The Electrocardiogram in Some Indian Population Groups

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Several epidemiologic studies of cardiovascular diseases are now being undertaken with a view to assessing the relative incidence of the different types of heart disease. The methods of assessment of electrocardiograms in such studies have been the subject of debate. The definition of a normal electrocardiogram has become difficult, as with increasing numbers of subjects studied the range of normality is widened. The Research Committee of the International Society of Cardiology, the Minnesota Code, Higgins' modification, and the W.H.O. Expert Committee have all adopted certain criteria for the interpretation of the electrocardiogram. Although these methods are somewhat different and although none has found universal acceptance, there is general agreement on the need to report the so-called "abnormalities" in the different population groups as such, rather than to interpret them.

In this paper the recommendations of the Research Committee of the International Society of Cardiology and of the W.H.O. Expert Committee have been largely followed and the features are recorded rather than interpreted.

Material and Methods

The electrocardiograms of 941 subjects belonging to some South-Indian population groups, civil and military, were studied. The dietary habits, total serum cholesterol and phospholipid levels, blood pressure, and coagulation times of these subjects have been reported earlier. Table 1 shows the age, income, and occupation of these subjects who were all healthy male adults without any clinical evidence of heart disease. The civilian subjects were drawn from the industrial and nonindustrial population belonging to the Nilgiris district (Madras State), Trivandrum (Kerala State), and Hyderabad (Andhra Pradesh). Officers of the defence forces undergoing the staff course at the Defence Services Staff College at Wellington and sepoys and other ranks stationed in the Nilgiris constituted the army personnel.

No selection of subjects was made in any of these groups. All the 121 army officers in the staff college during the year 1958 were studied. The subjects representing industrial labor were from the Cordite factory in the Nilgiris district and formed 16 per cent of the total factory strength. Nonindustrial subjects were members of the staff of the Pasteur Institute, South India, Coonoor, the Lawrence Memorial School, Loe- dale, the Regional Research Laboratory, Hyderabad, and professional people and businessmen in Coonoor. The subjects at Trivandrum were drawn from the secretarial staff, Medical College and Hospital staff, and from the city and surrounding areas. In the early stages of this study subjects over 20 years of age were included but later only subjects beyond 30 years were studied. A subject was designated as belonging to the high- or low-income group, depending on whether his income exceeded 200 rupees per month. The so-called high-income group therefore included not only the really well-to-do but also the middle classes. The low-income group represented the really poor class.

Although drawn from a wide area it is evident from our previous paper that the subjects were fairly uniform with regard to dietary habits, serum cholesterol levels, blood pressure, and body weights. In addition to the recording of height, weight, routine history, and clinical examination on a standard form, estimation of blood pressure, urinalysis, and biochemical studies of blood, a 12-lead electrocardiogram at least five minutes after resting in the recumbent posture was recorded. Smoking, eating, and any form of physical exercise were prohibited for at least half an hour prior to the test. Unless contraindicated by the resting electrocardiogram a Master's two-step exercise test was done and records were taken within 30 to 45 seconds after the end of the exercise. Sometimes, another set of records was

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Table 1

<table>
<thead>
<tr>
<th>Age group, years</th>
<th>Civilian population</th>
<th>Army personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low income</td>
<td>High income</td>
</tr>
<tr>
<td>21-30</td>
<td>102</td>
<td>15</td>
</tr>
<tr>
<td>31-40</td>
<td>135</td>
<td>92</td>
</tr>
<tr>
<td>41-50</td>
<td>109</td>
<td>94</td>
</tr>
<tr>
<td>Beyond 50</td>
<td>73</td>
<td>90</td>
</tr>
<tr>
<td>Total</td>
<td>419</td>
<td>291</td>
</tr>
</tbody>
</table>

* Does not include 16 subjects who had electrocardiographic evidence of myocardial infarction.

Results and Discussion

Unequivocal Abnormalities

Sixteen patients, all civilians, nine in the high- and seven in the low-income group had definite evidence of myocardial infarction according to the criteria listed. Of these, eight had evidence of old anterior and eight of posterior infarction. There were no cases with bundle-branch block, multiple ventricular extrasystoles (more than three per record), cardiac arrhythmias, conduction defects, or marked ST or T-wave changes that might suggest ischemic heart disease. This indicated an incidence of myocardial infarction of 1.7 per cent in the entire study. The low incidence of myocardial infarction and other definite evidence of ischemic heart disease is remarkable. According to Keys, such incidence for men in middle age in Western population groups is 10 per cent. Padma\-vati found, on the other hand, that the incidence of ischemic heart disease among high-income groups was 5.5 per cent and among 1,426 subjects of the poor class 0.33 per cent. Mathur found 6 per cent and 1 per cent in the two groups. The incidence of silent or painless infarcts has been put variously at 15 per cent, 20 per cent, and as high as 50 per cent. Judged from a definite electrocardiographic pattern of infarction, the incidence in the present study would appear to be low, there being no significant differences between high and low income and civil and military personnel. Of the 16 cases, only one was a silent infarct and the rest were symptomatic. Hiss and Lamb in a study of 122,043 individuals have placed the incidence of myocardial infarction as 0.34 per 1,000 and of all abnormalities as 4.7 per cent.

