THE SICK SINUS SYNDROME

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SYNOPSIS

Disease of the S-A node or the right atrium with impairment of their normal function, often results in a wide variety of atrial arrhythmias to which the term "sick sinus syndrome" has been succintly applied (Ferrer, 1968). This paper describes 4 patients presenting with this syndrome—3 showing chronic S-A block and one with sinus arrest alternating with atrial tachyarrhythmias. It is believed that in all 4 patients, the cause of the arrhythmias lies in an anatomical damage of the S-A node.

The term "sick sinus syndrome" refers to a wide variety of atrial arrhythmias which occur as a result of anatomical damage to the sino-atrial (S-A) node of the heart (Ferrer, 1968). In this paper, we describe 4 patients with this syndrome—3 showing chronic S-A block and one with sinus arrest presenting as nodal bradycardia alternating with atrial tachyarrhythmias. In all these patients, we believe that the cause of the atrial arrhythmias was an impairment of the normal function of the S-A node as a result of injury.

CASE REPORTS

Case 1

A 65 year old Chinese woman was first seen for giddiness in August 1968. At that time, her pulse was noted to be regular, with a rate of 42 per minute. However, no further observations of this bradycardia was made.

Investigations revealed that she was suffering from diabetes mellitus, for which she was given oral Tolbutamide. The total white count, the haemoglobin level, the serum electrolytes and the blood urea were all normal.

She remained well till 17.1.71 when she was admitted to the ward for a sudden spell of giddiness associated with vomiting. Clinical examination showed that the significant abnormalities were confined to the cardio-vascular system. The blood pressure was 200/100 and the fundi showed Grade 2 changes (Keith, Wagener and Barker, 1939). The pulse was found to be irregular and the rate was around 42 per minute. The apex beat was displaced outside the midclavicular line at the sixth left intercostal space. The ECG recorded on 18.1.71 (Fig. 1) showed sinus rhythm with frequent periods of S-A block. In addition, changes of left ventricular hypertrophy were also seen. The serum SGOT was 70 K.U. and the serum cholesterol 250 mgm.%. The blood Kahn test was negative. A skiagram of the chest showed cardiomegaly. Her diabetes remained controlled with oral tolbutamide.

A trial of intravenous Isoprenaline infusion was instituted. Before the infusion, the heart rate was around 42 per minute. This increased to around 60 per minute and 100 per minute at steady infusion rates of 10 mgms. and 20 mgms. isoprenaline per minute, respectively. No ectopic beats or anginal symptoms occurred during the period of infusion. She was then started on oral Saventrine (long-acting Isoprenaline) 180 mgm. per day in divided doses. The pulse rate with this therapy was maintained at around 60 per minute and she was discharged from the ward 8 days after admission. When reviewed one month later, she was found to be well and the pulse rate was maintained around 60 per minute with oral Saventrine. However, the ECG still showed occasional periods of S-A block.

Case 2

A 55 year old Chinese woman was admitted to the unit on 23.1.71 with a history of palpitations for 7 days prior to admission. She had been suffering from diabetes mellitus for the past 5 years and had been treated by various general practitioners with oral antidiabetic drugs. There was no history of angina or heart failure.

Clinical examination showed that the pulse was irregular with a rate of approximately 45 per minute. The blood pressure was 190/90 and no murmurs were heard over the praecordium.

The fasting blood sugar was 178 mgm.% and the blood urea was 62 mgm.%. The total white count and the haemoglobin level were both within the normal limit. The ECG showed a sinus rhythm

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with periods of S-A block (Fig. 2). In addition, changes of myocardial ischaemia were seen. With a steady intravenous Isoprenaline infusion of 10 mgm. per minute, the heart rate increased from 45 per minute to 100 per minute (Fig. 3). The patient was then started on oral Saventrine 90 mgms. per day in divided doses. She responded well to this treatment and the pulse rate was maintained around 70 per minute. She was discharged with this therapy 4 days after admission. When reviewed one month later, she was found to be well with a pulse rate of 60 per minute. However, the ECG recorded at this time still showed periods of S-A block.

