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Appraisal of multifocal atrial tachycardia

Edward K. Chung

From Division of Cardiology, Department of Medicine, West Virginia Uuiversity School of Medicine, Morgantown, West Virginia, U.S.A.

The diagnostic criteria and the clinical significance of multifocal atrial tachycardia are described in detail. The diagnostic criteria include:

1 Two or more ectopic P waves with different configurations and with two or more different ectopic PP cycles.

2 Atrial rate between 100 and 250 beats/min (occasionally slower than 100 beats/min).

3 Isoelectrical line present between PP intervals.

4 Frequent occurrence of varying PR intervals and AV block of varying degree (non-conducted ectopic P waves).

The commonest underlying cause of multifocal atrial tachycardia is chronic lung disease (60–85%), and digitalis intoxication is another common cause of this arrhythmia. Multifocal atrial tachycardia is often refractory to the usual management, and treatment of the underlying lung disease is more important than the use of antiarrhythmic drugs. The mortality rate in this arrhythmia is extremely high (50–60%) regardless of the treatment.

Appraisal of multifocal atrial tachycardia

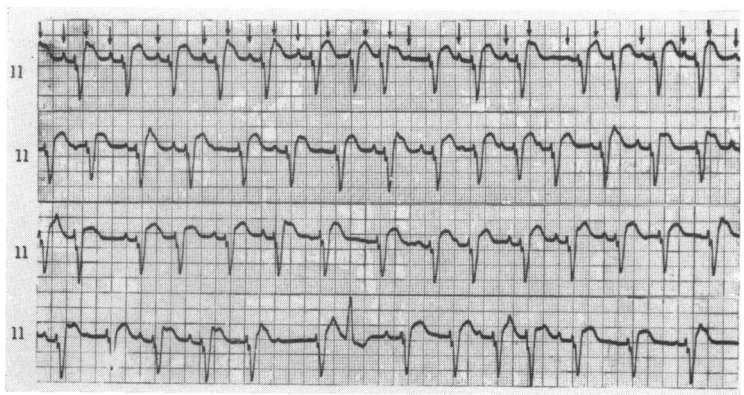
Multifocal atrial tachycardia has a distinctly different clinical significance in comparison with ordinary atrial tachycardia. This arrhythmia has been called 'repetitive multifocal paroxysmal atrial tachycardia', 'chaotic atrial tachycardia or rhythm,' and 'wandering pacemaker in the atria' by different authors (Phillips, Spano, and Burch, 1969; Shine, Kastor, and Yurchak, 1968; Abrams and Eaddy, 1965). However, the electrocardiographic descriptions under these different names are either identical or very similar to each other.

The purpose of this paper is to review the previous published reports concerning multifocal atrial tachycardia, with particular emphasis on the diagnostic criteria and the clinical significance of this arrhythmia. Sixty-five cases of multifocal atrial tachycardia collected will also be included for discussion.

Diagnostic criteria (Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1958; Weber and Phillips, 1966) The electrocardiographic criteria for the diagnosis of multifocal atrial tachycardia are as follows: (1) Two or more ectopic P waves with different configurations and with two or more different ectopic PP cycles. (2) Atrial rate between 100 and 250 beats/min (occasionally slower than 100 beats/min). (3) Isoelectrical line present between PP intervals. (4) Frequent occurrence of varying PR intervals and AV block of varying degree (non-conducted ectopic P waves).

Multifocal atrial tachycardia often produces a relatively slow rate (Fig. 1), and thus is

FIG. 1 *All strips of lead II are continuous. Arrows indicate ectopic P waves. The tracing shows multifocal atrial tachycardia (rate: 140/min) with varying AV block. Note, varying PP cycles with varying configuration of the P waves.*



