Case reports

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Bradycardia-dependent peri-infarction block

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A case is reported in which electrocardiographic signs appeared during the acute phase of myocardial infarction, which we have interpreted as indicating bradycardia-dependent peri-infarction block.

Bradycardia-dependent intraventricular block of the bundle-branch type (paradoxical bundle-branch block) is a recognised electrocardiographic finding (Massumi, 1968; Sarachek, 1970). Similarly, focal (Rosenbaum et al., 1968) or intramyocardial (Hecht and Kossmann, 1973) block, during the acute phase of myocardial infarction (peri-infarction block), unrelated to rate, has been previously documented (First et al., 1950; Shadaksharappa et al., 1968). Tachycardia-related focal block has also been reported (Gambetta and Childers, 1973). However, to our knowledge a bradycardia-dependent peri-infarction block has not yet been reported, and it constitutes the subject of this paper.

Case report

A 60-year-old male patient was first seen in June 1970 with typical anteroseptal myocardial infarction. He made an uneventful recovery but remained in clinical class II, with physical signs of ventricular asynergy. For over a year the ST segment was still displaced (Fig. 1A) in leads I, aVL, and V2 to V6, though he was still in sinus rhythm at 70 bpm, with a PR of 0·16 s, QRS of 0·09 s, and a frontal plane AQRS of 90°. In October 1971 he had an episode of weakness and diaphoresis, without chest pain, lasting 2 hours. Three days later he presented with pulmonary oedema and the electrocardiogram showed sinus tachycardia at 102 bpm, PR 0·21 s, left atrial enlargement, widening of the QRS to 0·11 s, and no changes in either the frontal plane AQRS or the initial vectors (Fig. 1B). However, the late vectors were changed in III, aVF and aVL, producing a W-shaped complex in the last lead. Left ventricular failure persisted and 6 days after the episode of weakness the electrocardiogram showed an atrial rate of 120 bpm and a ventricular rate of 60 bpm, with a 2:1 atrioventricular block and a bizarre QRS configuration (Fig. 1C).

The latter showed a slowing of the ventricular depolarisation process after the first 0·05 to 0·06 s, lasting 0·08 to 0·09 s, and resulting in a wide QRS of 0·18 s. The erythrocyte sedimentation rate and white blood cells were raised on the same day but no increase in enzyme level was noted. On the following day both the 2:1 atrioventricular block and the peri-infarction block disappeared (Fig. 1 D).

An electrocardiogram obtained on the afternoon of the same day (14 October 1971) showed a sinus rate of 109 bpm (PP interval of 0·55 s), a 3:2 atrioventricular block of the Wenckebach type (4:3 in V6), and a ventricular response with the following characteristics (Fig. 2): alternating cycle lengths of 1·02 and 0·63 s; the long pauses being terminated by wide QRS of the type described above, and short pauses terminated by normal duration QRS. It can be seen from this tracing that the early vectors are identical for both types of complexes, mainly in right precordial leads, while there is an obvious delay in activation after those early vectors.

Discussion

The clinical picture, laboratory findings, and electrocardiographic abnormalities are suggestive of a new infarct in the lateral wall of the left ventricle, probably in an area near the previous infarction. On the sixth day a transient second degree atrioventricular block associated with intraventricular conduction delay was noted. This conduction defect shows a different morphology than the usual defect found in either total or partial bundle-branch block, but retains the characteristic features of peri-infarction block (First et al., 1950). This case also presents several clinical similarities with the cases reported by Shadaksharappa et al. (1968): onset in the first week of a myocardial infarction, being transient and more frequent during a second infarction.

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Fig. 1 (A) Electrocardiogram a year after the first infarction. (B) Acute phase of second infarction before appearance of 2:1 atrioventricular block. (C) Acute phase of second infarction: appearance of 2:1 atrioventricular block and peri-infarction block. (D) Acute phase of the second infarction after atrioventricular block.

