Intra-Atrial Block

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Attention is drawn to differences of opinion regarding the upper normal limit of P-wave duration and the definition of intra-atrial block. There seems to be good reason for accepting 0.11 sec. as the upper limit of normal and a P-wave duration of 0.12 sec. or more as indicative of intra-atrial block. By this criterion 4,500 consecutive electrocardiograms taken in a general hospital were examined and the findings are reported.

Although proposed definitions of intra-atrial block vary, a number of authorities consider that the criterion for diagnosis is a P wave measuring 0.12 sec. or longer. It is our impression that most electrocardiographers pay little attention to the duration of the P wave in routine interpretation and consequently have little conception of the relative frequency of intra-atrial block. Systematic scrutiny of the P waves in the course of interpreting records in a general hospital has revealed that intra-atrial block, as defined above, is a common finding, accounting for nearly one third of all types of blocks encountered.

The purpose of this communication is to draw attention to the high incidence of intra-atrial block and to discuss criteria for its diagnosis.

Material and Methods

All electrocardiograms were taken with Sanborn or Cambridge direct-writing instruments. In the course of daily interpretation of inpatient and outpatient records in a general hospital, the duration of P waves was routinely observed in 4,500 tracings, almost all of which were 12-lead records. The sole criterion for recording intra-atrial block was the finding in any lead of P waves measuring 0.12 sec. or more. When notching with peak interval of more than 0.04 sec. was present it was noted in addition; but where such notching occurred in the absence of a duration of 0.12 sec., intra-atrial block was not recorded.

The difficulties in exact measurement of P-wave duration are well appreciated. We have accepted P-wave prolongation only in those tracings in which the beginning and end of the P waves were clearly distinguishable in at least 1 lead. Where definition was not sufficiently clear, because, for example, of alternating current interference or muscle tremors, even though it seemed probable that the P waves spanned 0.12 sec., the diagnosis of intra-atrial block was not recorded. Other sources of error occur when the preceding U wave merges with the P wave making the true onset of atrial activity uncertain or when the P wave merges imperceptibly at its end with the Tp wave. When for either of these reasons the beginning or end of the P wave could not be determined with reasonable accuracy, intra-atrial block was not recorded even if it were suspected.

In the great majority of tracings, P-wave prolongation was noted and measured in 1 of the limb leads. But there would seem to be no good reason for selecting any particular lead or set of leads as the best arbiter of the duration of atrial activation and we have followed the logical dictum of Ashman and Hull that "the P wave must be measured in the lead where it is widest." We have also taken clarity of inscription into account and if P waves were unusually clearly written in precordial leads, 1 of these was used for more exact measurement. The actual number of times that each lead was used for the recorded measurement was as follows: lead I, 8; lead II, 124; lead III, 25; aVR, 22; aVL, 2; aVF, 17; V1, 1; V3, 3; V5, 1.

Results

Among 4,500 electrocardiograms consecutively interpreted by one of us, 203 (4.5 percent) were found to contain P waves of at least 0.12 sec. duration. These 203 tracings were derived from 150 patients. The incidence of P-wave durations is given in table 1 together with the incidence of significant notching found for each duration-group. Samples of various types of P waves classified as intra-atrial block are presented in figure 1.

Among these 4,500 tracings, there were 221 examples of atrioventricular block and 239 of
intraventricular block. The incidence of the various blocks encountered is detailed in table 2. It is clear that intra-atrial block, by the definition here employed, is almost as common as either atrioventricular or intraventricular block.

**Discussion**

**Definition of Intra-Atrial Block**

Katz reported "300" instances of intra-atrial block among "about" 47,000 records.

**Table 1.—Incidence of Various Durations of P Waves and the Incidence of Notching in Each Group**

<table>
<thead>
<tr>
<th>Duration (sec.)</th>
<th>Number</th>
<th>Notching</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.12</td>
<td>116</td>
<td>9</td>
</tr>
<tr>
<td>0.13</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>0.14</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>0.15</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>0.16</td>
<td>7</td>
<td>—</td>
</tr>
<tr>
<td>0.17</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Total</td>
<td>203</td>
<td>22</td>
</tr>
</tbody>
</table>

**Fig. 1.** Examples of P waves that indicate intra-atrial block. Those in the top row show gross prolongation (0.15 to 0.16 sec.) without true notching. Those in the middle row show gross notching with peak interval of 0.04 sec. or more. Those in the bottom row might well be passed as normal in routine interpretation, but they measure 0.12 sec. and, we believe, probably indicate atrial abnormality.

