

ELECTROCARDIOGRAPHIC CHANGES DURING HYPERVOLEMIA IN DOGS*

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Many observations on the effects of decreasing the blood volume have been reported, but much less information is available on the effect of increasing the blood volume. It is known that an increase in blood volume produced by the rapid intravenous administration of fluid will produce a rise in venous pressure, increase in size of the heart and cardiac output. The increase in size of the heart and the cardiac output will increase strain on the heart, and patients, with heart failure may show poor tolerance to intravenous infusions (2, 3 and 4).

Warren *et al* (7) observed that increase in blood volume consistently caused a rise in atrial pressure but cardiac output, arterial blood pressure and pulse rate did not show consistent change. They suggested that increased blood volume and arterial pressure did not put demonstrable mechanical burden on the heart in normal subjects and that this may also be true in cases of heart failure. The present investigations were undertaken to study the electrocardiographic evidence of cardiac strain due to hypervolemia.

MATERIALS AND METHODS

The experiments were carried on 20 healthy street male dogs anaesthetised with pentobarbital sodium (NEMBUTAL 25 mg/Kg. I/V). The blood volume was increased by injection of 10, 20, 30 and 40 ml of dextran/Kg. body weight. The electrocardiogram (Standard limb leads) was recorded before and 10 minutes after the dextran injection. It was also recorded on alternate days for seven days after giving the same quantity of nembutal to eliminate the effects of anaesthesia.

OBSERVATION AND RESULTS

(a) Effect of injection of 10 ml. of dextran/Kg. body weight. (Fig. 1) P_1 and P_2 showed an increase in voltage which was maintained upto 7th day. P_3 showed increase after 48 hours which was also maintained up to 7th day. Q_1 and Q_2 showed increase in voltage after 48 hours which persisted even on the 7th day. Q_3 after an immediate initial decrease showed an increase within 48 hours which was maintained even on 7th day. ST segment was immediately raised in Lead I but returned to normal after 48 hours and then showed depression which was present even on the 7th day. ST segment in Lead II and III did not show any apparent change. T_1 became inverted or the degree of inversion increased if it was already inverted, but became isoelectric or even positive after 48 hours. T_2 and T_3 also showed immediate depression which returned to normal after 48 hours but became biphasic on 5th or 7th day.

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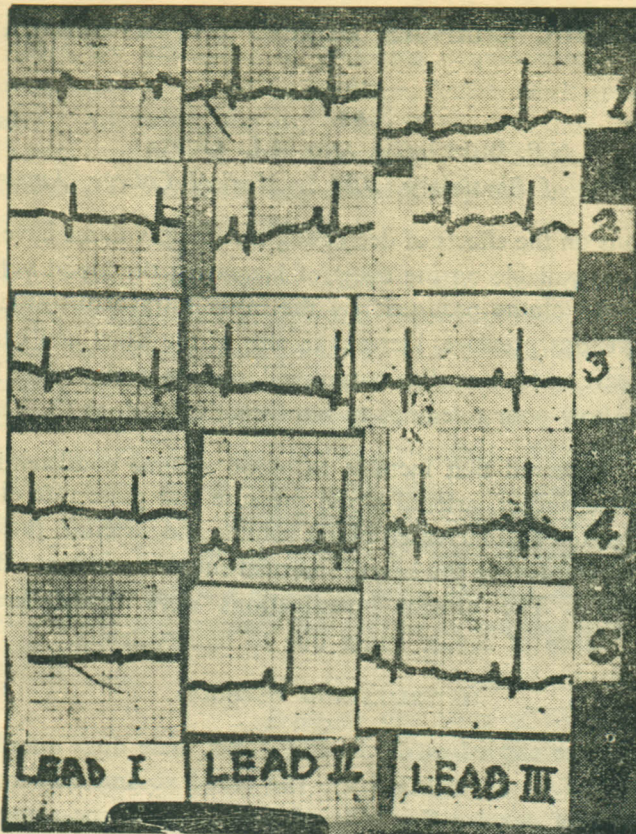


Fig. 1 : Shows the effect of injection of 10 ml of dextran/Kg. body weight in lead I, II and III. Tracings marked 1 are initial, No. 2 have been recorded 10 minutes after injection of dextran; Nos. 3, 4 and 5 have been recorded after 48 hours, 5th day and 7th day.

P_2 became prominent in No. 2, remaining so subsequently. Q_1 shows deepening immediately after 10 minutes which does not persist in subsequent tracings. Q_3 appears very prominently after 48 hours persisting on 5th day and diminishing on the 7th day. R_1 became quite prominent in the record taken after 10 minute persisting upto 5th day. On the 7th day it was of similar weight as initially. R_2 and R_3 showed increase in subsequent records. T wave has shown a tendency of decreased voltage.

(b) Effect of injecting 20 ml of dextran/Kg body weight. (Fig. 2) P_2 became isoelectric from an initial positive condition and returned to normal on 3rd or 5th day. Q wave showed similar changes as with 10 ml of dextran. ST segment did not show any apparent changes. T_1 showed increased inversion immediately after injection but returned to initial level on the 5th day. T_2 and T_3 also showed initial inversion in one case but returned to normal after 48 hours.