Fig. 2 Bradycardia-dependent peri-infarction block recorded during 3:2 atrioventricular block.
A change from 2:1 to 3:2 atrioventricular block revealed the most interesting finding: the intraventricular conduction delay became intermittent, appearing always after the long pauses and disappearing after the short ones, best seen during the 4:3 block recorded in V6. This rate-dependent peri-infarction block behaves like the paradoxical bundle-branch block which sometimes accompanies a variable atrioventricular block during the course of a myocardial infarction (Puech and Grolleau, 1972).

It might be speculated whether the block is located in the distal Purkinje system or in the myocardial fibres. The former will most probably alter the initial vector forces, like the fascicular or the focal septal block described by Gambetta and Childers (1973). Its occurrence in the latter part of the QRS (0-05 s after the onset) and its duration (0-08 to 0-09 s) suggest a conduction delay within the myocardial fibres affected by the ischaemic insult. Its appearance only during the prolonged RR intervals explains the name of paradoxical or bradycardia-dependent peri-infarction block.

The early work of Singer et al. (1967) was followed by numerous reports of slow rate-related arrhythmias, i.e. paradoxical bundle-branch block (Massumi, 1968; Sarachek, 1970), aberrant late nodal beats (Sarachek, 1970), normalisation of WPW syndrome with slow rhythms (Massumi and Vera, 1971), paroxysmal atrioventricular blocks (Counsel et al., 1971; Rosenbaum et al., 1973), and the underlying mechanism of other types of arrhythmias like intermittent parasystole (Cohen et al., 1973), and intermittent bigeminy (Levy et al., 1975).

According to these reports, several factors might increase the slope of phase 4 of the Purkinje system and, consequently, a late stimulus could find the diastolic potential less negative, producing an action potential of diminished amplitude with decreased dV/dT of phase 0, resulting in conduction disturbance. A similar situation is produced when a premature stimulus falls on the early part of phase 3, before complete repolarisation is reached. Both disturbances are voltage dependent (Singer et al., 1967; Singer and TanEick, 1971), and the conduction delays associated with rapid or slow rhythms have been called phase-3 and phase-4 blocks (Rosenbaum et al., 1973), though some authors prefer to call them tachycardia- or bradycardia-dependent blocks (El-Sherif, 1972).

It appears that the critical factor is an increase in extracellular potassium following the cell necrosis during the course of a myocardial infarction (Harris, 1966; Sutton and Davies, 1968; Lazzara and Sherlag, 1972). It is difficult to explain a tachycardia-dependent block, in a disease state, only on the basis of voltage changes of phase 3; other factors, such as the time relation and the sodium pump, a decrease of the resting potential, or cell membrane responsiveness, are probably involved (Fisch et al., 1973; El-Sherif et al., 1974; Neuss et al., 1974). In bradycardia-dependent block, besides the slope of phase 4, other factors such as hypopolarisation, increase in threshold potential, and alterations of cell membrane responsiveness might play a role (Singer et al., 1967; El-Sherif et al., 1974; Neuss et al., 1974; Rosenbaum et al., 1974; Kretz et al., 1975).

Under normal conditions myocardial cells do not have automaticity, but during an ischaemic insult they may suffer electrophysiological changes, such as spontaneous diastolic depolarisation during phase 4 (Solberg et al., 1972), which, if associated with other factors, will cause the block; on the other hand, if we accept these changes at the myocardial cell level, the case reported here would be an instance of pacemaker activity of these cells.

The combination of a variable atrioventricular block and intramyocardial block make it possible to speculate on a common aetiological factor, such as the increase in extracellular potassium.

Lastly, why is this a rare phenomenon? If we consider the frequency of peri-infarction block (39%—Shadaksharappa et al., 1968) and also of atrioventricular nodal block during infarction (3%—Stock and Macken, 1968), at least 1 per cent of the infarction cases would meet the necessary conditions of heart rate and cell necrosis for its appearance. The fact that paradoxical block is less frequently seen as peri-infarction block than as bundle-branch block, makes us think that the conditions necessary for the occurrence of the first are more difficult to meet. In our case all these rare circumstances were present: old infarction, acute infarction in a nearby area, variable atrioventricular block, and patient survival.

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References


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