A and B are from aged patients with arteriosclerosis; C, F, and I are from patients with rheumatic heart disease; D is from a patient with severe hypertension shortly before the onset of atrial fibrillation; E is from another patient with severe hypertension who had previously had atrial fibrillation; G and H are also from hypertensive patients.
TABLE 2.—Incidence of the Various Heart Blocks in 4,500 Tracings

<table>
<thead>
<tr>
<th>Type of Block</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A block</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Intra-atrial block</td>
<td>205</td>
<td>30</td>
</tr>
<tr>
<td>A-V block</td>
<td>221</td>
<td>33</td>
</tr>
<tr>
<td>first degree*</td>
<td>195</td>
<td>29.1</td>
</tr>
<tr>
<td>second degree†</td>
<td>18</td>
<td>2.7</td>
</tr>
<tr>
<td>complete†</td>
<td>8</td>
<td>1.2</td>
</tr>
<tr>
<td>Intraventricular block</td>
<td>239</td>
<td>36</td>
</tr>
<tr>
<td>complete LBBB</td>
<td>77</td>
<td>11.5</td>
</tr>
<tr>
<td>complete RBBB</td>
<td>70</td>
<td>10.4</td>
</tr>
<tr>
<td>others§</td>
<td>92</td>
<td>13.7</td>
</tr>
</tbody>
</table>

* Excluding isolated finding with atrial premature beats or after interpolated ventricular premature beats.
† Excluding the block associated with atrial flutter and tachycardia.
‡ Excluding those instances associated with atrial fibrillation.
§ Including incomplete BBB, peri-infarction and other atypical intraventricular blocks.

(about 0.64 per cent). This represents an incidence about one seventh of ours. In Katz’ series, however, it is not certain what criterion was used for the diagnosis, because he defined intra-atrial block differently at 2 places in his text. On page 772 he required a P wave “prolonged to or beyond 0.12 sec., especially if notched and large,” whereas on page 142 he stated that P waves “over 0.12 sec. are abnormal, and those between 0.10 and 0.12 sec. should be viewed with suspicion.” If in our series only those P waves measuring 0.13 sec. or more are accepted as evidence of intra-atrial block, we are left with a total of 87 records giving an incidence of 1.9 per cent; this is still 3 times the approximate incidence recorded by Katz. It is of interest that in the revised volume by Katz and Pick,4 in which the table of incidence of the various arrhythmias is now based on about 100,000 records, intra-atrial block has been omitted from the table.

Emphasis is often placed on notching as well as prolongation of P waves. Bellet7 gave as his requirements for intra-atrial block a P wave of more than 0.12 sec. duration that is also tall and notched. We do not believe that either notching or height is necessary to the diagnosis of intra-atrial block. The records A, B, and C in figure 1 all show gross prolongation and therefore, we believe, give unequivocal evidence of intra-atrial block. None of the 3 shows true notching and A shows little amplitude. All 3 were from grossly diseased hearts.

Normal Upper Limit of P-Wave Duration

There is no uniformity of opinion concerning the normal upper limit of P-wave duration. Many authorities regard 0.10 sec. as the normal maximum, while, at the other extreme, some consider that a duration in excess of 0.12 sec. is sometimes a normal finding.

Evidence and Opinion Placing 0.10 sec. as the Upper Limit. White6 and Luisada,7 stated that the upper limit of normal was 0.10 sec. The Criteria Committee of the New York Heart Association1 defined a “broad” P wave as one that exceeded 0.10 sec. in 1 of the standard leads. Sorsky and Wood8 found a maximum P-wave width of 0.10 sec. in the limb leads of 114 normals, but the majority of their subjects were under the age of 16 years. Among 100 normal subjects Thomas and Dejong9 found no P waves of longer duration than 0.10 sec. Recently Gibert-Queralto and associates10 considered P waves in excess of 0.10 sec. to be abnormal.

