ELECTRO-CARDIOGRAPHIC CHANGES IN ACUTE HEMORRHAGE*

By

N.P. BHATNAGAR** AND M.L. GUPTA

Department of Physiology and Biochemistry, S.M.S. Medical College, Jaipur

Electrocardiographic changes during hemorrhage have been studied by many workers. Marchal and associates (3) assigned them due to disturbance in blood volume and circulation as they were able to correct them by saline or blood transfusion. On the other hand Szekeley (8) and Hunter (2) observed such electrocardiographic changes in anemia but found no relation of them with severity of anemia. Scherf and co-workers (7) observed these changes constantly in acute hemorrhage and assigned them to the rapidity of bleeding rather than to hemoglobin level. However, such observations have been meagre and isolated.

The present investigations were undertaken to study the various electrocardiographic changes due to various degrees of acute severe hemorrhage and to study whether these were reversible or irreversible.

MATERIALS AND METHODS

The experiments were done on 40 healthy dogs weighing between 6.4 *kg* to 20 *kg* anesthetised with a suitable fixed dose of pentobarbital sodium (NEMBUTAL) 25 *mg/kg* body weight given intravenously. The animals were kept for a week on a standard diet before experimentation. These were divided into two groups. In one group (25 dogs) the blood was removed in steps of 10 *ml/kg* body weight while in others (15 dogs) 20 *ml/kg* body weight at intervals of 10 minutes till the dog died. Electrocardiographic tracings (standard leads) were recorded in the beginning and then after each removal.

In five of the first group of dogs, the blood was removed up to 3 stages (of 10 *ml/kg.*) only and then the entire amount of blood was replaced in steps of 10 *ml/kg.* body weight at intervals of 10 minutes. E.C.G. was recorded after each removal and replacement.

In 5 dogs of each group, 10 *ml* and 20 *ml* of blood per kg. body weight respectively, was removed once only and was not replaced and the delayed effects of hemorrhage and the recovery of electrocardiographic changes were studied for a varying period from 7 to 17 days by recording the E.C.G. after administering the same dose of anesthesia to eliminate the effects of anesthesia.

---

*Presented at the VIII Annual Conference of the Association of Physiologists & Pharmacologists of India at Jaipur in 1962.

**Present address: B.J. Medical College, Ahmedabad-16.

RESULTS AND DISCUSSION

We have observed that the removal of 10 *ml* of blood per kilo body weight after every 10 minutes (Fig. 1) did not give uniform effects on P and Q waves. There was a tendency of in-