Case 3

A 36 year old Indian man was admitted to the unit on 5.2.71 for exertional dyspnoea since childhood. He also volunteered a history that since the age of 15 years, he has had a slow and irregular pulse with the rate usually around 50 per minute. He has had no significant illnesses in the past and does not indulge in alcohol or tobacco. Both his parents and 2 elder sibs are alive and well. He has no history to suggest ischaemic heart disease.

On clinical examination, the only abnormalities were confined to the cardio-vascular system. The pulse rate was 40 per minute and irregular. The blood pressure was 120/70. The apex beat was at the fifth left intercostal space within the mid-clavicular line. No murmurs were heard over the praecordium.

A skiagram of the chest showed a normal cardiac silhoeutte with normal lung fields. The erythrocyte sedimentation rate and the total white count were both normal. The ECG recorded on 29.1.71 showed periods of S-A arrest which were always terminated by nodal escape beats (Fig. 4).

While in the hospital, his pulse rate was noticed to fluctuate between 45 to 60 per minute. As he was not incapaciated, it was decided not to give him any specific treatment. He was discharged from hospital 4 days after admission.

Case 4

A 72 year old Chinese woman was admitted to the unit with a history of being discovered unconscious in bed by friends. On clinical examination, she was found to be cold and clammy with a blood pressure of 80/50. The pulse was irregular and the rate was 40 per minute. The ECG showed changes of an acute posterior myocardial infarction (Fig. 5). The heart rate was around 40 per minute and the rhythm was nodal in character. The serum lactic dehydrogenase was 1,035 units and the total white count was 11,400. Atropine, 0·6 mg. was given intravenously as a bolus, but there was little change in the rate or rhythm of the heart. She was then treated with an Aramine infusion (50 mgms. in one pint of 5% dextrose); intravenous Atropine 0·6 mg. were also given 6 hourly. With this treatment, the blood pressure rose to 90/60 and on the same evening the Aramine infusion was stopped. Instead, a continuous infusion of isoprenaline was given (5 mgm. Isoprenaline in 1 pint of 5 per cent dextrose).

For the next 2 days, the patient remained critically ill, although an adequate blood pressure and pulse rate were successfully maintained for most of the time. Continuous ECG monitoring revealed that the cardiac rhythm would vary rapidly from a nodal bradycardia to periods of rapid supra-ventricular tachycardia (Fig. 6). Sinus activity was absent throughout the patient's illness. She died 3 days after admission. At necropsy, the left coronary artery was found to have a narrowed lumen. Just beyond the right coronary ostium, there was an organising thrombus with a fresh clot extending along the artery. There was an infarct in the posterior portion of the inter-ventricular septum and the posterior wall of the left ventricle.

Histological examination revealed wide areas of infarction and haemorrhages in the right atrium. The S-A node was carefully looked for in the histological slides, but could not be identified.

DISCUSSION

Most of the studies on cardiac arrhythmias have been so far confined to ventricular abnormalities, scant attention being directed towards the atrial arrhythmias and their pathogenesis. However, it is clear that diseases of the S-A node or the right atrium with impairment of their normal function often results in a wide variety of atrial arrhythmias to which the term "sick sinus syndrome" has been applied (Ferrer, 1968).

According to Ferrer (1968), patients with the "sick sinus syndrome" may present with one or more of the following abnormalities:

1. Persistent and severe sinus bradycardia with no apparent cause.
2. S-A block or arrest not due to drug therapy or increased vagal tone.
3. Chronic atrial fibrillation with a slow ventricular rate not as a result of drugs like digitalis. In these cases, an atrio-ventricular (A-V) block exists and lends support to the presence of a damaged S-A node, since binodal disease frequently co-exists.

