

### OVERVIEW OF THE ECG

This ECG shows an irregular, wide complex tachycardia with a ventricular rate of 114bpm (19 x 6). The differential diagnosis of an irregular, wide complex tachycardia includes: a) atrial fibrillation (AF) with bundle branch block (BBB), atrial flutter (AFL) with variable AV block and BBB, pre-excited AF, polymorphic ventricular tachycardia and multifocal atrial tachycardia (MAT) with BBB.

### MORE DETAILED ANALYSIS OF THE ECG

The first step in the analysis of this ECG is to look at the morphology of the QRS complexes in leads V1 and V6. In V1, the QRS complex resembles a typical right BBB pattern (note the rsR' complex with a broad terminal R' wave). In V6, the QRS complex resembles a typical RBBB pattern with a septal Q wave followed by a rapid R wave and a small broad S wave. When looking at the limb leads, there is left axis deviation (QRS axis of -75 degrees) with small R waves and deep terminal S waves in III and aVF – this pattern is compatible with left anterior fascicular block (LAFB). There are also different morphology complexes visible, best seen in lead II (QRS complexes 5, 13 and 16), which represent premature ventricular complexes (PVCs) with varying degrees of fusion.

A WPW pattern can cause a wide-complex QRS complex and left axis deviation. In this ECG, the absence of a short PR interval preceding each QRS complex and lack of delta waves (initial slurring of the QRS complexes) exclude a WPW pattern. There are also distinct P waves preceding all QRS complexes which exclude a diagnosis of AF. AF with RBBB and LAFB, pre-excited AF, polymorphic ventricular tachycardia can therefore be excluded.

The next step is to try and identify P waves. These are best seen in the rhythm strip (lead II).

Closer inspection of the P waves reveals that the P waves are varying in rate and morphology. There are 6 different P waves visible (labelled in Figure 1) with slight variation in the

subsequent PR intervals confirming the diagnosis of multifocal atrial tachycardia.

**The answer to (1) is (e): Multifocal atrial tachycardia with RBBB and LAFB.**

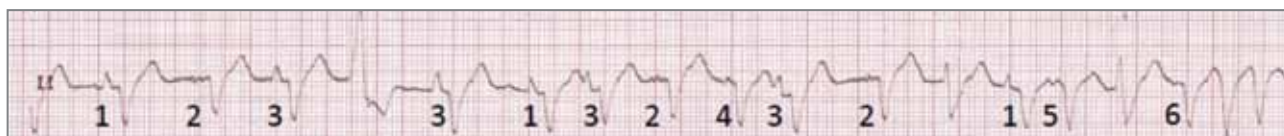
MAT is defined as a rhythm with an atrial rate >100bpm with at least 3 morphologically distinct P waves, irregular P-P intervals, and an isoelectric baseline between P waves (distinguishing MAT from AF and AFL). MAT can be misdiagnosed as AF. This distinction is crucial as incorrect treatment may lead to possible harmful therapy e.g. if anticoagulation is incorrectly prescribed for MAT.

Pulmonary disease (usually chronic obstructive pulmonary disease [COPD]) in an elderly patient is the most common setting of MAT accounting for around 60% of all cases of MAT.<sup>(1)</sup>

**The answer to (2) is (a) Chronic obstructive pulmonary disease.**

Patients with MAT and COPD have a high mortality rate most likely due to the severity of the underlying illness. A combination of right atrial enlargement, hypoxaemia, acidosis, theophylline and adrenergic stimulation can cause atrial ectopic foci. Heart failure and electrolyte abnormalities (hypokalaemia, hypomagnesaemia) have also been associated with MAT, but usually patients also had underlying pulmonary disease. The mechanism of MAT has never been elucidated. Triggered activity due to delayed after depolarisations secondary to calcium overload has been proposed, but not proven. This rhythm has also been described in young infants and children. Cardio-respiratory illnesses accounted for 50% of causes in one study.<sup>(2)</sup>

As MAT is typically an epiphenomenon of underlying pulmonary disease, the rhythm per se does not require treatment. MAT is usually transient and will resolve after precipitating factors are reversed. The pulmonary disease should be treated, electrolytes and hypoxaemia corrected, and theophylline and



**FIGURE 1:** Rhythm strip (lead II) with 6 different P wave morphologies.

beta-agonist therapy should be decreased/stopped. Cardioversion is not successful as the mechanism of MAT is triggered activity. Antiarrhythmic therapy has limited efficacy in treating this condition. Beta-blocker therapy (metoprolol) and high dose magnesium has shown limited efficacy in small trials.

This patient has severe underlying COPD secondary to smoking. His lung function tests revealed a severe obstructive pattern: FEV1 600ml (predicted 2 490ml), FVC 1 700ml (predicted 3 310ml), FEV1/FVC 35% (predicted 64%).

Interestingly, this patient also has a definite diagnosis of arrhythmogenic right ventricular cardiomyopathy (ARVC). ARVC is a genetic, desmosomal cardiomyopathy which causes fibro-fatty infiltration of the right ventricle which predisposes to right ventricular tachycardia (VT). He initially presented 26 years ago with recurrent monomorphic VT from the right ventricular outflow tract (RVOT). He underwent a successful partial RV disconnection procedure in which the myocardium of the RVOT is separated from the septum to acute marginal branch of the right coronary artery with several cryoablations to the RVOT. This procedure successfully abolished his VT for the next 26 years with no recurrences! His RBBB and LAFB was iatrogenic and acquired during this cardiac surgery.

## LESSONS AND CONCLUSIONS

An irregularly, irregular rhythm is not always due to atrial fibrillation. Always perform a 12 lead ECG to confirm the rhythm.

Multifocal atrial tachycardia is usually associated with severe chronic obstructive pulmonary disease and carries a poor prognosis.

Treatment of multifocal atrial tachycardia involves treatment of the underlying cause and does not require treatment per se.

## REFERENCE

1. Kastor JA. Multifocal atrial tachycardia. N Engl J Med. 1990 Jun 14;322(24):1713-7.
2. Bradley DJ, Fischbach PS, Law IH, et al. The clinical course multifocal atrial tachycardia in infants and children. J Am Coll Cardiol. 2001 Aug;38(2):401-8.

**Conflict of interest: none declared.**