Multifocal Atrial Tachycardia  
(Chaotic Atrial Tachycardia)  
Clinical Associations and Significance  

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SUMMARY
Multifocal atrial tachycardia, also designated "chaotic atrial tachycardia," was identified in the records of 31 patients. It was particularly noted that the arrhythmia progressed to atrial fibrillation or flutter in 17 cases (55%). Unifocal or multifocal premature atrial contractions preceded the arrhythmia in 20 cases (64%). The arrhythmia developed during an acute illness in 18 cases (58%). However, it occasionally occurred in paroxysms without an apparent cause in patients with chronic disease. Significant acute or chronic pulmonary disease was present in 12 cases (39%). The arrhythmia was not associated with digitalis toxicity or with rhythm disturbances known to occur in digitalis intoxication such as paroxysmal atrial tachycardia with block. In general, digitalis therapy seemed to have little effect on the course of the arrhythmia, but in some cases it appeared to be beneficial, especially if atrial fibrillation supervened. In several patients there seemed to be a transition from multifocal premature atrial contractions through chaotic atrial tachycardia to atrial fibrillation. These observations suggested that chaotic atrial tachycardia might be a forewarning of atrial fibrillation and that the two arrhythmias may have a similar mechanism.

Additional Indexing Words:
Arrhythmia Atrial fibrillation and flutter Chaotic atrial mechanism  
Digitalis therapy and toxicity Electrocardiogram Premature atrial contractions  
Pulmonary disease

T HIS REPORT presents a review of 31 cases of an arrhythmia which we have termed "chaotic atrial tachycardia." It has been variously designated as multifocal atrial tachycardia and repetitive multifocal paroxysmal atrial tachycardia.¹ ² Descriptions of arrhythmias with similar features, usually without reference to a specific term, have been infrequent.³⁻⁸ The essential features of the arrhythmia are a rapid atrial rhythm, varying P-R interval, irregular P-P intervals, and changing P-wave morphology. Pathogenesis has not been defined and several different explanations of the arrhythmia have been presented. Some have stated that the disturbance of rhythm is unique and not related to other atrial tachycardias; others have thought that it was a variant of atrial fibrillation. The arrhythmia is probably more common than generally realized but may have been infrequently identified because of its transient nature and conversion to a more stable familiar rhythm such as atrial fibrillation.

Methods
The records of supraventricular arrhythmias of adult patients over a 6-year period at the New England Medical Center Hospitals were examined. Chaotic atrial tachycardia was defined as a rhythm with an atrial rate of over 120/min, P

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waves of different morphology, and a changing P-R interval for three consecutive beats. The patients’ records were reviewed for clinical and electrocardiographic associations as indicated in Table 1. Particular attention was paid to the identification of any arrhythmias that preceded and succeeded the episodes of chaotic atrial tachycardia. Special care was taken to identify the arrhythmia in more than one lead, as occasionally respiratory movements caused marked continuous changes in P-wave morphology in a single lead that superficially resembled chaotic atrial tachycardia. This problem was circumvented by examining all leads rather than a single rhythm strip. Thirty-one patients satisfying the above criteria were identified. There were 19 males and 12 females. The ages ranged from 40 to 88 years with a mean of 68 years.

**Table 1**

<table>
<thead>
<tr>
<th>Clinical and Electrocardiographic Associations of Chaotic Atrial Tachycardia: Clinical or Electrocardiographic Factor</th>
<th>Frequency in 31 cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsequent premature atrial contractions</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td>Pre-existing premature atrial contractions</td>
<td>20</td>
<td>64</td>
</tr>
<tr>
<td>Pre-existing sinus tachycardia</td>
<td>19</td>
<td>61</td>
</tr>
<tr>
<td>Recurrence of chaotic atrial tachycardia</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>Acute illness</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>Subsequent atrial flutter or fibrillation, or both</td>
<td>17</td>
<td>55</td>
</tr>
<tr>
<td>Subsequent atrial fibrillation</td>
<td>14</td>
<td>45</td>
</tr>
<tr>
<td>Apparent benefit from digitalis (tried or increased in 24 cases)</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>Obstructive pulmonary disease</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>Persistence of rhythm for less than 1 day</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Clinical evidence of hypoxia</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Death of patient during the hospital course</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Pre-existing atrial fibrillation</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>Rhythm development during a first postoperative day</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Hypokalemia (potassium under 3.5 mEq/L)</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Pre-existing chronic multifocal premature atrial contractions</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Suspicion of digitalis toxicity</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Association with paroxysmal atrial tachycardia</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Association with paroxysmal atrial tachycardia with block</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