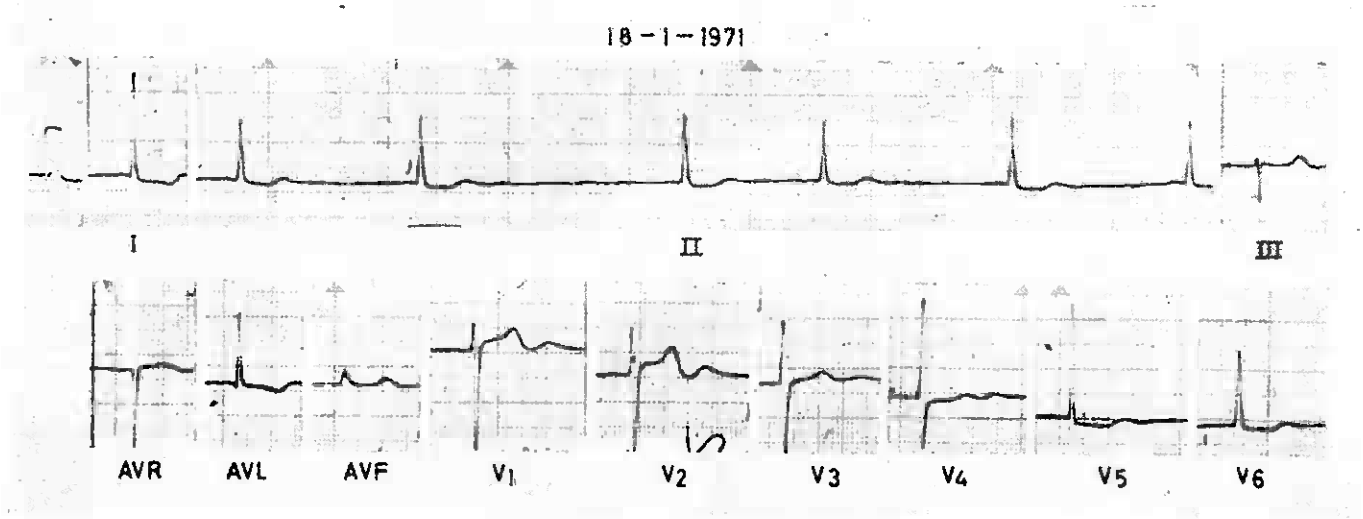

Fig. 1. Electrocardiogram of Case 1.

