

## Multifocal Atrial Tachycardia

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Multifocal atrial tachycardia (MAT, also known as chaotic atrial rhythm) is an unusual arrhythmia in children. The defining characteristics—P-waves of three or more distinct morphologies with irregular P–P intervals in the context of a rapid rate, greater than 100 beats per minute—are the same as those in adults (Figure 1).

### Clinical Context

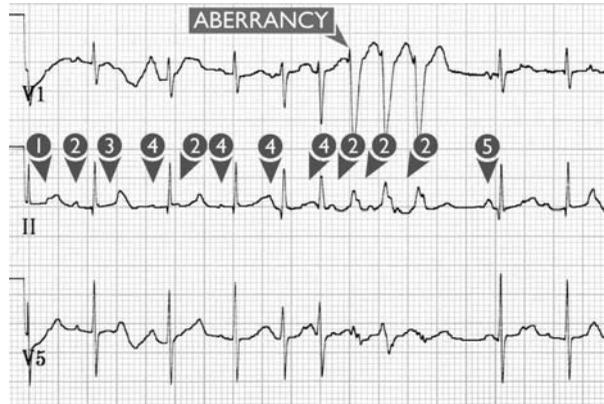
Whereas the adults with MAT are nearly uniformly affected with severe chronic lung disease, pediatric patients with MAT are a heterogeneous group including some of the healthiest and the most severely ill. In all large pediatric series, a significant association (30%–60%) is observed between MAT and respiratory illness, including both infectious processes, such as bronchiolitis or croup, and non-infectious conditions such as respiratory distress syndrome of prematurity and bronchomalacia. Resolution of the arrhythmia does not always exactly parallel recovery from the respiratory illness or treatment of it. Nor does oxygen saturation *per se* appear linked to the presence of MAT.

MAT in the context of severe, life-threatening illness, including myocarditis, complex cyanotic heart disease and birth

asphyxia has been described. Patients with structural heart disease may comprise up to 33% of pediatric MAT. The routine cardiac monitoring of cardiac patients while in the hospital for management of the cardiac malformation probably leads to overrepresentation of this patient subgroup. No particular cardiac lesions have emerged as associated with the incidence of MAT, although coarctation of the aorta, hypertrophic cardiomyopathy, atrial septal defect, tetralogy of Fallot, and complex single ventricle lesions have been reported. Thus, a thorough evaluation of the patient with newly diagnosed MAT is necessary to identify any coexisting conditions that may impact the patient's prognosis.

The most common presentation of MAT, in approximately half of cases, is as an incidental finding in an otherwise healthy infant. The markedly rapid and irregular rhythm may be an unexpected observation in a presumed "well" child. A history of recent viral upper respiratory symptoms may be elicited, but in many patients there is none. Such children may feed and grow normally, without any evidence of abnormality or congestive heart failure.

As in other forms of supraventricular tachycardia, sustained or recurrent, rapid MAT has the potential to affect cardiac



**FIGURE 1.** Three electrocardiograph leads (I, II, III) in a 3-month-old boy with MAT. Note the five different P-wave morphologies (arrows). Note also the aberrant conduction (complexes 8–10 from the left). Reprinted with permission from Bradley DJ et al. Clinical course of MAT in infants and children. *J Am Coll Cardiol* 2001;38:401–408, the American College of Cardiology Foundation.

function, sometimes severely. In our published series, 27% (4 of 15) patients who had echocardiograms demonstrated either dilation of cardiac chambers or abnormal indices of function. Longitudinal follow-up of these patients has revealed that the cardiac function normalizes once the arrhythmia resolves or is brought under control.

Most children diagnosed with MAT are infants, and those over five years of age are rare. In our experience, 1 (5%) was over a year old at presentation, and three demonstrated heart rate irregularity on fetal monitors.

### Incidence

MAT accounts for a very small proportion of arrhythmias treated in major pediatric cardiology centers. As an estimate of its incidence in healthy newborns, in a survey of the heart rhythms of 3,383 infants by ambulatory monitoring, two (0.02%) were found to have MAT.