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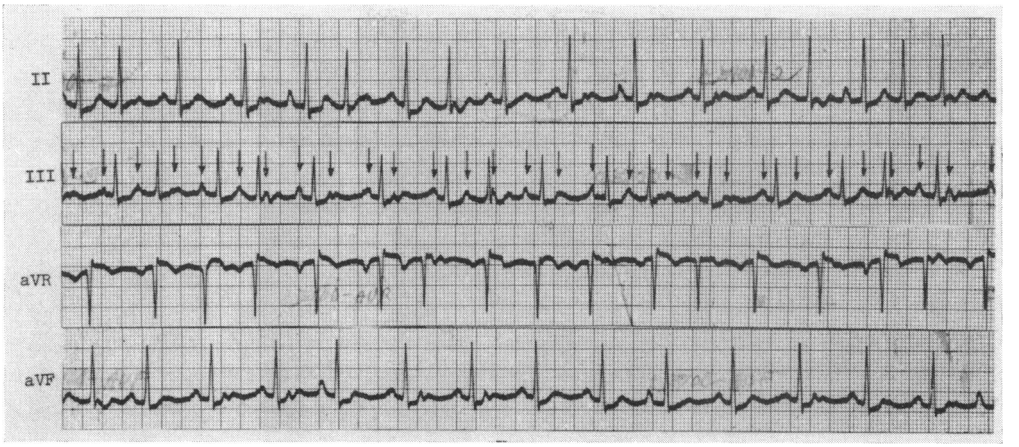
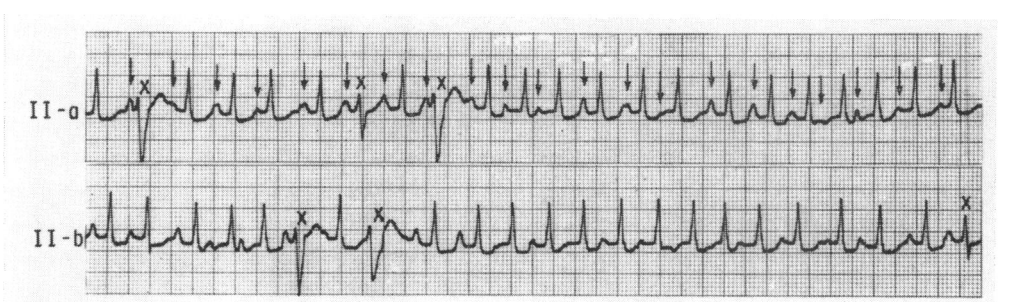


FIG. 2 *Arrows indicate ectopic P waves. The tracing shows multifocal atrial tachycardia (rate: 180–190/min) with varying AV block.*

different from an ordinary unifocal atrial tachycardia. The mode of the onset of multifocal atrial tachycardia is usually not paroxysmal, another different point. Similarly the ventricular rate in multifocal atrial tachycardia is often slower than in ordinary atrial tachycardia, probably because of the frequent association of higher degree AV block, in addition to a slower atrial rate in the former (Fig. 2). The ventricular rate in multifocal atrial tachycardia may be as slow as 50 to 60 beats/min but, in most cases, it ranges between 100 and 150 beats/min.

The ectopic P waves in multifocal atrial tachycardia are often peaked and tent-shaped because chronic pulmonary disease is a frequent underlying disorder (Fig. 3). Rarely, multifocal atrial tachycardia may have an extremely rapid atrial rate which is slightly faster than 250 beats/min. In this case, aberrant ventricular conduction frequently occurs because of a partial refractory period in the intraventricular conduction system due to the rapid rate (Walsh, 1962; Langendorf, 1951) (Fig. 4). Multifocal atrial tachycardia with aberrant ventricular conduction may resemble ventricular tachycardia or even ventricular fibrillation. The diagnosis of multifocal atrial tachycardia can be made in this circumstance by identifying the ectopic P waves preceding the bizarre QRS complexes. Rarely two atrial ectopic foci may produce a double atrial tachycardia, and in this case two different P waves with two different PP cycles occur periodically or alternately (Chung and Thomas, 1965) (Fig. 5). Multifocal atrial tachycardia is often initiated by multifocal atrial premature contractions.

FIG. 3 *Leads II-a and b are continuous. Arrows indicate P waves. Note varying configuration of P waves and varying PP cycles. This tracing shows multifocal atrial tachycardia (atrial rate: 150–160/min) with varying AV conduction and frequent multifocal ventricular premature contractions (marked X). Some P waves are peaked because of P pulmonale.*