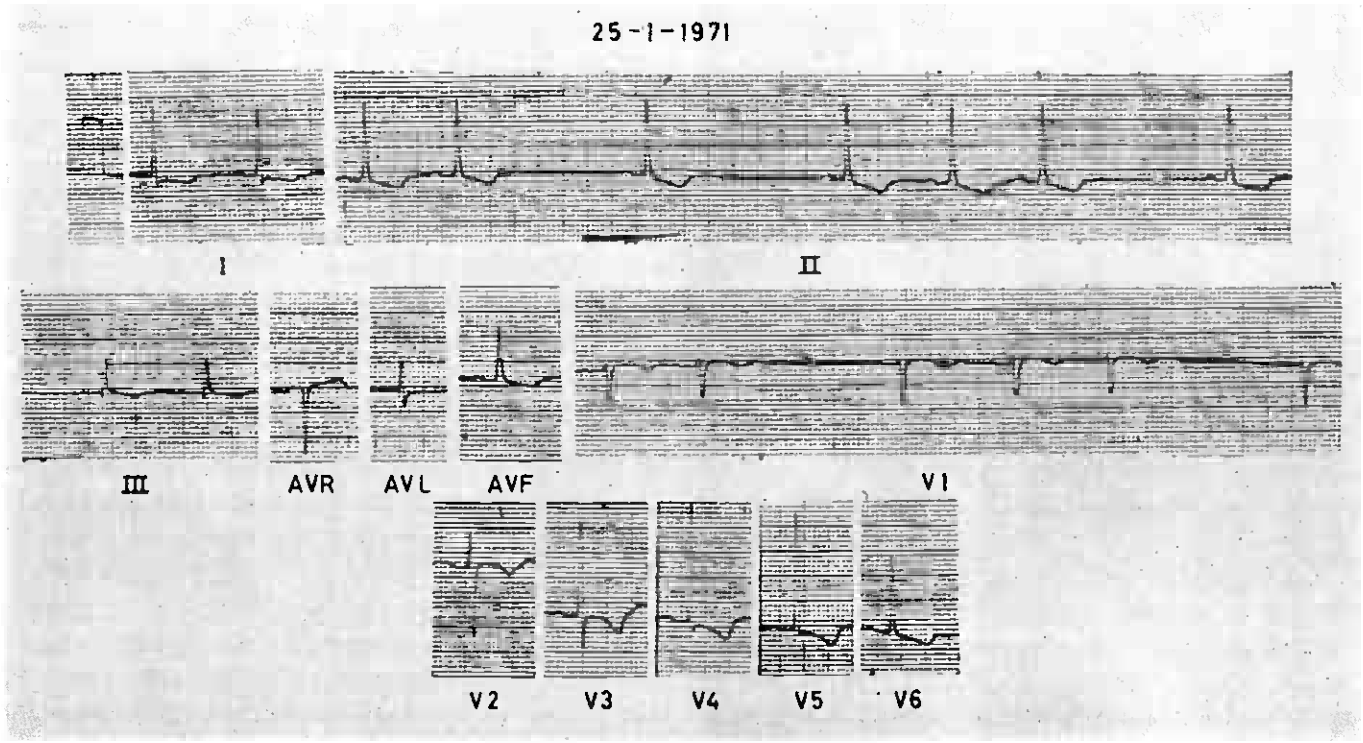

Fig. 2. Electrocardiogram of Case 2.

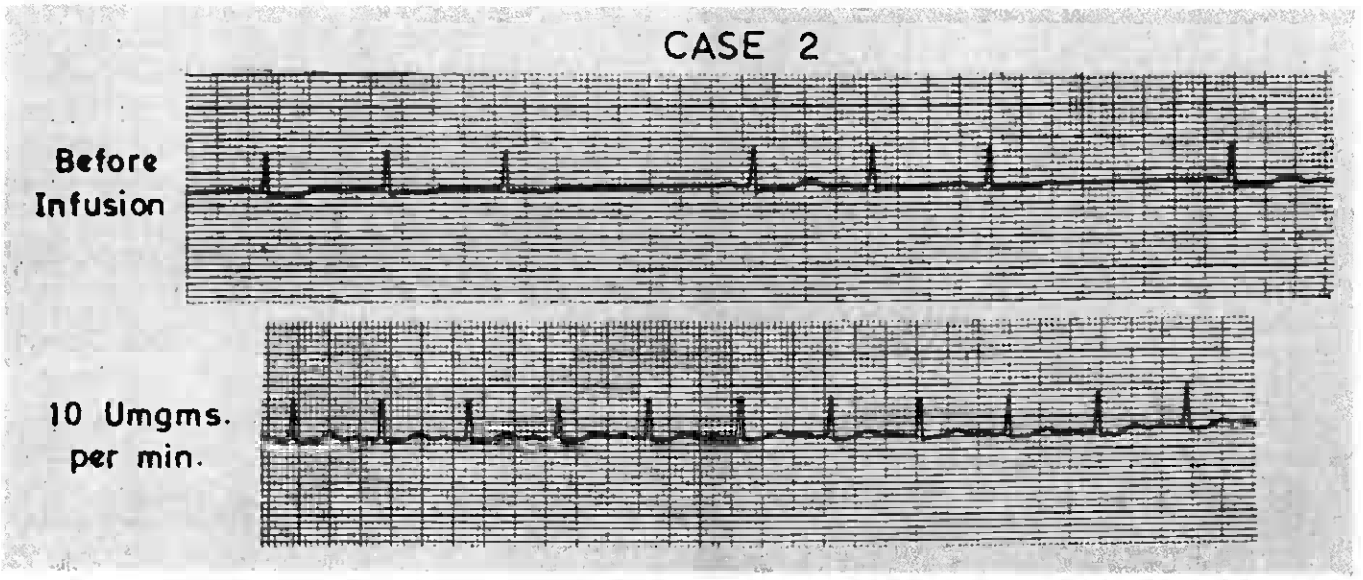

Fig. 3. Isoprenaline infusion test in Case 2.