devolved atrial fibrillation during their hospital course. The chaotic atrial tachycardia usually converted to the atrial fibrillation within a few hours or days without any intervening sinus or other atrial mechanism. Atrial flutter followed chaotic atrial tachycardia in a few cases.

Chaotic atrial tachycardia was associated with an acute illness in 18 cases (58%), but many episodes occurred in the course of a chronic illness without apparent worsening of the patient’s condition. In a few cases it appeared without apparent cause in seemingly healthy persons. There was an association with obstructive pulmonary disease (12 cases, 39%). Nine patients died during the course of the hospitalization (29%). However, death was not attributable to the arrhythmia in any case.

There appeared to be little relationship between chaotic atrial tachycardia and digitalis toxicity. Only two of the patients were suspected of having digitalis intoxication. Even in these two cases, the relationship of
Patient M. M. who had acute congestive heart failure, chronic coronary heart disease, and chronic obstructive pulmonary disease. The patient's electrocardiograms showed an apparent progression from premature atrial contractions (PAC) through chaotic atrial tachycardia to atrial fibrillation. The records also illustrated the appearance of chaotic atrial tachycardia during an acute illness in a person who usually had a sinus rhythm. (In this and other figures only lead II is shown.)

digitalis intoxication to chaotic atrial tachycardia was unclear because the patients were acutely ill, a state which in itself showed a high correlation with chaotic atrial tachycardia in these studies. In this regard, there was a complete absence of conversion from chaotic atrial tachycardia to paroxysmal atrial tachycardia with block. Similarly, only one case of chaotic atrial tachycardia seemed to convert to paroxysmal atrial tachycardia; however, this patient had a history of paroxysmal atrial tachycardia.

Pre-existing premature atrial contractions were recorded in 20 cases (64%). In five cases (16%) they took the form of chronic multifocal premature atrial contractions. Some patients who developed chaotic atrial tachycardia had a long history of unifocal or multifocal premature atrial contractions. An example of this is shown in figure 5. In some cases the chaotic atrial tachycardia seemed to be an
extension of the tendency for multifocal premature atrial contractions. In a similar manner, some patients appeared to have a pre-existing atrial rhythm which could be called a changing or multifocal atrial pacemaker. Examples of this are shown in figures 2 and 7.

However, many patients developed the rhythm of chaotic atrial tachycardia without a pre-existing disturbance of rhythm. Some patients had had records showing normal sinus rhythm without premature atrial contractions going back over many years. Examples of this are illustrated in figures 1, 3, 4, and 6.

In general, chaotic atrial tachycardia lasted a relatively short time. It disappeared within 1 day in 10 cases (32%). When it lasted longer, no single episode exceeded a period of 1 week. However, recurrences were common. Chaotic atrial tachycardia was an uncommon arrhythmia and was found in only 31 cases out of a total of 60,000 electrocardiograms taken during a 6-year period. Yet it is probable that a larger number were not recorded due to the transient nature of the rhythm disturbance.

The patients with chaotic atrial tachycardia seemed to have a diagnostic spectrum of heart disease expected in adult patients in a general hospital. Coronary heart disease was present in 21 cases (68%). Rheumatic valvular disease was present in four cases (13%).

Patient P. P. who had chronic obstructive pulmonary disease and chronic coronary heart disease. The patient illustrated the association of chaotic atrial tachycardia with a basically changing atrial pacemaker. The records also seemed to show the progression of chaotic atrial tachycardia to atrial fibrillation on two separate occasions.
pulmonary disease without evidence of coronary heart disease was present in three cases (10%). There was one case of systemic lupus erythematosus in a patient with evidence of coronary heart disease. There were no cases of myocarditis or congenital heart disease, and in general, rare forms of heart disease were not noted.