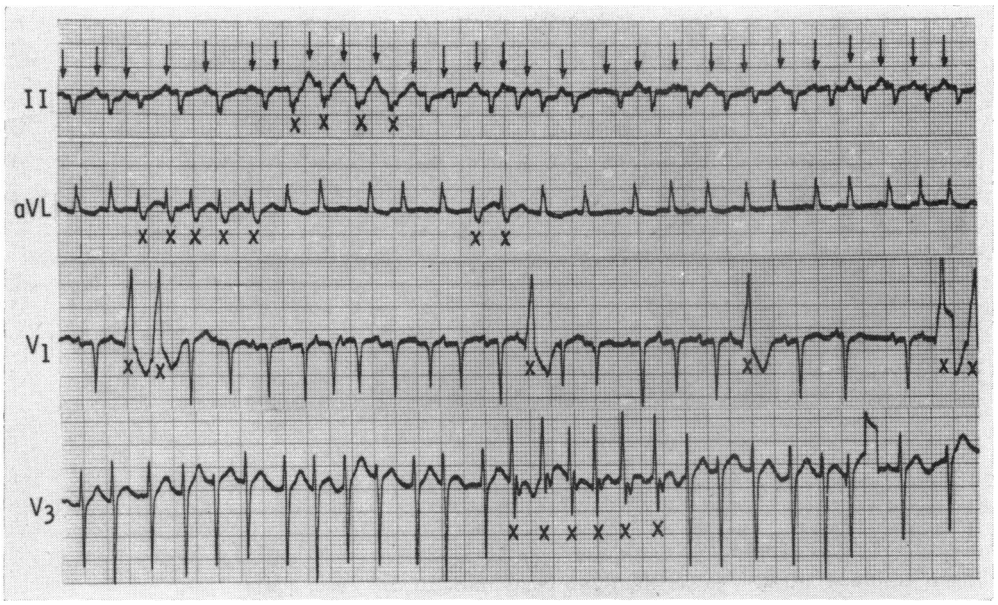
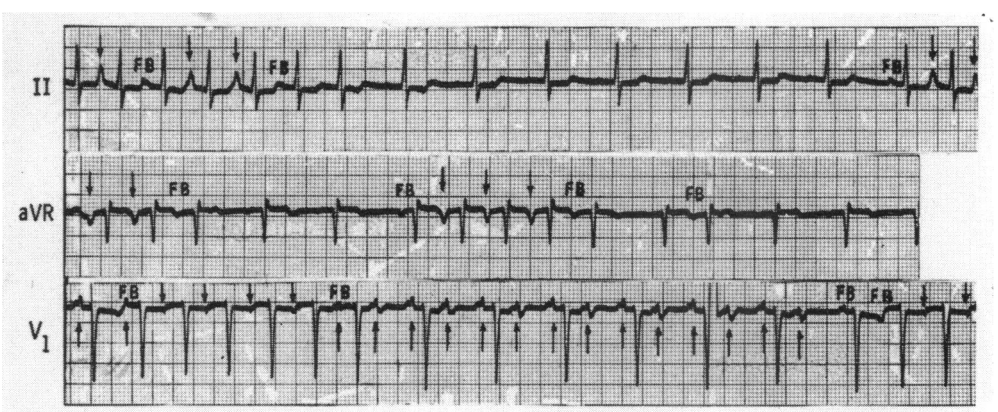


FIG. 4 *Arrows indicate ectopic P waves. The rhythm is multifocal atrial tachycardia (atrial rate: 190–200/ min) with frequent aberrant ventricular conduction (marked X). The configuration of the P waves varies from beat to beat with varying PP cycles.*

Differential diagnosis Multifocal atrial tachycardia may resemble atrial fibrillation or flutter because of the irregularity of the PP cycles and the common association of irregular RR cycles. However, the presence of a definite ectopic P wave, rather than an atrial fibrillation or flutter wave, proves the diagnosis of multifocal atrial tachycardia. By auscultation, without an electrocardiogram, the differential diagnosis between multifocal atrial tachycardia and atrial fibrillation or flutter with varying AV response is impossible.

As described earlier, multifocal atrial tachycardia with aberrant ventricular conduction should be distinguished from ventricular tachycardia or fibrillation. Ectopic P waves

FIG. 5 *Double atrial tachycardia. Downward arrows indicate longer PP cycles (0·44 sec); this tachycardia (Type A) shows 1:1 AV conduction with first degree AV block (PR interval: 0·22 sec). Upward arrows indicate shorter PP cycles (0·34 sec); this tachycardia (Type B) shows 2:1 AV block. Atrial rate is 140/min in Type A and 175/min in Type B. Note frequent atrial fusion beats (marked FB). (Reproduced from Chung and Thomas, 1965.)*



preceding each QRS complex exclude the latter.

Atrial parasystole and atrial dissociation also produce additional ectopic P waves in addition to the basic rhythm, but the diagnosis is usually obvious. Detailed description of atrial parasystole and atrial dissociation is found elsewhere (Chung, Walsh, and Massie, 1964, 1965; Chung, 1968, 1970a).