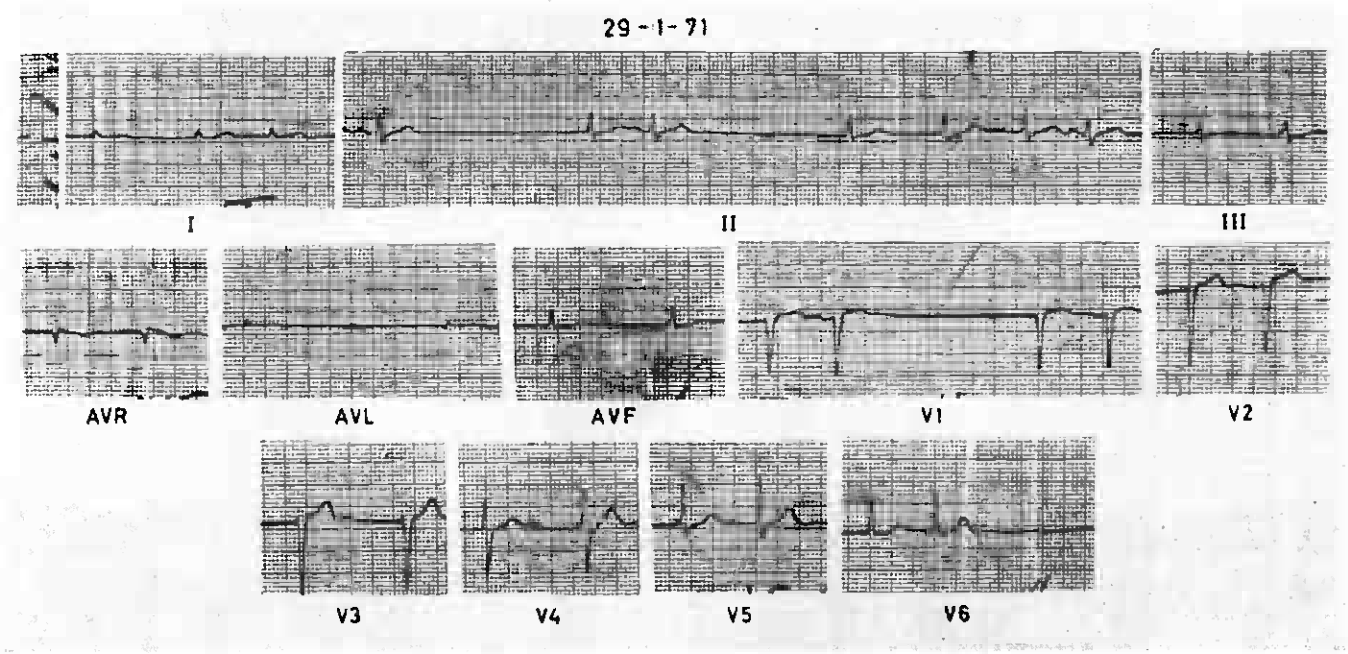

Fig. 4. Electrocardiogram of Case 3.