(c) Effect of increasing 30 ml of dextran/Kg. body weight. P_2 and P_3 showed immediate marked decrease in voltage, which was maintained even on the 7th day. Q_1 showed marked

increase in voltage but returned to initial level after 48 hours. Q_2 showed tendency for increase but Q_3 did not show any apparent change. ST segment did not show any apparent change except in one dog in which there was depression in all the three leads but returned to initial level within 7 days. T_1 and T_3 showed immediate inversion if it was initially positive and increased inversion if it was initially negative. In some T_1 and T_3 returned to normal while in others the inversion was maintained even on the 7th day.

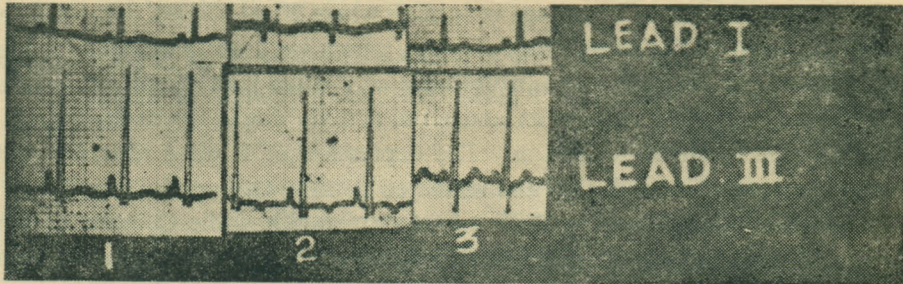


Fig. 2 : Shows the effect of 20 ml of dextran/Kg. body weight in Lead I and III. Tracings marked 1 are initial, no. 2 are recorded after 10 minutes and no. 3 after 48 hours.

It will be seen that P_1 shows decreased voltage in the second record but shows recovery in the 3rd record Q_1 also appears in second record, disappearing within 48 hours. R_1 wave shows decrease in the second record but shows recovery in the third. P_3 shows decrease voltage after 48 hours, which persists in the third record. S_3 becomes quite prominent after 48 hours. T_1 and T_3 show inversion in second record and recovery in the third one.

(d) Effect of injecting 40 ml. of dextran/Kg. body weight. (Fig. 3) P_2 and P_3 showed a decrease which became more prominent after 48 hours. Q_1 showed marked increase immediately but returned to initial level within 48 hours, while Q_2 and Q_3 showed no change. ST

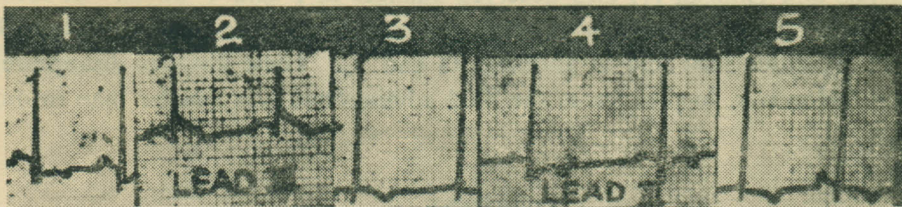


Fig. 3 : Shows the effect of injection of 40 ml of dextran/Kg. body weight in Lead III. Tracing marked No. 1 is initial No. 2 recorded 10 minutes after the injection; No. 3,4 and 5 have been recorded after 48 hours, on 5th day and 7th day.

R wave shows some decrease in voltage in 2nd record but recovery in the subsequent ones. ST segment is seen to be raised immediately after the dextran administration but is found to show recovery in 3rd, 4th and 5th tracings. Twave which is negative in the initial tracing shows increased negativity in subsequent tracings.

segment did not show any apparent change. T_1 and T_2 showed increased inversion while T_3 from an initial inverted or positive condition became isoelectric either immediately or within 48 hours.

DISCUSSION AND CONCLUSIONS

With 10 ml. of dextran/Kg. P wave became prominent immediately after injection of dextran while it became decreased in voltage in animals where 20 ml., 30 ml. and 40 ml. of dextran/Kg. was given. In most of the cases, these changes, which were well marked in Leads II and III, persisted even on the 7th day. The prominence of P wave with 10 ml. of dextran is possibly due to increased coronary circulation and atrial activity due to increased systolic and diastolic pressure without much hemodilution. The depression of P wave observed with greater infusion is possibly due to hemodilution and increased strain. Q_1 and Q_2 have shown increase in voltage immediately after injection of 10 ml. of dextran/Kg. while Q_3 have not shown any change in most of the animals. The increase in voltage is maintained even on 7th day. This may indicate increased ventricular activity. Though Q wave shows similar changes with larger amount of dextran, it returns to initial level earlier than in animals who received 10 ml. of dextran/Kg. This is possible due to early return of plasma volume to initial level of former cases. Huggins *et al* (5) studied circulatory adjustments to massive blood transfusions in dogs. They reported that though plasma including proteins escaped from the vascular system even with the smallest transfusions, the plasma loss exceeded the quantity infused in heavy transfusions. Smith *et al* (6) also observed that considerable quantities of plasma was "trapped" with the cells and thus more plasma was lost than expected. The elevation of ST segment in Lead I and inversion or depression of T wave in all the Leads shows almost complete recovery in 48 hours. This indicates that the changes which are due to myocardial strain disappear with return of blood volume to initial level.

Altschule and Gilligan (1) also observed changes in P and T waves. In their cases P wave increased in one or more leads. T wave also showed increased voltage in Lead I and II while in one, T_1 diminished and in another, T_2 and T_3 . These changes disappeared within 2 to 3 hours. However, in their cases the fluid administered was smaller than in our experiments.

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