Atrioventricular Block in Acute Myocardial Infarction

Arthur B. Simon, M.D., William E. Steinke, M.D., and John J. Curry, M.D.

One hundred thirty-four patients with acute myocardial infarction complicated by various degrees of A-V block are presented. First degree block was seen in 11.8 percent of all myocardial infarction patients; one-third of these—many with a P-R interval of 0.24 seconds or more—progressed to a higher level of block. Those with first degree block only had an equal incidence of anterior and inferior sites of infarction; block often persisted throughout the hospital course and the mortality rate was 18.3 percent, which did not differ from that of nonblock patients. Some myocardial infarction patients (4.8 percent) demonstrated second-degree block. Those who did not progress had a mortality rate of 41.4 percent. Not uncommonly, this block was associated with congestive heart failure, hypotension or digitalis toxicity. Onset of block tended to be delayed until the third hospital day, possibly because of the development of digitalis toxicity. Inferior myocardial infarction was more common than anterior. Type I block (Wenckebach) occurred much more frequently than type II. Complete heart block occurred in 45 (5.9 percent) of myocardial infarction patients with a mortality rate of 64.4 percent. Fifty-three percent of the patients were in shock at the time complete block was discovered. Onset of block and death were early phenomena and duration was brief. Eight of the 45 had anterior myocardial infarction, but only one survived.

The extensive use of coronary care facilities and continuous monitoring of patients with acute myocardial infarction has enhanced our knowledge of arrhythmias which occur during the acute phases of the illness. Atrioventricular (AV) block occurring during the course of acute myocardial infarction (AMI) has been the subject of several comprehensive reviews, and data concerning its frequency and associated morbidity and mortality have been previously reported.

The purpose of this report is to describe the onset and subsequent clinical course of AV block in a group of continuously monitored patients who had a confirmed AMI treated in one coronary care unit. Although little has been reported on these sequential events, these observations are necessary if prognostic and therapeutic decisions are to attain any degree of objectivity.

METHODS

The data were collected during a four-year-period, January 1, 1965, December 31, 1968, in a six bed coronary care unit of a general community hospital and was part of a larger study to evaluate coronary care units in a variety of hospitals. Twelve lead electrocardiograms were taken daily for three days; patients were monitored continuously for an average of seven days; 30 second rhythm strips were obtained hourly for the first two days, and both were obtained on a selective basis thereafter. Tracings from all patients were reviewed on a daily basis by one of four physicians. Representative strips were saved for the patient's permanent hospital record and for subsequent coding and examination. Other information on history, present illness, and hospital course was also coded. All patients having atrioventricular block demonstrated on either the monitor strips or 12 lead electrocardiograms obtained at any time during their hospital course were studied in detail. The diagnosis of acute myocardial infarction (AMI) was re-evaluated on the basis of positive history, electrocardiographic findings and transaminase (SGOT) enzyme titers and autopsy, when available. Patients were considered as having first degree AV block if they had a PR interval exceeding 0.20 second. Type I (Wenckebach) second degree AV block was diagnosed when the patient had sinus rhythm, progressively prolonged AV conduction times, a non-conducted P wave, and a return to a PR interval to some duration shorter

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Table 1— The Initial and Highest Level of AV Block Attained in the 134 Patients Studied.

<table>
<thead>
<tr>
<th>Initial Block, Degree</th>
<th>Highest Level Block Attained, Degree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>60</td>
<td>14</td>
<td>15</td>
<td>89</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>15</td>
<td>15</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>28</td>
<td>28</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>60</td>
<td>29</td>
<td>45</td>
<td>134</td>
</tr>
</tbody>
</table>

than the last. Type II (Mobitz) second degree AV block was diagnosed when failure of ventricular activation occurred after a normal P wave and without preceding progressive prolongation of AV conduction time. Since a 2:1 conduction ratio may be either type I or II,\textsuperscript{12} patients were classified according to the preceding rhythm, when available. Patients who demonstrated only 2:1 conduction ratios were classified as indeterminate type, and evaluated separately.

Patients were excluded from the study if they developed AV block during agonal and pre-terminal states, post resuscitation, or following a period or profound cardiovascular collapse. Patients with paroxysmal atrial tachycardia with block were not included.

Unless specifically stated, the data refer only to the highest degree of block attained by a given patient. Since the study is concerned primarily with progression to higher levels of block and the consequences thereof, first and second degree block which followed upon a higher degree of block (ie regression) were not considered. Severity criteria were developed to indicate morbidity associated with the infarction and block at the time the specified conduction abnormality began. Class I is used to indicate infarction uncomplicated by congestive heart failure or hypotension; Class II denotes mild and Class III severe heart failure and/or hypotension. Class IV indicates shock. The criteria were similar to those described by Fillmore, Shapiro, and Killip\textsuperscript{13} and Gregory and Grace.\textsuperscript{14} The total duration of block was measured from the first to the last time it was noted.