Apparent Deviations From The Normal Not Amounting to a Definite Abnormality

Heart Rate

Fifty-three subjects (5.7 per cent) had a

Table 2

<table>
<thead>
<tr>
<th>Incidence of High Voltage of QRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>21-30</td>
</tr>
<tr>
<td>31-40</td>
</tr>
<tr>
<td>41-50</td>
</tr>
<tr>
<td>Beyond 50</td>
</tr>
<tr>
<td>Totals</td>
</tr>
<tr>
<td>Number with bradycardia</td>
</tr>
</tbody>
</table>

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heart rate of 60 or less per minute. The incidence in the high-income civilian group was 6.3 per cent while in the low-income group it was 7.2 per cent, among military officers 8.3 per cent, and in the other ranks 6.4 per cent. There was no particular trend with regard to age.

*Voltage of QRS Complexes*

*High Voltage.* It is stated that a value of over 35 mm. for $SV_1 + RV_5$ in the chest leads is abnormal over the age of 40 years. There were 23 subjects with such high voltages in the low-income group and 20 in the high-income group beyond the age of 40 years (table 2). The number was larger in the ages below 40, where it may be considered within normal limits. Values over 45 mm., considered significant by some,\(^6\) were found only in two subjects over the age of 40 in the low-income group. None of these subjects had any evidence of heart disease by physical signs or symptoms. There were no T-wave changes suggestive of ventricular hypertrophy in these cases. Army personnel in "other ranks" had a higher incidence of such increased amplitude (17 per cent) as compared to army officers (7.5 per cent) and the civilian group, high income (12.2 per cent) and low income (10.7 per cent). None of these subjects had any evidence of hypertension (blood pressure over 160/95 mm. Hg) or clinical evidence of ischemic heart disease. Cumming and Proudfoot\(^7\) have found that in their series 39 per cent of the subjects had no clinical evidence of heart disease but had electrocardiographic evidence of left ventricular hypertrophy as judged by amplitude criteria. Thirty per cent of the subjects studied by Chou et al.\(^8\) and Scott et al.\(^9\) with electrocardiographic evidence of left ventricular hypertrophy were found to have no evidence of hypertrophy at autopsy. Selzer and co-workers\(^10\) also found similar results in a study of 108 subjects. It would appear, therefore, that while the majority of subjects with left ventricular hypertrophy had increased evidence of high voltage, the converse was not true. In the present study, after age 40, the incidence of such high voltage was equally distributed in the income groups and no conclusions are therefore warranted. Only a long-term study, however, is likely to show whether these increased voltages were portents of heart disease as has been suggested by previous workers.

*Low Voltage.* Low-voltage complexes (amplitude below 5 mm.) in the standard leads were present in 26 subjects (2.8 per cent), 12 of whom showed low complexes in the chest leads also. These were unassociated with any other abnormality. Four subjects were overweight and a thick chest wall might have contributed to the low voltage.

*Grusin's Pattern*

Grusin\(^21\) reported that among African subjects without obvious heart disease 25 per cent had elevated ST junction and segment arching with its concavity upwards and merging into a peaked T wave in the precordial leads. They were considered abnormal and probably of nutritional origin. Of the 925 normal subjects studied here, 69 (7.44 per cent) had such a pattern in the resting electrocardiogram, and after exercise in 14 of these subjects the ST segment and junction became isoelectric (table 3.). The frequency of this pattern was comparatively higher in the low-income group (9.5 per cent) than in the high-income group (4.9 per cent). Between the army officers and the other ranks it was five times more frequent in the latter—8.5 per cent against 1.7 per cent. The nutritional status of the "other ranks" was satisfactory and the adequacy of their diets cannot be doubted. The significance of this pattern therefore remains uncertain.

*ST-segment Changes*

Thirty-seven subjects had ST-segment depression of 1 mm. or more in the resting elec-

### Table 3

**Incidence of Grusin's Abnormality**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Low income</th>
<th>High income</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-40</td>
<td>32 (195)</td>
<td>12 (199)</td>
</tr>
<tr>
<td>41-50</td>
<td>9 (123)</td>
<td>8 (104)</td>
</tr>
<tr>
<td>Beyond 50</td>
<td>8 (75)</td>
<td>(90)</td>
</tr>
</tbody>
</table>

Figures in parentheses refer to number of subjects.

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Table 4

Incidence of Depression of ST Segment (1.0 mm. or More) in Standard Leads I and II or V4-6 in the Resting Electrocardiogram

<table>
<thead>
<tr>
<th>Age group</th>
<th>Low income</th>
<th>High income</th>
<th>Total</th>
<th>Number with T-wave changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-30</td>
<td>3 (120)</td>
<td>2 (19)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>12 (195)</td>
<td>4 (199)</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>41-50</td>
<td>5 (123)</td>
<td>2 (104)</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Beyond 50</td>
<td>4 (75)</td>
<td>5 (90)</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

Figures in parentheses refer to number of subjects studied.

trocardiogram either in the standard leads I and II or the chest leads V4-6 (table 4). These were evenly distributed in the various groups, 6.8 per cent in the low-income group, 5.3 per cent in the high-income group, 5.0 per cent in the army officers, and 6.3 per cent in the other ranks.