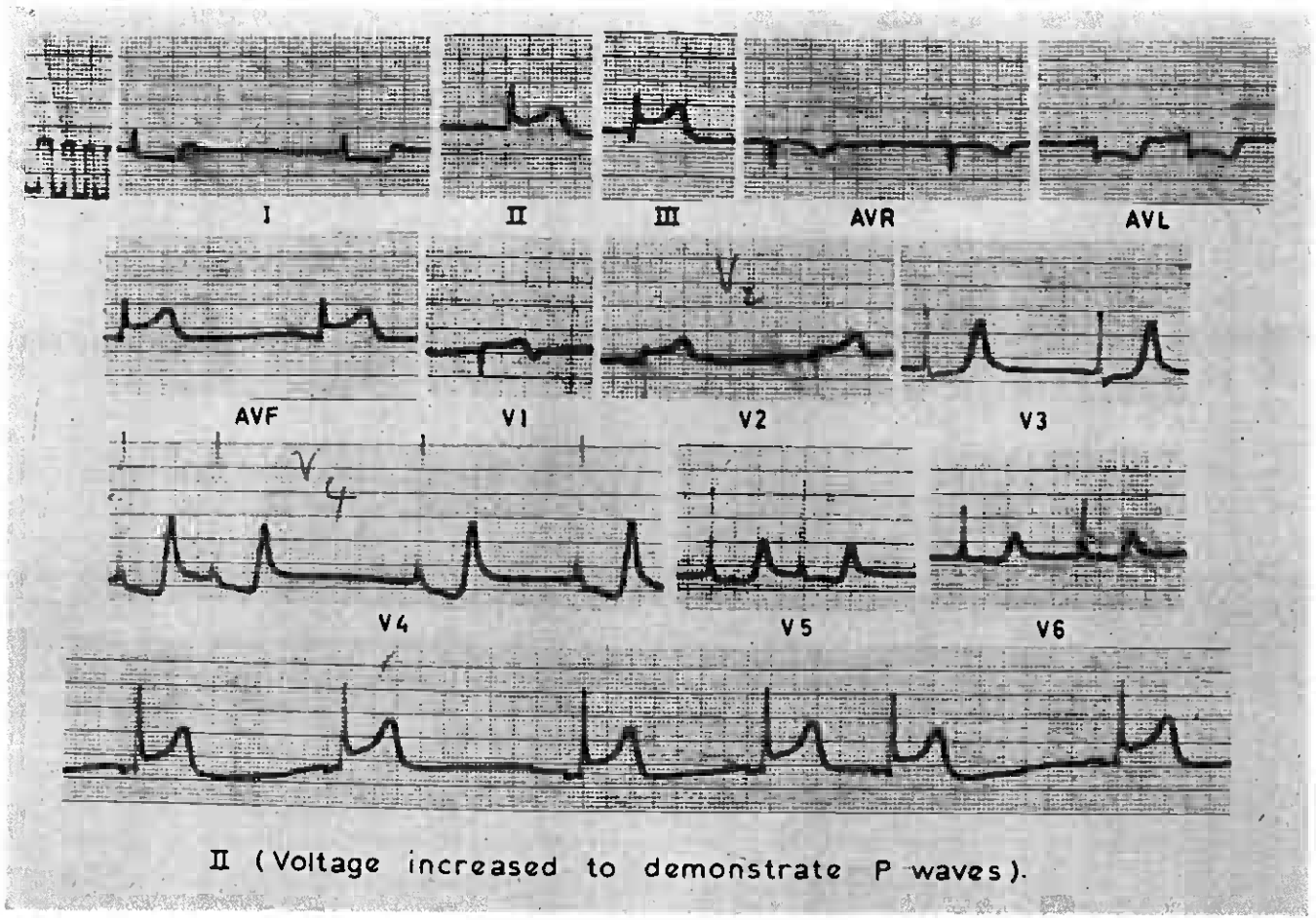

Fig. 5. Electrocardiogram of Case 4.