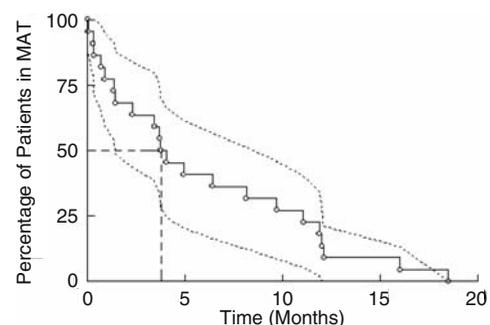
### Clinical Course

The course of MAT, regardless of treatment, is self-limited. Half of patients will have no residual evidence of MAT five months after

diagnosis (Figure 2). In our long-term follow-up, recurrence has not been observed.

### Electrocardiographic Features

MAT is typically extremely irregular and can be very rapid, with atrial rates as high as 400 beats per minute. Care must be taken to identify different P-wave forms on the ECG, although the effort to find them is often prompted by MAT's signature ECG appearance, which includes scattered,



**FIGURE 2.** Resolution of MAT. Fifty percent of patients (indicated by broken line) were free of arrhythmia five months after diagnosis. The dotted line indicates a 95% confidence interval. Reprinted with permission from Bradley DJ et al. Clinical course of MAT in infants and children. *J Am Coll Cardiol* 2001;38:401–408, the American College of Cardiology Foundation.



**FIGURE 3.** ECG tracing of MAT in a 5-month-old boy with three multiple P-wave morphologies with the aberrant conduction.

aberrantly conducted beats and pauses, due both to sinus node suppression after a run of MAT beats, as well as blocked conduction of premature atrial impulses (Figures 1 and 3). Prolonged ECG recordings demonstrate periods of sinus rhythm alternating with MAT in most patients.

### Mechanism

The multiple P waveforms on the electrocardiogram that characterize MAT suggest that the mechanism of the arrhythmia is possibly triggered activity at several ectopic sites. This mechanism has not, however, been demonstrated. If an ensemble of ectopic foci gives rise to the arrhythmia, it is unusual that they would fire together in bursts, rather than each creating spontaneous, unifocal atrial runs at separate times.

An alternative mechanistic explanation is variable propagation through the atrium of rapid impulses from a single focus. Supportive of this concept is one report of successful radiofrequency ablation of MAT in an infant at a single atrial site. Additionally, at least two reported patients had the diagnosis of (unifocal) ectopic atrial tachycardia prior to their diagnosis of MAT.

The poor response of MAT to direct current cardioversion and to overdrive pacing, however, along with the observed cycle length irregularity, is strong evidence that the mechanism is not re-entrant.

### Antiarrhythmic Therapy

The poor response of MAT to standard, “first-line” antiarrhythmic agents compels the clinician to make the assessment whether treatment is indeed necessary. Though correction of magnesium deficit, administration of beta blockers (such as metoprolol) and calcium channel blockers (verapamil) are reported effective in adults, no consistent response to any of these in pediatric patients has been described. The reported treatment strategies are varied, however, and no well-designed trials have been carried out. With regard to beta-blockade, the few reported patients with MAT treated with propranolol have shown no clear response. Probably due to its known, albeit rare, potential to cause hemodynamic collapse in infants, verapamil has not been described for MAT in children. Flecainide was of reported benefit in two patients. Amiodarone however, appears to be the current treatment of choice for pediatric MAT, when treatment is necessary.

### Patient Management

The asymptomatic infant with newly diagnosed MAT who has no evidence of inter-current illness, cardiac anomaly or dysfunction may be observed regularly as an outpatient without further investigation. Follow-up should include ECG and ambulatory (Holter) monitoring, as MAT may occur

sporadically and not be detected on ECG alone. The patient should be followed until there is no further evidence of MAT. An excellent outcome can be anticipated.

The patient with any suspected cardiac pathology should have anatomy and function defined by echocardiogram. Concurrent illness should be treated. Periods of MAT can be expected to alternate with sinus rhythm on cardiac monitor. If the patient's reduction in cardiac function is significant or complicates other conditions, medical therapy with amiodarone should be begun. Outcome in such patients will depend on recovery of function and resolution of the associated condition. Once the rhythm has normalized, recurrence is not expected.

## SUGGESTED READING

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