T-wave Changes

The percentage of flat or inverted T waves was higher in the high-income groups, both civil and military, and rose significantly after the age of 50 years (table 5). The percentage was higher at all ages in the high-income groups including young men between the ages of 31 and 40 years. These changes, which were primary in V4-6, were not associated with a juvenile pattern in the chest leads. Eighty-seven per cent of cases with T-wave changes did not have any other electrocardiographic abnormality. In the remaining 13 per cent ST depression greater than 1 mm. was also present. None of these subjects had any evidence of hypertension or any other heart disease clinically.

Various factors have been known to produce flat or inverted T waves. Among such factors are a high carbohydrate meal just before the electrocardiogram is recorded,22 fear or other emotions,23 anemia,24 or cold on the anterior chest wall.25 In this series the effect of emotions cannot be ruled out although the other factors could be. Hemoglobin levels were not determined in any of these subjects but none of them was anemic clinically. Mathewson and Varnam2 found that such T-wave changes may presage actual myocardial infarction in a longitudinal study and that they may indicate latent coronary artery disease.

Tall peaked T waves. Forty-one subjects had T waves over 10 mm. in the chest leads. The incidence was greatest in the low-income group (6.2 per cent) followed by the high-income civilian group (3.6 per cent), army "other ranks" (3.7 per cent), and the army officers (1.7 per cent). There was no particular age trend. None of these subjects had evidence of any disease. Electrolyte levels were not considered to be etiologic factors.

Table 5

Incidence of Inverted and Isoelectric T Waves in the Resting Electrocardiogram

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of subjects</th>
<th>Low income</th>
<th></th>
<th></th>
<th></th>
<th>High income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Lead I</td>
<td>Lead II</td>
<td>Lead V4-6</td>
<td>Total</td>
<td>Lead I</td>
<td>Lead II</td>
<td>Lead V4-6</td>
</tr>
<tr>
<td>21-30</td>
<td>120</td>
<td>(2.05)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>199</td>
<td>(8.02)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>31-40</td>
<td>195</td>
<td>(3.55)</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>104</td>
<td>(8.60)</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>41-50</td>
<td>123</td>
<td>(4.90)</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>90</td>
<td>(17.8)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Beyond 50</td>
<td>75</td>
<td></td>
<td>3</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in parentheses indicate per cent values.

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Postexercise Records

The interpretation of postexercise electrocardiograms is the subject of much debate. Scherf and Schaffer,26 Twiss and Sokolow,27 Biörck,28 and Master et al.29 all have different criteria with regard to the amount of ST depression, the leads involved, and T-wave inversions if present.

Among the 120 subjects (all civilians) in whom the standard two-step test was performed, 45 (37.5 per cent) showed an ST depression of 1 mm. or more in the standard limb leads or the left chest leads and three showed a flattening of T waves (table 6). A depression greater than 2 mm. is considered abnormal by all investigators;30 judged by this criterion 30 of the 45 had an abnormal response. The incidence was a little higher among the higher-income groups (28.5 per cent) than in the lower-income groups (21.4 per cent). This would indicate a higher incidence of this abnormality and perhaps of coronary artery disease in the high-income groups. This is in keeping with findings elsewhere in India, such as in Delhi and Agra.11

Summary

Of 941 subjects studied, there were 16 cases of myocardial infarction of which one was a silent infarct. Of these, nine were in the low-income group and seven in the high-income group. All the cases were among the civilian population.

About 11 of the subjects had high voltage in the chest leads without any evidence of hypertension or other heart disease. These were equally distributed at all ages in the different income groups, civil and military.

There was no significant difference in the incidence of ST-segment depression in the various groups. On the other hand, T-wave changes in standard leads, I, II and left chest leads was higher in the high-income groups at all ages than in the low-income groups and the increase was significant after the age of 50 years.

ST and T-wave changes following exercise were slightly higher in the high-income groups than in the low-income groups among the civilian subjects.

The incidence of Grusin's abnormality was higher in the low-income group, both civil and military, than in the high-income groups.

The incidence of ischemic heart disease (and of electrocardiographic abnormalities generally) was very low in this study as compared to studies elsewhere.

References


Table 6

Incidence of Depression in ST Segment (Standard Leads I and II and V4-6) (2 mm. or More after Exercise)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of subjects studied</th>
<th>Low income</th>
<th>Number of subjects studied</th>
<th>High income</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-40</td>
<td>35</td>
<td>10</td>
<td>39</td>
<td>10</td>
</tr>
<tr>
<td>41-50</td>
<td>16</td>
<td>4</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Beyond 50</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>
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