The entire group with AV block was compared according to age, medical history, and mortality with the remainder of patients in the series who didn't have AV block.

RESULTS

During the period of the study, 1,475 patients with possible acute cardiovascular disease were admitted to the CCU, and 757 of these had a confirmed acute myocardial infarction. Of these confirmed cases 151 died (19.9 percent); 118 deaths (78 percent) occurred in the CCU, and 33 (22 percent) occurred to initially unit treated patients on the hospital wards after discharge from the CCU. Of the 757 AMI patients 134 (17.7 percent) manifested AV block. Men outnumbered women by 2:1 and were approximately eight years younger. Mortality rate in both sexes increased with advancing age. However, there was no significant difference (by the Chi-square test) in age or sex distribution, or in the presence of a prior history of myocardial infarction, hypertension, diabetes mellitus or angina pectoris between the 134 patients with AV block and the 623 non-block patients. The two groups were dissimilar only in that patients with AV block had more commonly: a) taken digitalis in the two weeks preceding hospitalization (39 vs 22 percent) and b) had a prior history of congestive heart failure.

First Degree Block

First degree block was the sole block in 60 patients (7.9 percent) and was also seen in an additional 29 patients before they progressed to a higher level of block (Table 1); a total of 11.8 percent of the patients, therefore, demonstrated first degree block while under observation.

Progression to a higher level of block and mortality rate were both related to the PR interval when first degree block was first noted. Of the 31 patients with a PR interval of 0.24 seconds or more 39 percent
progressed to complete heart block and 42 percent died. Of the remaining 58 patients who had a PR interval of 0.23 seconds or less and 5 percent progressed to complete heart block and 19 percent died (Table 2). The 29 patients who progressed from first to second degree block acquired the morbidity and mortality characteristics associated with the advanced level of block.

The 60 first degree block patients were similar to nonblock patients in mortality rate (18.3 percent and 17.5 percent, respectively) and severity classification (Table 3). Also, the incidence and mortality rates of anterior (including anteroseptal) and inferior (including posterior) sites of infarction were approximately equal (Table 4). Thirty-eight of these 60 patients were receiving digitalis and toxicity was suspected in seven.

Consideration of the time-course of first degree block reveals that it was present on admission in 33 of the 60 patients (55 percent) and was seen in an additional 16 percent within 48 hours (Fig 1). It persisted throughout hospitalization in 53 percent. The remaining 47 percent either reverted to conduction or died (Table 5). The overall duration of first degree block was extremely variable (Fig 2).

Second Degree Block

Second degree block was the highest level of block attained by 29 (3.8 percent) of the infarction patients and in 14 of these was preceded by first degree block (Table 1). Second degree block progressed to third degree in seven more cases (three with type I, two type II, and two indeterminate) for a total of 36 (4.8 percent of all myocardial infarction patients). Six of these seven patients died. Two of the patients with type I (Wenkebach) block had only transient second degree block before advancing to third degree; only one patient had a sustained period of type I followed by complete heart block. Since type II was decidedly less common than type I block, mortality rates cannot be readily compared (Table 6). Patients with second degree block tended to cluster in severity classes II and III, and had a higher mortality rate than patients of corresponding severity class with first degree block or no block (Table 3). An inferior site of infarction was much more common than anterior and was associated with a lower mortality rate, although the number of patients with anterior infarction and second degree block was too small to be statistically significant (Table 4). Ten of these 29 patients (seven with type I and three with type II) were thought to have digitalis toxicity, but only one of them progressed to third degree block.

Second degree block was present on admission in three of the 29 (10.3 percent) and appeared within 48 hours in an additional 20.6 percent (Fig 1). No patient remained in second degree block and only three of the 17 survivors had persistent first degree block at the time of hospital discharge (Table 5). The onset of second degree block tended to be later than complete block (Fig 1) and its duration moderately short, lasting two to seven days in 65 percent of patients, and over seven days in only one individual (Fig 2). Only two of the 12 deaths in this group occurred within 24 hours after onset of the second degree block (Fig 3).

Third Degree Block

Complete heart block occurred in 45 patients (5.9 percent); it was preceded only by first degree block in ten patients and by second degree block in

<table>
<thead>
<tr>
<th>Table 3—Influence of Severity Class** and AV Block as Combined Risks for Mortality</th>
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<tbody>
<tr>
<td>Highest Level Block Attained</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Nonblock*</td>
</tr>
<tr>
<td>First degree</td>
</tr>
<tr>
<td>Second degree</td>
</tr>
<tr>
<td>Third degree</td>
</tr>
</tbody>
</table>

*The nonblock patients are taken from the first 476 patients with acute myocardial infarction admitted to the series. The somewhat higher mortality in Classes II and III between first degree and nonblock patients is not significant.