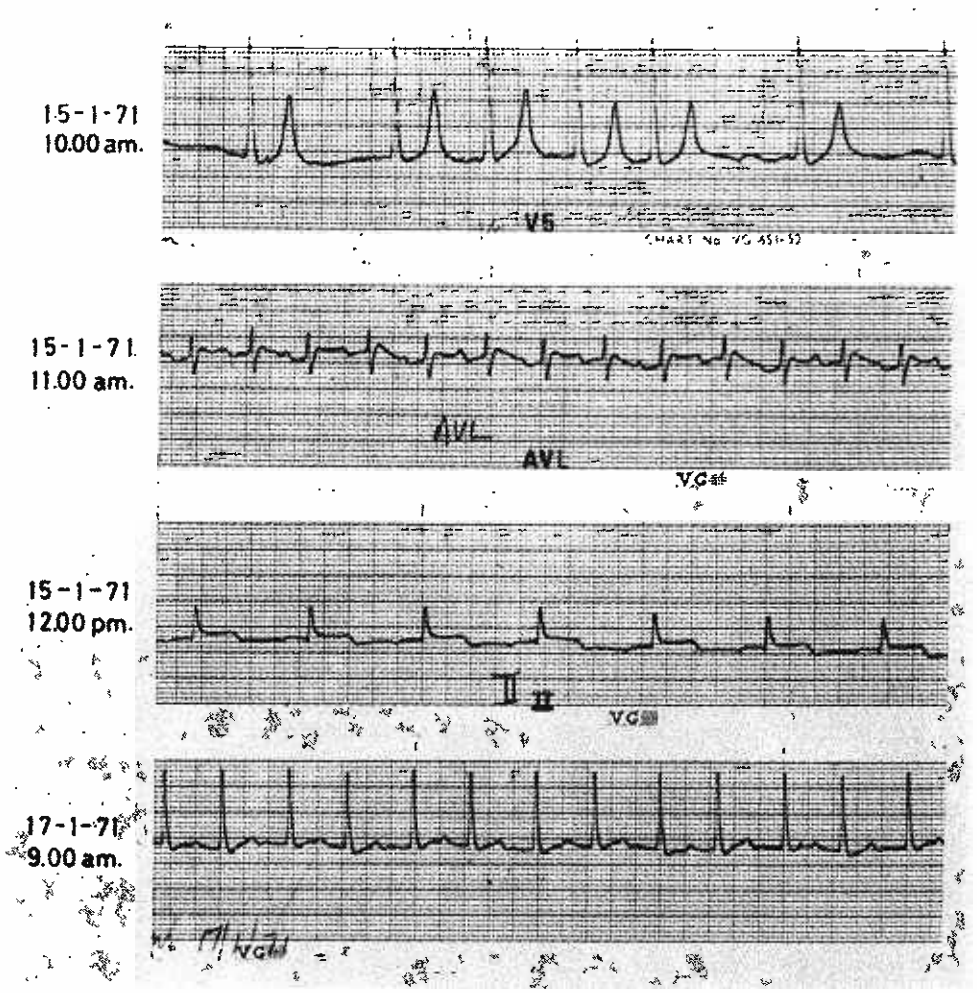

Fig. 6. Electrocardiogram of Case 4.

4. Inability of the heart to maintain a sinus rhythm after electrical cardioversion for chronic atrial fibrillation.

An interesting and specific disorder of atrial rhythm which has been termed variously as "Chaotic atrial mechanism" (Phillips *et al*, 1969), "Multifocal atrial dysrhythmia" (Cheng, 1969; Chia *et al*, 1971) and "Multifocal atrial tachycardia" (Shine *et al*, 1968) could also be included as one of the manifestations of the "sick sinus syndrome". In this abnormality, chaotic atrial activity as evidenced by changing P wave morphology is seen with no evidence of normal sinus activity. No necropsy studies of the S-A node or the right atrium in patients with this arrhythmia have been done to date, as far as the authors are aware. However, Phillips and his co-workers (1969) have postulated that "Chaotic atrial mechanism" may be due to damage in the S-A node or the right atrium.

The possible aetiological causes of the "sick sinus syndrome" are as varied as its manifestations. Injury incurred during cardiac surgery, ischaemia, inflammatory processes such as diptheric or rheumatic carditis could all result in anatomical damage to the S-A node. In 1957, Jervell and Lange-Nielson described a syndrome characterised by congenital deafness, prolongation of the Q-Tc interval in the ECG, syncopal attacks and sudden deaths due to cardiac arrhythmias. Post mortem studies have revealed minute infarctions in and around the S-A node.

In this series of 4 cases, 3 patients presented with chronic S-A block. The diagnosis of S-A block was made in accordance with the criteria of Greenwood and Finkelstein (1964). A first degree S-A block cannot be diagnosed electrocardiographically. A second degree S-A block, as seen in Cases 1 and 2, is diagnosed as being present only when the pauses between the P waves are exactly a multiple of the P-P distance or less than 0·10 secs. from this. This rigid criteria is necessary to exclude ECGs which show extreme sinus arrhythmia. An absence of sinus activity for long periods of time (as is seen in Case 4), may be due to either a third degree S-A block, sinus arrest or sino-ventricular conduction. The last can usually be excluded if retrograde P waves are seen. It is not possible at present to distinguish between third degree S-A block and sinus arrest. This problem will remain until the advent of S-A node ECG recordings.

Case 1 was admitted for giddiness associated with vomiting and Case 3 for exertional dyspnoea. In both these patients, the symptoms were most likely due to hypo-perfusion as a result of the extreme bradycardia. Case 2 was admitted for palpitations for 7 days prior to admission. However, the ECG recorded soon after admission showed periods of S-A block, with no tachycardia. Case 3 is specially interesting since the patient volunteered a history that his pulse was slow and irregular since the age of 15. His ECG showed periods of S-A arrest followed by nodal escape beats, but no other abnormalities.

S-A block has been previously considered a rare and transient arrhythmia which may occur in young healthy individuals (Muller and Finkelstein, 1966) or which may be brought on voluntarily by those who practise the art of Yoga (Wenger *et al*, 1961). All these cases are thought to be due to short bursts of intense vagotonia. Other causes of S-A block include a hypersensitive carotid sinus reflex, digitalis therapy (Levine, 1916) and febrile illnesses. However in this series, the aetiology of the S-A block seen in Cases 1 to 3 is most likely due to some form of anatomical damage to the S-A node, because of the chronic nature of the arrhythmia. Although Cases 1 and 2 had no history of angina, ischaemic heart disease is thought to be a likely cause in both these patients, considering their age and the presence of diabetes. The cause of the arrhythmia in Case 3 is totally obscure since he has had no previous illnesses which could account for this abnormal rhythm. Careful post mortem studies by James *et al* (1967) on 2 young, healthy atheletes who died suddenly, has revealed an isolated occlusion of unknown aetiology of the S-A nodal artery. Taking into consideration the young age of Case 3, and his absence of previous illnesses, the present authors believe that this patient most likely has such an isolated occlusion of his S-A nodal artery causing damage to his S-A node.