Discussion

Prefibrillatory Associations of Chaotic Atrial Tachycardia

One of the most striking findings of this study was the occurrence of atrial fibrillation or atrial flutter, or both, following chaotic atrial tachycardia. This course occurred in 17 cases or 55% of this series. A common sequence was the appearance of unifocal or multifocal premature atrial contractions (20 cases, 64%), then chaotic atrial tachycardia, followed by atrial fibrillation. This series of events is illustrated in figures 1, 2, and 3. Because of this association, in our clinical services, chaotic atrial tachycardia had earned the reputation of heralding the onset of atrial fibrillation. This process sometimes occurred in a condensed form after cardioversion for atrial fibrillation in which post-conversion sinus rhythm was transformed into a rhythm resembling chaotic atrial tachycardia, which in turn rapidly changed to atrial fibrillation. This is illustrated in figure 8. It was also noted that atrial fibrillation preceded chaotic atrial tachycardia in eight cases (26%). Thus, in these studies there was a strong association both in electrocardiographic and clinical terms, between chaotic atrial tachycardia and atrial fibrillation. It was of interest that the finding of the frequent progression of chaotic atrial tachycardia to atrial fibrillation has not been emphasized. Shine and his associates noted chaotic atrial tachycardia in some patients with atrial fibrillation after they had received digitalis. However, they did not report on the incidence of atrial fibrillation following chaotic atrial tachycardia. Parkinson and Papp reported a link among "auricular systole, repetitive auricular tachycardia, and auricular flutter and fibrillation." In reviewing

Figure 3

Patient N. N. who had carcinoma of the lung with mediastinal metastasis but little change in clinical course over a long period of time. The records illustrate the appearance of chaotic atrial tachycardia in a person with a basic sinus rhythm and the conversion of chaotic atrial tachycardia to atrial flutter and then to atrial fibrillation.
Patient L. H., who had chronic coronary heart disease and chronic obstructive pulmonary disease and entered the hospital for an acute pulmonary infection. His usual rhythm was sinus. He showed the development of chaotic atrial tachycardia at a time when his condition had appeared to improve. Some of the records showed a rhythm transitional between multifocal premature atrial contractions and chaotic atrial tachycardia.

Conversely, chaotic atrial tachycardia was not associated with paroxysmal atrial tachycardia as conversion to the latter rhythm was noted in only one case. Parkinson and Papp did include in their 1947 report an occasional association between chaotic atrial tachycardia and paroxysmal atrial tachycardia. However, examination of their records indicate that some cases designated as paroxysmal atrial tachycardia would not be so identified by more recent criteria. These findings taken together were consistent with the conclusion that the mechanism of chaotic atrial tachycardia is related to that of atrial fibrillation and flutter and not to that of paroxysmal atrial tachycardia.
MULTIFOCAL ATRIAL TACHYCARDIA

The close association of chaotic atrial tachycardia and atrial fibrillation was such that commonly it was possible to trace the gradual progression of the arrhythmia from multifocal atrial beats, through chaotic atrial tachycardia, to atrial fibrillation. It appeared reasonable to conclude that the mechanism of the three disturbances of rhythm might be closely related.

**Association with Acute Illness and Pulmonary Disease**

Of the 31 patients studied, 18 (58%) had evidence of an acute illness. Nineteen (61%) had sinus tachycardia just before the onset of the chaotic atrial tachycardia. Twelve patients (39%) had a clinical history of chronic pulmonary disease. Many of these patients also had evidence of coronary heart disease. Previous reports have emphasized the association of this arrhythmia with acute illness and especially with acute pulmonary disease.\(^5\) The use of aminophylline in patients with pulmonary disease in association with the onset of the arrhythmia has been noted.\(^2\) Hypoxia as well as sinus tachycardia has been emphasized.\(^5\)\(^,\)\(^6\) In the present study the subsequent death rate during the same admission in nine cases (29%) was high. Yet the rhythm disturbance itself was benign, in that, although it occurred frequently in seriously ill patients, death was not attributed to it in any case. Illustrated in figure 4, is a case of chaotic atrial tachycardia which developed in a patient with acute exacerbation of chronic