**Severity class at time of onset of specified conduction abnormality.

<table>
<thead>
<tr>
<th>Table 4—Mortality Classified by Highest Degree of Block and Location of Infarction</th>
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</thead>
<tbody>
<tr>
<td>Site of Infarction</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Inferior Group</td>
</tr>
<tr>
<td>Anterior Group</td>
</tr>
<tr>
<td>Other Sites</td>
</tr>
</tbody>
</table>
ATRIOVENTRICULAR BLOCK IN ACUTE MYOCARDIAL INFARCTION

FIGURE 2. Duration of highest level of block. The percentages are expressed as the proportion of patients with first, second and third degree block respectively.

seven. These were the most severely ill of all myocardial infarction patients, more than one-half being in shock at the time third degree block was first discovered. Even the less severely ill patients (classes I, II and III) clearly showed excess mortality compared to nonblock or first degree block patients (Table 3).

The great majority of patients had inferior myocardial infarction, and only one of eight patients with anterior myocardial infarction survived (Table 4). Twenty-five patients were receiving digitalis at the time third degree block was discovered, of whom five may have been toxic.

Third degree block appeared early in the course of myocardial infarction, being detected on admission in 18 patients (40 percent) and within 48 hours in another 18 (Fig 1). No patient remained in complete heart block at the time of discharge, although first degree block persisted in 19 percent of the survivors (Table 5). The block was of brief duration, resolving or the patient dying within 24 hours in 68.8 percent of the cases. Only one patient persisted in complete block more than seven days (Fig 2).

Packemakers gradually came into use in this hospital during the period of study; 13 were inserted, but only eight actually paced the heart. Therefore, the series nearly represents a "natural

Table 5—AV Conduction of Survivors at Time of Discharge from Hospital

<table>
<thead>
<tr>
<th>Highest Level Block, Degree</th>
<th>Normal AV Conduction (No Block)</th>
<th>First Degree Block*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>23</td>
<td>26</td>
<td>49</td>
</tr>
<tr>
<td>Second</td>
<td>14</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Third</td>
<td>13</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>

*No patient was discharged from the hospital with block higher than first degree.

Table 6—Mortality in the 36 Patients with Second Degree Block Including the Seven Who Went on to Complete Block

<table>
<thead>
<tr>
<th>Second Degree Block</th>
<th>Alive</th>
<th>Dead</th>
<th>Total Mortality, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>14</td>
<td>13</td>
<td>27</td>
</tr>
<tr>
<td>Type II</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>18</td>
<td>36</td>
</tr>
</tbody>
</table>

Discussion

The incidence and mortality of first, second, and third degree block in this series is similar to that already reported and recently reviewed by Friedberg.1 Clearly, the mortality increases with advanced degrees of block, but further correlation with the various parameters of severity—especially congestive heart failure, hypotension and shock (Table 3)—markedly enhances prognostic accuracy and demonstrates an interrelationship between degree of block and clinical severity of the myocardial infarction: the majority of patients with first degree block were in Class I; second degree block patients tended toward Classes II and III, and patients with third degree block were mostly in Class IV.

First degree block carried no excess risk of death at any level of severity compared with nonblock patients. However, patients with second and third degree block have a higher mortality rate in all severity classes, except Class IV (shock patient), where the mortality is already sufficiently high to obliterate other differential factors. Nevertheless, the fact that eight patients out of 24 with shock and complete heart block did survive, should preclude a

Figure 3. Interval from onset of death. The percentages represent the proportion of patients with second and third degree block who expired.
hopeless attitude.

The association of complete heart block with inferior myocardial infarction is quite common, but its association with anterior myocardial infarction is apparently more lethal.\textsuperscript{2,16} This would seem to be true in the present series for patients with advanced (second and third degree) block. Patients with inferior wall infarction had a mortality rate of 51 percent in contrast to those with anterior infarction who had a mortality rate of 79 percent. The relevant mechanism has been demonstrated by detailed sectioning of the conduction system. Sutton and Davies\textsuperscript{17} observed either no changes in the conduction system, or only focal necrosis in the AV node and bundle branches without destruction in cases of complete heart block associated with inferior myocardial infarction; however, in anterior infarction and complete heart block extensive destruction of both bundle branches is seen.