Mechanism The mechanism of multifocal atrial tachycardia is the same as ordinary unifocal atrial tachycardia except that there is more than one atrial ectopic focus. Detailed description regarding the mechanism of atrial tachycardia has been described elsewhere (Chung, 1971).

Clinical significance and personal observations Multifocal atrial tachycardia is almost always found in seriously ill elderly individuals (Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1958; Weber and Phillips, 1966) and an average age of my study is 62 years old; more than 85 per cent are men. Probable causes of multifocal atrial tachycardia in 65 cases are listed in the Table.

TABLE *Probable causes of multifocal atrial tachycardia in 65 cases*

Probable causes	*No. of cases*	%
Chronic cor pulmonale	60	92·3
Digitalis intoxication	42	64·6
Coronary and/or hypertensive heart disease	34	52·3
Pulmonary embolism (or infarction)	7	10·7
Valvular heart disease	2	3·1
Congenital heart disease	1	1·5
Hypokalaemia	4	6·2
General anaesthesia	7	10·7

The commonest underlying cause of multifocal atrial tachycardia is chronic cor pulmonale which accounts for 92 per cent. The much higher incidence of chronic cor pulmonale in my study in comparison with previous reports by other authors (60–85%: Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1958; Weber and Phillips, 1966) is most likely due to a prevalence of coalminers among my study group. Digitalis intoxication is another common cause of multifocal atrial tachycardia which accounts for 64·6 per cent. The underlying disease, in this circumstance, is frequently chronic cor pulmonale (Chung, 1969, 1970b, c). In digitalis-induced multifocal atrial tachycardia, AV block of varying degree nearly always coexists to produce multifocal atrial tachycardia with varying AV block (Fig. 2). The extremely high incidence of digitalis intoxication in chronic lung disease is well known (Chung, 1969, 1970b, c). Coronary and/or hypertensive heart disease is also an often underlying heart disease (52·3%) which is frequently associated with severe congestive heart failure. Multifocal atrial tachycardia is not uncommonly observed after operation under general anaesthesia and this is attributed to hypoxia (Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1958; Weber and Phillips, 1966). Less commonly, multifocal atrial tachycardia may be observed in electrolyte imbalance, particularly hypokalaemia (6·2%), in pulmonary embolism or infarction (10·7%), in valvular heart diseases (3·1%), and in congenital heart disease (1·5%) (Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1968; Weber and Phillips, 1966; Surawicz, 1966). One interesting observation is that a large number of patients with multifocal atrial tachycardia have diabetes mellitus according to one study (Phillips *et al.*, 1969), but I was unable to support this finding. The exact role of diabetes mellitus in the development of multifocal atrial tachycardia has not been ascertained.

Multifocal atrial tachycardia is often refractory to the usual management, and treatment of the underlying disease is more important than the use of antiarrhythmic drugs (Chung, 1969, 1970b, c). Since chronic lung disease is frequently the underlying pathology, improvement of pulmonary function and control of superimposed infection are usually more beneficial than various antiarrhythmic drugs. Phenytoin, lignocaine, procainamide, propranolol, and quinidine have been used but are usually not satisfactory (Chung, 1969). Digitalis may be effective when multifocal atrial tachycardia is associated with congestive heart failure. When multifocal atrial tachycardia is due to digitalis intoxication, needless to say, digitalis should be discontinued immediately (Chung, 1969). Potassium administration is often effective for the treatment of multifocal atrial tachycardia in digitalis intoxication with or without hypokalaemia. DC shock may be tried when all available measures are exhausted, but again the effectiveness is not promising. It should be noted that new cardiac arrhythmias, particularly ventricular fibrillation, may develop after DC shock when the patient is taking digitalis (Chung,

1969, 1970b, c; Kleiger and Lown, 1966; Szekely *et al.*, 1969).

The mortality rate in multifocal atrial tachycardia is extremely high (50–60%) regardless of the treatment (Phillips *et al.*, 1969; Shine *et al.*, 1968; Abrams and Eaddy, 1965; Katz and Pick, 1956; Corazza and Pastor, 1958; Weber and Phillips, 1966; Chung, 1969). The reason for this is that multifocal atrial tachycardia is frequently encountered in severely ill and elderly patients with long-standing chronic cor pulmonale, intractable congestive heart failure, and digitalis intoxication.

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