Evidence and Opinion Placing 0.11 sec. as the Upper Limit. Ashman and Hull,2 Katz,3 Goldberger,11 Scher and Boyd,12 Burch and Winsor13 all stated that 0.11 sec. was the maximum normal duration. Among 100 normals Ashman and Hull found only 1 record in which P waves exceeded 0.10 sec. In a study of mitral valve disease and its influence on the electrocardiogram, White and his colleagues14 concluded that P waves of over 0.11 sec. duration in any lead should be considered abnormal. Stewart and Manning15 came to a similar conclusion after analyzing the records of 500 healthy airmen between the ages of 18 and 32; there were 37 examples of P waves longer than 0.10 in lead II, with fewer instances in the other standard leads. From their analysis they concluded that 0.12 sec. represented a significant prolongation.

Evidence and Opinion Placing the Upper Limit Above 0.11 sec. Among the champions of
longer normals, Lepeschkin\textsuperscript{16} stated that the upper limit was 0.12 sec. Shipley and Hallaran\textsuperscript{17} examined the records of 200 normal adults and found a P-wave duration of 0.11 sec. in 13, and 0.12 sec. in 3 (1.5 per cent). Graybiel and his co-workers\textsuperscript{18} found a similar incidence of 0.12 sec. P waves when they analyzed the tracings of 1,000 normal airmen between the ages of 20 and 30; 15 (1.5 per cent) had P waves in lead II measuring 0.12 sec., with smaller incidences in the other standard leads. It has been implied in a later work by Graybiel and co-authors\textsuperscript{19} that the normal P wave may rarely exceed 0.12 sec. in duration.

\textit{Justification for Applying the Term Intra-Atrial Block to Prolonged P Waves}

It is customary to apply the term intra-ventricular block to QRS complexes of 0.12 sec. or more (provided ectopic ventricular rhythms and pre-excitation have been excluded). The term is applied to widened complexes even when it is clear, or at least probable, that the widening is the result of ventricular enlargement rather than true block. By analogy, if one could establish an agreed critical limit for P-wave duration, it would be reasonable to apply the term intra-atrial block to all P waves exceeding this limit even when the presumable cause was atrial enlargement.

\textit{Justification for Adopting 0.11 sec. as the Upper Normal Limit of P-Wave Duration}

From 2 points of view we believe that the figure 0.11 can be justified. It is obvious that for P-wave duration, as with all biologic values, no clear-cut dividing line can be drawn between normal and abnormal. Wherever the line is drawn there will be some normals on the “abnormal” side of it and some abnormals on the “normal” side. The best that one can hope to achieve is to determine the point at which overlap is minimal. It is customary to place the upper limit of normality at a point that will contain 98 per cent of the normal population.\textsuperscript{20} To find this point one must obviously appeal to the largest available series of normals. The only 2 sizable series of normal adults in which we are given the number who had P waves of 0.11 and 0.12 sec. are those of Graybiel and associates\textsuperscript{18} and of Shipley and Hallaran.\textsuperscript{17} From these workers’ figures, involving a total of 1,200 normal subjects, it would seem that 98 to 98.5 per cent of normal subjects have P waves that measure less than 0.12 sec. By this standard, therefore, the line between “normal” and “abnormal” may reasonably be drawn between 0.11 and 0.12 sec.

A second approach is to observe what company the P wave in question keeps. An analysis of the 150 patients, from whom the 203 tracings showing intra-atrial block were obtained, shows that their electrocardiograms contained the following concomitant abnormalities:

- Left ventricular hypertrophy and strain ............. 68
- First degree A-V block ................................ 47
- Myocardial infarction, previous or contemporary .... 38
- ST-T abnormalities, nonspecific ....................... 27
- Atrial fibrillation, previous or subsequent ........ 18
- Left bundle-branch block .............................. 6
- Right bundle-branch block ............................. 6
- Complete A-V block .................................. 4
- Second degree A-V block .............................. 4
- Right ventricular hypertrophy and strain ............ 4
- Other abnormalities (incomplete intraventricular block, previous atrial flutter, etc.) ............. 10

In other words, the 150 patients showing intra-atrial block amassed between them a total of 234 other electrocardiographic abnormalities. Of these 150 there were only 7 patients whose tracings showed no other definite abnormality. Of these 7, 2 had hypertension and 1 suffered from angina and had previously been in congestive failure. Thus there were only 4 of the 150 patients with prolonged P waves in whom there was no good reason to suspect cardiac abnormality. Two of these 4 had P waves measuring 0.12 and the other 2 measured 0.13 sec. From this analysis we venture to conclude that the great majority of P waves measuring 0.12 sec. are associated with cardiac abnormalities and probably reflect atrial involvement.