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**Figure 5**

Patient J. F. who had stable chronic coronary heart disease and entered the hospital for evaluation of unexplained fainting attacks. Some electrocardiograms revealed paroxysmal chaotic atrial tachycardia, which seemed to be the cause of the syncopal attacks.
pulmonary disease. Although the association of chaotic atrial tachycardia with acute illness has been emphasized in recent years, its occurrence in a paroxysmal manner in normal children and young adults has been reported. In this series that consisted of adults, only one patient appeared to be normal.

**Response of Chaotic Atrial Tachycardia to Digitalis Therapy**

Chaotic atrial tachycardia was often brief and usually required no treatment. Occasionally, it was sufficiently prolonged or associated with a rapid ventricular response that it required treatment. In an occasional case, digitalis seemed to block transmission of some atrial impulses or to decrease the atrial rate. This is illustrated in figure 6. However, the majority of patients showed little response in rate to digitalis. Some improvement was suggested in 11 out of 24 cases in which digitalis was tried or increased. Interpretation of a favorable effect was made difficult by the brief life of the arrhythmia, the gravity of the condition of the patients, and the concurrent improvement in congestive heart failure attributed to digitalis and other agents. On the whole, our impression with regard to the effect of digitalis on slowing the ventricular response in chaotic atrial tachycardia was similar to that of Shine and associates who did not find it effective in this respect. However, the close association of the chaotic atrial tachycardia to atrial fibrillation in this study indicated the importance of digitalis therapy in order to control ventricular response in the event of the development of
MULTIFOCAL ATRIAL TACHYCARDIA

1. Patient's usual slow changing atrial pacemaker 1st day
2. Chaotic atrial tachycardia resembling atrial fibrillation 11th day
3. Chaotic atrial tachycardia more evident on another ECG of 11th day

Figure 7
Patient I. M. with chronic coronary heart disease who developed chaotic atrial tachycardia. One electrocardiogram seemed to show atrial fibrillation although careful study revealed an atrial wave before each QRS complex. Another electrocardiogram the same day with a better adjustment of electrocardiograph stylus showed the atrial waves of the chaotic atrial rhythm more clearly.

Figure 8
Patient J.F. who was subjected to cardioversion in an attempt to revert chronic atrial fibrillation. During both attempts sinus rhythm was briefly re-established. However, in the first few seconds following cardioversion, a rhythm appeared which resembled chaotic atrial tachycardia. This arrhythmia rapidly merged into one of stable atrial fibrillation.

atrial fibrillation. It should be noted, however, that digitalis therapy in chaotic atrial tachycardia is not for the primary purpose of controlling ventricular rate and should not be employed toward that end.

Absence of Association with Digitalis Toxicity
The arrhythmia did not seem to be related to digitalis intoxication (suspected in only two of our cases). Similarly, discontinuation of digitalis in a few cases in which digitalis was being taken did not seem to alter the disturbance of rhythm. There was little association with hypokalemia or with paroxysmal atrial tachycardia with block in this series, thus further emphasizing the fact that the arrhythmia does not have the common associations of digitalis toxicity.

Paroxysmal Chaotic Atrial Tachycardia Without Acute Illness
Although the rhythm of chaotic atrial tachycardia was often associated with acute disease and pre-existing sinus tachycardia, it occasionally occurred in the course of chronic illness apparently without an acute change in the clinical condition. In one case, illustrated in figure 5, the patient suffered fainting...
attacks during certain episodes of chaotic atrial tachycardia, and this association was only discovered after admission during the investigation. A case of chaotic atrial tachycardia in the absence of acute illness is illustrated in figure 3.

