Electrocardiographic changes during exercise in Kurdish and Yemenite Jews in Israel

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The electrocardiographic changes of 33 Kurdish and Yemenite Jews aged 18-30 years were studied at rest and during four levels of exercise, on an upright stationary bicycle ergometer.

The results obtained confirm and extend our previous findings on Europeans (Davies et al., 1971) and suggest that a depression of less than 1 mm at a point in the ST segment 68 msec after the onset of the R wave, and increased slope of the ST segment is a normal response to exercise in both Jewish and British subjects. No evidence was found to support those who claim that otherwise healthy people of Jewish descent have an unusually high incidence of electrocardiographic abnormality either at rest or during exercise.

It is well known that the incidence of ischaemic heart disease is not identical in different parts of the world (World Health Organization, 1956) and may even vary within a given country depending upon the pattern of ethnic and social groups (Toor *et al.*, 1960). In a study of a working population in the United States, it was found that the prevalence of coronary heart disease among Jewish men was twice as frequent as among Italian men, but no ethnic difference could be discerned among women (Epstein, Boas, and Simpson, 1957). In Israel, the claim that Jewish people are more prone to ischaemic heart disease than their Caucasian counterpart of European descent has been disputed (Brunner and Manelis, 1960).

In this study the pattern of electrocardiographic changes during exercise of graded intensity up to and, in some cases, including maximal work was studied in Kurdish and Yemenite Jews, aged 20-30 years, inhabitants of the southern arid part of Israel. Particular attention has been given to those changes in ST₂ segment of the electrocardiographic complex, which are widely accepted as indicators in the early diagnosis of ischaemic heart disease (Rose and Blackburn, 1966). A comparison has been carried out with similar results obtained on young Englishmen resident in the U.K.

Subjects and methods

33 subjects, Kurdish and Yemenite Jews, 17 men and 16 women, were studied at rest and during four

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levels of exercise of increasing severity. Details of the exercise procedure and the method used for determination of gas exchange have been given previously (Davies, 1968, 1971). Each subject was given a physical examination and only those free from clinical signs of disease were invited to take part in the definite study.

The physical characteristics of the subjects reported in this study are given in Table 1.

TABLE 1 *Physical characteristics of subjects in the present investigation*

Group	Age (yr)	Weight (kg)	Height (cm)
Englishmen (n = 17)	27.06 ± 6.02	68.98 ± 9.37	173.43 ± 6.66
Kurdish and Yemenite Jews (male) (n = 17)	24.89 ± 3.76	65.88 ± 9.30	166.84 ± 6.26
Kurdish and Yemenite Jews (female) (n = 16)	24.75 ± 3.30	54.57 ± 9.78	153.04 ± 4.64

The cardiac frequency and electrocardiogram were recorded continuously during exercise and the immediate recovery period. On 14 subjects, recordings were obtained during the performance of maximal physical effort as well. A single electrocardiographic lead was used corresponding to position CR₅ (one electrode at the height of the apex beat and the other over the shoulder; the earth electrode was positioned on the sternum). The electrocardiograph signal was amplified with a standard amplifier and fed directly to a tape recorder where it was continuously traced on a magnetic tape at a speed of 1.8"/sec. The electrocardiograph was calibrated at regular intervals with a standard 1 mV signal. The magnetic

tapes were analysed using a special hybrid computer (Neilson, Davies, and Kitchen, 1968). The computer performed the following analysis: it read the potential of each electrocardiograph wave complex from a reference point 46 msec before the upstrokes of the R wave and at 3 points – ST₁, ST₂, ST₃, respectively 50, 68, and 86 milliseconds after the onset of the R wave (Davies *et al.*, 1971). These results together with the instantaneous cardiac frequency (Neilson, 1963) were read out on to electrocardiograph paper moving at a speed of 1 cm/min on a 4-channel Devices recorder. Thus, a separate continuous record of the changes in the ST segment during the exercise test was obtained for further analysis.

The electrocardiograms were also analysed in terms of ST shift and changes in slope during the last 10 minutes of rest and the final minute of exercise at each work level.

Results

Effect of exercise on ST₂ segment

The ST₂ segment voltage changes during exercise are summarized in Table 2. Exercise produces an obvious decrease in ST₂ which is closely similar in all three groups. When similar levels of exercise are compared a statistical significant difference in ST₂ is only apparent between the Kurdish-Yemenite

Jews and their English counterparts at 900 kp m min⁻¹. Similarly between the women and the men only at 300 kp m min⁻¹.

In the Englishmen the mean decrease in ST₂ segment voltage during exercise appears to be linearly related to work load (Table 2). However, this is not true of the remaining two groups. In the Kurdish and Yemenite men (and more particularly in the women) there is a distinct tendency for the change in ST₂ segment voltage to level off at higher work loads; thus the ST₂ relation becomes asymptotic.

Concomitant with the large changes in ST₂ segment voltage is an equally large change in ST segment slope (Table 3). The change in slope is particularly obvious in the Kurdish-Yemenite men (4.49 mV sec⁻¹ at 900 kp m min⁻¹ compared with 2.83 mV sec⁻¹ at the same workload in Englishmen).