\textit{Known Causes of P-Wave Prolongation}

A number of factors are known to be capable of lengthening the time of atrial activation. Digitalis, quinidine, and vagal stimulation all can increase the duration of the P wave.\textsuperscript{6}
Again, left atrial enlargement, as seen in mitral disease and in hypertension, produces lengthening of the P wave presumably mainly because of the additional time required for the impulse to reach the outposts of the enlarged atrium. Coronary sclerosis can also lead to P-wave prolongation; the best documented mechanism for this is impairment of blood flow through Condorelli’s artery (left anterior atrial artery), which supplies Bachmann’s bundle and other inter-atrial connections. Experimental occlusion of Condorelli’s artery or clamping of Bachmann’s bundle has been shown to produce intra-atrial block and even at times atrial dissociation.21, 22

In this connection it may be of interest to note the clinical associations in our series of prolonged P waves. Our figures are conservative because clinical information about many of the patients was incomplete as we are dependent to a large extent on data (often inadequate) supplied by private physicians at the time of referral for an electrocardiogram. Of the 150 patients, over half (79) were hypertensive, 56 had evidence of coronary disease, 11 had rheumatic, and 2 had syphilitic heart disease. At least 34 of the patients were taking digitalis and 6 were receiving quinidine.

Although Shipley and Hallaran7 and Ashman and Hull2 were unable to demonstrate any relationship between heart rate and duration of P waves, Lepeschkin16 stated, on what he admitted might be unreliable evidence, that P-wave duration decreases with increasing heart rate; from his graph it appears that a P wave measuring 0.09 sec. at a rate of 55 may be expected to measure 0.07 sec. at a rate of 135. It has apparently been shown recently that total atrial activity (P plus Tp) varies inversely with atrial rate.23 If further evaluation confirms that the duration of the P wave itself is related to rate, it will obviously be undesirable and inaccurate to abide by an arbitrary limit for P-wave duration that makes no allowance for the prevailing rate; further study may show, for instance, that 0.12 sec. is always an abnormal duration at a rate of 100 but is within normal range at half this rate.

Summary

In 4,500 consecutive electrocardiograms taken in a general hospital, P-wave duration was routinely noted. With a P-wave duration of 0.12 sec. or more as the criterion for diagnosing intra-atrial block, this diagnosis was recorded in 203 tracings, or 4.5 per cent. This incidence was almost as high as that of atrioventricular or intraventricular block in the same series. Only 22 of the 203 records showed significant notching of P waves (peak interval of 0.04 sec. or more). Criteria for the diagnosis of intra-atrial block are discussed and reasons for accepting 0.11 sec. as the upper normal limit of P-wave duration are given. Known causes of P-wave prolongation are briefly reviewed.

Sumario in Interlingua

In 4500 electrocardiogrammas consecutiva in un hospital general, le duration del unda P esseva notate rutinarimente. Un duration del unda P de 0,12 secundas o plus esseva usate como criterio del diagnose de bloco intra-atrial. Super iste base, le diagnose de bloco intra-atrial esseva obtenite in 203 registrasiones, i.e. in 4,5 pro cento del serie total. Iste incidentia esseva quasi tanto alte como le incidentia de bloco atrioventricular o intraventricular in le mesme serie. Solmente 22 del 203 registrasiones monstava significativa grandos de indentation del undas P (intervallo del culmines amontante a 0,04 secundas o plus). Es discutite criterios pro le diagnose de bloco intra-atrial. Es explicate le rationes pro le acceptation de 0,11 secundas como limite superior del duration normal del unda P. Le recognoscite causas del prolongation del unda P es revidite brevemente.

References


If "idle star-gazers" had not watched long and carefully the motions of the heavenly bodies—our modern astronomy would have been impossible, and without our astronomy "our ships, our colonies, our seamen," all which makes modern life could not have existed. Ages of sedentary, quiet, thinking people were required before that noisy existence began, and without those pale preliminary students it never could have been brought into being. And nine-tenths of modern science is in this respect the same: it is the produce of men whom their contemporaries thought dreamers—who were laughed at for caring for what did not concern them—who, as the proverb went, "walked into a well from looking at the stars."—WALTER BAGEHOT, 1826–1877.
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Circulation. 1956;14:1073-1078
doi: 10.1161/01.CIR.14.6.1073
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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