adenosine unveiled the underlying rhythm of AFL illustrated in chest leads V3–V6 (*Figure 3*).

Figure 3. The effect of adenosine. Note the presence of flutter waves in the ventricular leads V3–V6 as conduction is slowed through the atrioventricular node by adenosine.



Treatment

Restoration and maintenance of sinus rhythm is the key to the management of this arrhythmia. This usually alleviates the patient's symptoms, improves exercise tolerance and can reduce the incidence of thromboembolic events (Singh et al, 1999).

The main therapeutic goals are adequate rate control, anticoagulation (if there is a history of thromboembolism, or structural abnormality of the heart), conversion to sinus rhythm (either pharmacologically or with DC cardioversion) and maintenance of sinus rhythm (either pharmacologically or with radiofrequency ablation of the macroreentrant circuit's common isthmus).

Pharmacological treatment for rate control

Useful rate-limiting medications include the AVN-blocking agents: calcium channel blockers, beta-blockers and digoxin.

Chemical cardioversion

Drugs that prolong atrial refractory times can be used for cardioversion, including class Ia (quinidine, procainamide, disopyramide), class Ic (flecainide, propafenone) and class III (sotalolol, amiodarone, dofetilide, ibutilide).

Dofetilide, a newer class III agent, aims to selectively block the component of the delayed rectifier current (I_{kr}), while ibutilide augments the slow inward sodium current. Overall cardioversion rates for recent onset of AFL are 54% and 38–63% respectively (Gallik et al, 1997). If planning to use ibutilide the serum potassium should be >4 mmol/litre, QTc should be ≤440 msec, the patient should have normal left ventricular function and he/she should be monitored for torsade de pointes.

Radiofrequency ablation

Radiofrequency ablation can cure of isthmus-dependent AFL by creating a line of conduction block along the tricuspid valve–inferior vena cava isthmus thus interrupting the common narrow point through which the circuit must pass. This has a 90–95% success rate and carries a low risk of atrioventricular block requiring a permanent pacemaker (<1%).

Pacing

Short bursts of atrial overdrive pacing, usually 10 bpm above the atrial rate, may

restore and maintain sinus rhythm. This is particularly useful in patients who have a pacemaker when high rate burst atrial pacing can be used. The key feature to identify on surface ECG during atrial burst pacing is the development of positive atrial complexes in lead II which indicates that the circuit has been entrained from the high right atrial pacing site. Abrupt termination of pacing or gradual slowing to a desired rate after 15–30 seconds are often successful in terminating the flutter. Occasionally atrial fibrillation may be triggered by atrial pacing, but this may self-terminate. However, it may also promote the transition into permanent atrial fibrillation requiring DC cardioversion.

Response to flecainide

The patient described in this case unfortunately suffered the proarrhythmic side effects of flecainide. Flecainide slows atrial conduction in a use-dependent manner and increases atrial refractoriness during sinus rhythm. The AVN can conduct the atrial re-entrant activation at a higher rate and thus 1:1 conduction occurs resulting in a potentially hazardous tachycardia. QRS duration is also prolonged but without an increase in ventricular refractory time (Katritsis et al, 1995). The mechanisms of pharmacological termination of AFL include refractory block and cycle length oscillation, which can predispose to rapid conduction by enabling collision of electrical waves or return reexcitation (Tai and Chen, 2001).

Despite the hazardous side effects of flecainide it appears to be a safe and effective treatment for patients with paroxysmal supraventricular tachycardias. Flecainide should be prescribed with an AVN-blocking agent in AFL patients in order to avoid this problem of slowing AFL rates which facilitates 1:1 atrioventricular conduction (Hopson et al, 1996). Flecainide is contraindicated in patients with acute ischaemia (Cardiac Arrhythmia Suppression Trial; Echt et al, 1991) and patients with structural heart disease or a history of sustained ventricular arrhythmia. However, the incidence of ventricular proarrhythmia in the absence of structural heart disease is low.

Conclusions

AFL is a common arrhythmia caused by a right atrial macro-reentrant circuit. It responds to antiarrhythmic agents but their efficacy is variable and can be associ-

ated with 1:1 ventricular response rates. Radiofrequency ablation can cure 90% of patients with typical isthmus-dependent AFL. Newer mapping techniques will reduce procedure times for this procedure and increase the success rate in patients with non-isthmus-dependent and left atrial circuits. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Atrial flutter is a re-entrant tachycardia which commonly involves the isthmus of tissue between the tricuspid valve annulus and inferior vena cava.
- Treatment involves protection against thromboembolism, ventricular rate control, and restoration and maintenance of sinus rhythm.
- Typical isthmus-dependent atrial flutter can be successfully treated with radiofrequency ablation with a low risk of complications.
- Flecainide should be combined with an atrioventricular node-blocking agent to maintain sinus rhythm and avoid 1:1 atrioventricular conduction of atrial flutter.