The change in ST segment slope is linearly related to work load and therefore to oxygen intake (VO₂), but unlike the changes in ST₂ segment voltage there appears to be no tendency for the relation to become curvilinear at high work rates. The linear regression equations relating the slope of the ST

TABLE 2 Changes in ST₂ segment during exercise (mean ± SD data)

Group	Rest ST ₂ (mm)	ST ₂ during exercise (kp m min ⁻¹) – mm				
		150	300	450	600	900
Englishmen (n = 17)	+0.68 ±0.78	—	–0.24 ±0.38	—	–0.64 ±0.59	–0.93 ±0.57 (n = 16)
Kurdish and Yemenite Jews (male) (n = 17)	+0.34 ±0.62	—	–0.17 ±0.43	—	–0.69 ±0.55 (n = 14)	–0.33* ±0.96 (n = 12)
Kurdish and Yemenite Jews (female) (n = 16)	+0.07 ±0.32	–0.71 ±0.51	–1.21† ±0.47	–1.01 ±0.55 (n = 13)	–0.83 ±0.69 (n = 10)	—

Male cf. male, * P < 0.05; male cf. female, † P < 0.001.

TABLE 3 Changes in ST₂ segment slope during exercise (mean ± SD data)

Group	Rest ST segment slope mV sec ⁻¹	ST segment slope during exercise (kp m min ⁻¹) – mV sec ⁻¹				
		150	300	450	600	900
Englishmen (n = 17)	+0.38 ±1.41	—	+0.88 ±1.60	—	+1.75 ±1.54	+2.83 ±1.63 (n = 16)
Kurdish and Yemenite Jews (male) (n = 17)	+0.51 ±0.79	—	+1.13 ±1.14	—	+2.00 ±1.18 (n = 14)	+4.49* ±1.83 (n = 12)
Kurdish and Yemenite Jews (female) (n = 16)	+0.39 ±0.37	+0.29 ±0.58	+0.74 ±0.62	+2.00 ±0.86 (n = 13)	+2.76 ±1.12 (n = 10)	—

* P < 0.05.

segment (Y) to $\dot{V}O_2(x)$ for the 3 groups are given by:

$$Y = 1.81 + 0.04 \times (\text{Englishmen } \delta) \quad r = 0.99$$

$$Y = -2.51 + 0.09 \times (\text{Kurdish-Yemenite } \delta) \quad r = 0.82$$

$$Y = -1.96 + 0.03 \times (\text{Kurdish-Yemenite } \varphi) \quad r = 0.71.$$

There are no statistically significant ethnic or sex differences for either the slope or the intercept of these regression lines.

The changes in ST_2 segment slope and voltage outlined above are conveniently summarized in the Fig.

The shaded and dotted rectangular areas represent the mean $\pm$ SD of the observed points for the Kurdish-Yemenite subjects (men and women) and the Englishmen, respectively. The diagram serves to emphasize the close similarity of the three groups, irrespective of differences in ethnic origin and sex.

Maximal exercise

Maximum exercise was performed and electrocardiograms taken on 14 subjects in the present study. The data are insufficient to allow a statistical comparison between the three groups but they do show

FIG. Relation between change in ST_2 and ST segment slope. (a) Male data. The shaded rectangular area represents the mean $\pm$ SD of the observed points of the Kurdish-Yemenite male data. The same data for the Caucasian men are given by the dotted rectangle. The observed points (●) are shown for the Kurdish and Yemenites. (b) Female data.

that the trend outlined during submaximal exercise is continued up to and including maximal levels of work. The mean ST₂ voltage change shows no tendency to increase during maximum work, the mean value for all subjects measured is -0.80 (cf. Table 2). The mean change in ST segment slope is 5.20 (cf. Table 3).

Discussion

Compared to the wealth of information on electrocardiographic abnormalities at rest and during recovery from exercise, there are few investigations aimed to evaluate the corresponding abnormalities during exercise. This is surprising in view of the repeated claims of some authors (Doan *et al.*, 1965) that abnormalities during exercise, particularly in respect of the ST segment, are of greater value in the diagnosis of ischaemic heart disease. In the present study the use of a new method has allowed for the instantaneous and continuous changes in the ST segment, during carefully controlled and standardized work, to be recorded and evaluated in two distinct ethnic groups.

In order to make comparisons with other published data we have concerned ourselves only with conventional changes in the ST segment, namely ST₂ depression and change in slope of the ST segment.

The ST₂ depression was taken 68 msec after the onset of the R wave and the slope of the ST segment was calculated from the difference between ST₁ and ST₃ voltage with respect to time. This is essentially the convention used by McHenry, Stowe, and Lancaster (1968), the accuracy and technical validity of which has been previously discussed (Davies *et al.*, 1971).

The results of the present study confirm and extend our previous findings on Europeans (Davies *et al.*, 1971) to Kurdish and Yemenite Jews living in Israel and clearly indicate that our original method for the quantitative analysis of the electrocardiogram which was developed in the laboratory can be applied to the more demanding field situation. The data suggest that the depression in ST₂ and the increased slope of the ST segment is a 'normal' response to exercise in both British and Jewish subjects. In all groups the slope of the ST segment consistently increases with increasing work, and though the depression of ST₂ tends to level off at the highest exercise levels, nevertheless a general progression and evolution of ST segment responses can be seen (Fig.). When the ST₂ change is plotted against the absolute slope after the method of McHenry *et al.* (1968), 3 Englishmen and 4 Kurdish-Yemenite

Jews lie outside their proposed line of discrimination between normal and abnormal (ischaemic) electrocardiographic responses to exercise. However, in each case the point is borderline. In order to make more meaningful statements regarding the likely prevalence or absence of ischaemic heart disease, it is clear that a large number of subjects from both ethnic groups would have to be studied. However, the results of this investigation do suggest that the abnormalities in the electrocardiogram during exercise in both Englishmen and male Jews are likely to be the same. In this sense these results support those of Brunner and Manelis (1960), who showed that Jews living in Israel were no more particularly prone to ischaemic heart disease than other comparable ethnic groups.

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