Although the prognosis in chronic S-A block is by and large better than in chronic A-V block, this arrhythmia may not be as benign as was previously regarded. In a series of 21 patients with chronic S-A block, Rasmussen (1971) found that 15 manifested Stokes-Adams attacks and 2 patients developed severe brain damage from these attacks.

Rasmussen (1971) was also of the opinion that drug therapy, such as Atropine or Isoprenaline was ineffective in the treatment of chronic S-A block. The best treatment, according to him, was the insertion of a permanent pacemaker, preferably of the atrial type. However, in this series, Cases 1 and 2 responded well to an initial trial of intravenous Isoprenaline infusion, followed later by oral Saventrine (long-acting Isoprenaline) therapy. In some cases of chronic S-A block, a special problem in therapy arises when there is a supra-ventricular bradycardia alternating with supra-ventricular tachyarrhythmia. Antiarrhythmic drugs such as Quinidine given for the tachyarrhythmia may result in severe bradycardia, whilst sympathomimetic drugs given for the bradycardia may precipitate further tachyarrhythmias. In such a dilemma, the insertion of a pacemaker is the only effective form of therapy.

Case 4 presented with a disturbance in rhythm associated with an acute posterior myocardial infarction. There was no evidence of any sinus activity throughout her illness (sinus arrest). The initial rhythm was a slow nodal bradycardia, but continuous ECG monitoring during the next 2 days showed that there was frequent alternation of the rhythm between a nodal bradycardia and periods of supra-ventricular tachycardia. This alternating bradycardia and tachycardia is characteristically seen in cases where the S-A node is damaged. In this particular patient however, the possibility that the intravenous Isoprenaline infusion was an aetiological cause of the tachycardia cannot be excluded. Intravenous Hydrocortisone, Atropine and Aramine were also given, but she died 3 days after admission.

As was expected, a thrombus just beyond the right coronary ostium was seen at necropsy. There was also infarction of the posterior wall of the left ventricle. Histological examination revealed that there were wide areas of recent infarction and haemorrhages in the right atrium. The S-A node could not be identified on microscopical examination, and was thought to be either completely destroyed or missed in the histological sections.

According to James (1961), when an acute myocardial infarction is complicated by an atrial arrhythmia, there is invariably damage to the S-A node due to an occlusion of its supply artery. The exact site of the occlusion in the coronary arterial tree can often be predicted from the presence of an atrial arrhythmia and the site of the infarct. The artery to the S-A node arises from the proximal parts of the right coronary artery in 60% of the population and from the left circumflex in the other 40%. Hence a posterior myocardial infarction together with an atrial arrhythmia localises the occlusion in the right coronary artery to near its origin as seen in Case 4. When there is an occlusion in the proximal part of the left circumflex artery, an atrial arrhythmia associated with an infarction of the lateral wall of the left ventricle will be present.

Two patients have been reported by Lippestad and Marton (1967) showing sinus arrest and persistent nodal bradycardia associated with posterior myocardial infarction due to a proximal occlusion of the right coronary artery. These 2 patients are identical to Case 4 in this series. Case 4 illustrates the therapeutic dilemma in patients who present with alternating bradycardia and tachyarrhythmias. In such cases, the only effective treatment is insertion of a pacemaker. When the rhythm of the heart is controlled effectively by the pacemaker, drugs such as Quinidine or Digitalis, which might otherwise prove to be fatal, could then be used with impunity.

ACKNOWLEDGEMENTS

We would like to thank Professor G. A. Ransome, A.M., M.D., F.R.C.P. for permission to publish the above cases. Dr. B. H. Ong, Department of Pathology, Outram Road General Hospital for supplying details of the post mortem findings in Case 4.

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