Two Varieties of the Onset of Atrial Fibrillation Studied by Monophasic Action Potential Recording

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SUMMARY

Two types of the initiation of atrial fibrillation are demonstrated in the continuous recordings of right atrial monophasic action potentials. In the first way, more common, atrial fibrillation takes place suddenly after an extrasystolic atrial beat, in the second one it develops gradually after atrial tachycardia. In the first type the micro reentry starts from the beginning, in the second type only after sustained focal atrial tachycardia.

Additional Indexing Words:
Atrial fibrillation  Monophasic action potential

THE monophasic action potential (MAP) obtained by a suction electrode technique is useful in the study of atrial arrhythmias, allowing a magnification of the electrical atrial activity and providing informations about the refractoriness of the myocardium.1)-5)

Atrial fibrillation is a complex atrial arrhythmia, and may be initiated by an isolated atrial premature beat or it may be transformed from atrial tachycardia or atrial flutter.6),7)

The aim of this work is to illustrate the 2 ways of the onset of atrial fibrillation in 2 patients by continuous recording of the right atrial MAP.

METHOD AND RESULTS

In order to record right atrial MAP a suction electrode catheter technique, described elsewhere, has been used.3),4)

In 2 patients with hyperthyroidism who spontaneously developed transitions from sinus rhythm to atrial fibrillation, the onset of atrial fibrillation was studied by continuous recording of right atrial MAP.

The recordings obtained from Case 1, a 36-year-old man with hyperthyroidism, are shown in Fig. 1 and 2, where right atrial MAP, intracavitary ECG and...
standard lead ECG were recorded simultaneously. In Fig. 1, the third MAP is an atrial premature beat, with a coupling interval of 360 msec, and a coupling index of 58%. The tenth complex is also an atrial premature beat, with a coupling interval of 300 msec, and the coupling index of 48%, followed by atrial fibrillation. The electrophysiologic data of this patient are shown in table I.

Case 2 is a 46-year-old man, with coronary heart disease and hyperthyroidism. The transition from sinus rhythm to atrial fibrillation, through atrial tachycardia and atrial flutter are shown in Figs. 3, 4, 5, and 6. In Fig. 3 the sinus rhythm is shown. The third complex is an atrial premature beat. In Fig. 4 atrial tachycardia with A-V block, in Fig. 5 atrial flutter with A-V block, and then in Fig. 6 atrial fibrillation are shown. This transition was accomplished during an hour,
Fig. 3. Simultaneous recording of lead II and right atrial monophasic action potential (RAMAP). Paper speed is 100 mm/sec.

Fig. 4. Simultaneous recording of lead III and right atrial monophasic action potential (RAMAP). Paper speed is 100 mm/sec.

Fig. 5. The same recording as in Fig. 4.
Fig. 6. The same recording as in Fig. 4 and 5.

Table II.

<table>
<thead>
<tr>
<th></th>
<th>MAP duration (s)</th>
<th>MAP amplitude (mV)</th>
<th>Atrial rate per min</th>
<th>Ventricular rate per min</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>180/250/280</td>
<td>4</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>AT</td>
<td>150/220/230</td>
<td>3.9</td>
<td>180</td>
<td>120</td>
</tr>
<tr>
<td>A Fl</td>
<td>175/7</td>
<td>3.8</td>
<td>340</td>
<td>120</td>
</tr>
<tr>
<td>AF</td>
<td>117/14</td>
<td>3.1</td>
<td>528</td>
<td>96</td>
</tr>
</tbody>
</table>

(x)—The 3 numbers represent the durations of MAP at 50%, 90%, and 100% levels of the amplitude.

SR = sinus rhythm, AT = atrial tachycardia, A Fl = atrial flutter, AF = atrial fibrillation.

The electrophysiologic data of this case are shown in Table II.

In both patients, the durations of right atrial MAP were shorter than the values found in normal patients (325 msec), and this may be explained as related to hyperthyroidism.8)

The relations between MAP duration and atrial rate, in both cases, during transition from sinus rhythm to atrial fibrillation are graphically represented in Fig. 7.

DISCUSSION

In both clinical and experimental studies, 2 modes of initiation of atrial fibrillation have been identified. The first type is a rapid onset of fibrillation with one premature atrial beat occurring early in the repolarization phase, during the vulnerable period, while the other type shows a gradually disorganized excitation after sustained period of tachycardia.7),9)

The atrial inhomogeneity is manifested by early premature atrial beat, or by gradual deterioration of the electrophysiologic events such as variation...
Fig. 7. The relation between monophasic action potential duration (MAP dur.) in msec, and atrial rate per minute, in both Cases 1 and 2, during the period of transition from sinus rhythm to atrial fibrillation.

Many works in the literature have studied the onset of atrial fibrillation, and it was demonstrated that the relapse into atrial flutter or atrial fibrillation was always preceded by an atrial premature beat, with a short coupling interval and a small coupling index. The arrhythmia takes place suddenly after the extrasystolic beat, and the first MAP has a longer duration than the following ones, during the whole period of arrhythmia. This way is shown by our first case.

The second way of onset of the atrial fibrillation is rather seldom. From sinus rhythm the first step is an atrial tachycardia, and then atrial flutter and finally atrial fibrillation. This gradual transition from sinus rhythm to atrial fibrillation is shown in our second case. We have observed and published such a gradual and reversed transition from atrial flutter, through atrial tachycardia, to sinus rhythm, after ajmalin given intravenously.

In the first type, which takes place suddenly after an atrial premature beat, the initiating mechanism is the micro reentry.

In the second type, the first step is an enhanced focal activity, atrial
tachycardia, the mechanism of which is suggested to be an unifocal activity instead of reentry mechanism, and then the micro reentry phenomenon follows.\textsuperscript{14),\textsuperscript{15)}

The short right atrial MAP duration in sinus rhythm indicating decreased myocardial refractoriness may explain the likelihood of the initiation of atrial fibrillation.\textsuperscript{5),\textsuperscript{8)}

A close relation, between atrial rate and atrial MAP duration during the transitions from sinus rhythm to atrial fibrillation is demonstrated as can be seen in Fig. 7.\textsuperscript{11)

**REFERENCES**

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