The functional significance of these pathologic findings has been demonstrated by His bundle recordings which show that in diaphragmatic infarction AV block is usually localized to the AV junction, while in anterior infarction the block is distal to the His spike.\textsuperscript{18} Attendant upon this may be a tendency for the anterior group to develop lower (idioventricular) pacemakers as opposed to the higher (junctional) pacemakers in patients with an inferior myocardial infarction.\textsuperscript{9,4,16} Again, the present series is consonant with this concept since one-half of the patients with an anterior myocardial infarction but less than one-fourth of the inferior myocardial infarctions demonstrated the lower (broad QRS) focus.

Eighty-one of the 134 block patients received digitalis, and in 22 of these cases (27 percent), it may have been involved in the genesis of the arrhythmia. Since heart block is a manifestation of myocardial infarction as well as of digitalis toxicity, the association could be specious; however, retrospective analysis of these cases demonstrated other supportive evidence of digitalis toxicity. Second degree block is especially notable in that 10 of 18 patients receiving digitalis were suspected of being toxic. Possibly the time required for the development of this toxicity may be the reason for the delay in peak incidence of second degree block to the third hospital day (Fig 1). Brown et al also reported a peak incidence in the third day.\textsuperscript{19}

Complete heart block, in contradistinction to second degree, has its peak incidence during the first hospital day. This was true in 62 percent of cases in the present series, and has been reported in 50 percent to 79 percent of cases in other series.\textsuperscript{1,3,20,21} Frequently, it is already present at the time of admission. In any event, within four hours after its recognition, 20 percent of all patients who developed complete heart block were dead, and this figure rose to 31 percent within 24 hours. In striking contrast, only 7 percent of all patients developing second degree block were dead within 24 hours.

Among all 74 patients with second or third degree block, only eight (11 percent) still had block longer than four days, and only two had it longer than seven days. It should be re-emphasized that the duration cited here includes the last occasion on which the block was identified, and there were no recurrences beyond the period specified. Courter\textsuperscript{22} reported a similar experience in which advanced block did not persist beyond six days.

**TREATMENT**

The number of pacemakers used in the present series is much too small to permit any comment upon the efficacy of this form of treatment. Pacemakers are commonly employed at the present time, but the rational use of this, or any other, treatment depends upon an appreciation of the basic processes involved and their natural history.

First degree block alone is not correlated with significant increased mortality or morbidity per se, but its functional significance in acute myocardial infarction derives primarily from the likelihood of progression to a higher level of block, and consequent worsening of the patients' prognosis associated with the advanced level of block. Treatment of the first degree block itself is probably not necessary, but close observation of patients with a PR interval of 0.24 sec or longer should enhance earlier detection and treatment of advanced degrees of block. Stock\textsuperscript{8} considered the same value of 0.24 sec to be a functionally and prognostically significant PR interval.

On the other hand, patients with a PR interval of 0.23 sec or less have a low probability of advancement to a higher level of block, and first degree block which does not progress differs rather fundamentally from advanced block in that: (a) the frequency of anterior and inferior sites of infarction are approximately equal, (b) the block tends to persist longer, not infrequently throughout the hospital course, and (c) morbidity and mortality are essentially the same as for nonblock patients.

Patients with second degree block tend to be more severely ill, usually with congestive heart failure or hypotension, and have a higher mortality rate than patients of similar initial severity class without block. A rather strong association of Type I block with digitalis toxicity is apparent, but progression to complete heart block is not common.
Therefore, it is not clear whether Type I second degree block, requires any direct treatment, ie temporary pacing, but surely the associated congestive heart failure, hypotension and digitalis toxicity demand recognition and treatment. Several patients in this group died in congestive failure or shock after the block had resolved.

Complete heart block is associated with a high mortality, especially when associated with anterior myocardial infarction. Because of its frequent association with cardiogenic shock it is not certain that the use of temporary pacing will alter the prognosis. The usual temporal course of third degree block suggests that if the patient survives the hemodynamic consequences of the infarction, only rarely would it be necessary to use a temporary pacemaker longer than seven days after onset of the block.

References
23 Paulk EA, Hurst WJ: Complete heart block in acute myocardial infarction. Amer J Cardiol 17:695-706, 1966

Editorial Expression
This excellent article points out the need for a well constructed prospective study of a large number of patients with heart block and acute myocardial infarction, to determine the precise indications for pacing. The study envisaged will undoubtedly have to consider the site of infarction, (anterior or inferior), the degree of block, the severity of bradycardia, and the hemodynamic status of the patients. It is unfortunate that so many variables must be considered, but it is likely that a combination of factors will determine the need for pacing. A large collaborative study may be the only way of obtaining the large number of patients necessary to solve the problem.

Kenneth M. Rosen, M.D.
Chicago