Concerning the pathogenesis of chaotic atrial tachycardia, argument could be raised that the arrhythmia could be explained by the simultaneous existence of premature atrial contractions and sinus tachycardia under the influence of excess sympathetic activity. However, the occurrence of paroxysmal chaotic atrial tachycardia in patients who were generally well or unchanged and who otherwise manifested slow sinus rhythms suggested that chaotic atrial tachycardia had features of an ectopic arrhythmia. Also, chaotic atrial tachycardia appeared to progress to atrial fibrillation in both the acutely ill and chronically ill patients.

Confusion with Atrial Fibrillation

The electrocardiogram of chaotic atrial tachycardia was sometimes difficult to read. Occasionally it resembled atrial fibrillation. This occurred in some leads because the mean atrial vector was directed perpendicular to that lead. It also occurred throughout the electrocardiogram when the stylus pressure was not correct, and stylus insensitivity obscured the small P wave before each QRS. An example of this is shown in figure 7.

Relationship Between Chaotic Atrial Tachycardia and Chaotic Atrial Mechanism Without Tachycardia

Recently it has been proposed that chaotic atrial tachycardia is part of the spectrum of a rhythm disturbance called "chaotic atrial mechanism" in which there is a slow multifocal atrial pacemaker. The present study seems to suggest that chaotic atrial tachycardia differs somewhat from a simple slow, changing atrial focus. In an occasional case, as in figures 2 and 4, the two arrhythmias were associated. But in general, there were many points of difference between the two. As compared to chronic slow chaotic atrial mechanism, the arrhythmia of chaotic atrial tachycardia was less common, appeared less stable, was more prone to convert to atrial fibrillation, and had more unfavorable effects on blood pressure. In this study only five patients (16%) had evidence of pre-existing chronic multifocal premature atrial contractions or multifocal atrial pacemaker. Most patients had pre-existing unifocal premature atrial contractions or sinus rhythm. On the other hand, in a review of other patients' records, many were found with a slow changing atrial focus, similar to that described for slow chaotic atrial mechanism, in which the rhythm lasted for years without any evidence of chaotic atrial tachycardia or atrial fibrillation. This slow chaotic atrial mechanism was often chronic, stable, and responsive to physiologic needs in a relatively normal manner. Thus, categorization of chaotic atrial tachycardia and a slow wandering, changing atrial pacemaker in the same spectrum of rhythm disturbance seemed unwarranted. Such a grouping would also tend to obscure the fact that the rapid chaotic atrial tachycardia had a marked association with subsequent or impending atrial fibrillation.

Considerations Concerning the Mechanism of Chaotic Atrial Tachycardia

The arrhythmia of chaotic atrial tachycardia seemed to be related in occurrence and pathogenesis to atrial fibrillation. The following associations and arguments seemed to lead to this conclusion: (1) It appeared before and after atrial fibrillation with a high frequency. (2) It appeared as a transitional rhythm during the conversion of atrial fibrillation to sinus rhythm and vice versa. (3) It appeared as a transitional rhythm after unsuccessful cardioversion of atrial fibrillation before atrial fibrillation reappeared. (4) As with atrial fibrillation, it did not seem to be associated with paroxysmal atrial tachycardia, paroxysmal atrial tachycardia with block, or digitalis toxicity. (5) As with atrial fibrillation, chaotic atrial tachycardia occurred both in patients who were acutely ill and in patients who were in the stable phase of a chronic condition. In both types of illness, chaotic atrial tachycardia frequently progressed to atrial fibrillation.
Chaotic Atrial Tachycardia
as a Unique Arrhythmia

This report and the report of others have concluded that chaotic atrial tachycardia is a distinctive electrocardiographic and clinical entity. We believe this to be justified in that the arrhythmia had the morphologic features which seemed to separate it from other supraventricular tachycardias. For example, it differed from the arrhythmia of sinus tachycardia with multifocal PACs by its paroxysmal nature and the fact that it often interrupted slow sinus mechanisms. In addition, the recognition of chaotic atrial tachycardia as a distinct entity points to its usual clinical associations and the probability of its progression to atrial fibrillation.

References
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