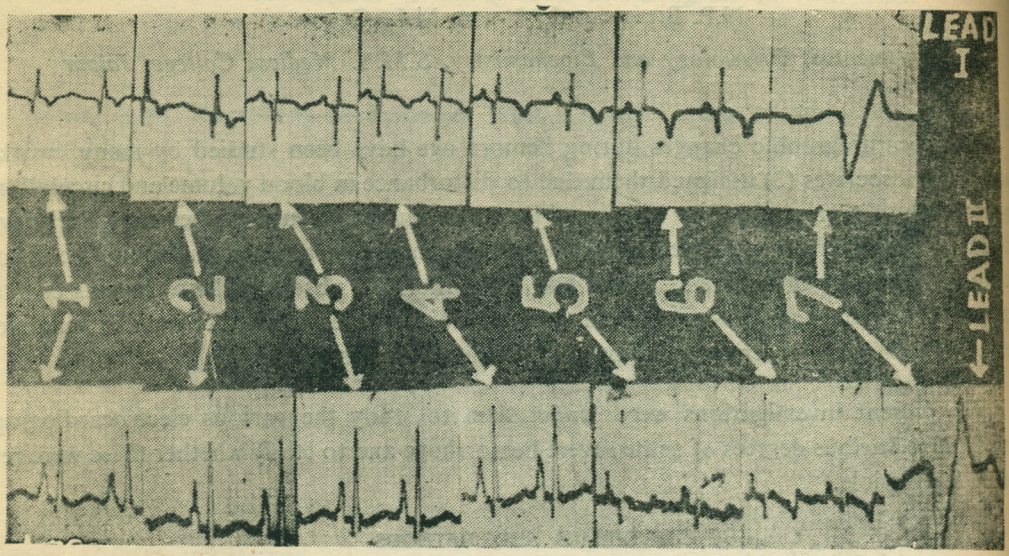

Fig. 1

Shows the effect of removal of blood in steps of 10 *ml/Kg. body weight on E.C.G. in Lead I and Lead II. Tracings marked no.* 1 *are initial (or control) . Tracing marked no.* 2, 3 ,4, 5, 6 *and* 7 *have been recorded each after* 10 *minutes of the removal of blood (every time* 10 *ml/Kg. body weight) till the blood was no more coming. It will be seen that P becomes more prominent progressively in both leads in the early stages but shows regression later on. T 1 shows progressive deepening. Q 2 shows progressive deepening while T shows flattening and subsequent inversion. In this tracing Q 2 is prominent and T inverted even in the initial tracing and ST segment changes were not seen.*

crease in P wave in all the three leads initially but with further removals P_2 showed increase in positivity while P_3 showed diminution in positivity. The increase of Q_1 and Q_2 was progressive with first few removals but showed regression with further removals. The changes in ST segment and T wave were most constant. Usually there was elevation of ST segment in lead I and depression in lead III. The changes in lead II were variable. The changes in ST segment increased with further removals.

In certain cases after remval of 40 to 60 *ml* of blood per kilo the elevation of ST segment became less and even came to initial level in some cases. T_1 usually showed progressively increased inversion while T_3 showed decreased positivity in some while inversion in others. T_2 gave variable results. Changes in ST segment and T wave were taken to indicate myocardial anoxia and necrosis. Scherf and Klotz (6) observed only inversion of T wave and have suggested that there was myocardial anoxia irrn hemohage. It is possible that the amount of hemorrhage in their

cases might have been less as compared to ours. The effect of removal of 20 *ml* of blood per kilo on ECG were more or less similar to that of 10 *ml* of blood per kilo bady weight but were of greater intensity. Dack, Corday and Master (1) also observed that the changes in ECG were related to the amount of blood lost.

In the series where 10 *ml* of blood per *kg.* was removed once only, P and Q waves did not show any changes except that these became prominent after 48 hours. Q_2 increased in voltage either immediately after bleeding or within 48 hours which remained so even on 5th day (Fig. 2),

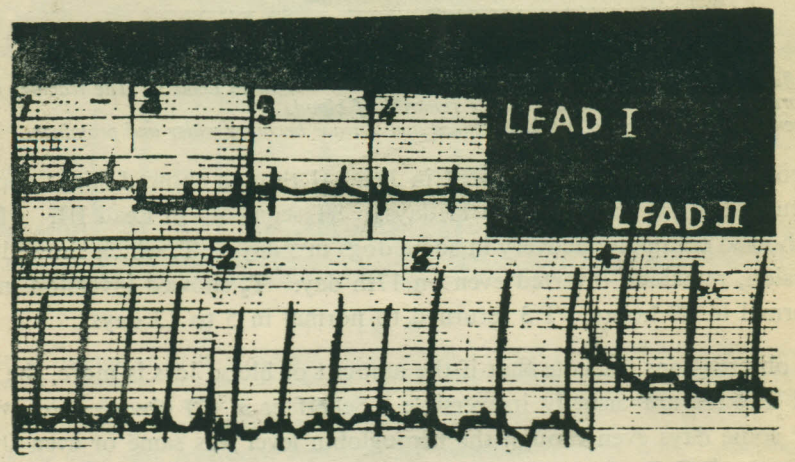

Fig. 2

It shows the effect of removal of 10 *ml of blood per Kg/body weight in Lead I and II once only. Tracing marked* 1 *are initial, while no.* 2, 3 *and* 4 *have been recorded after* 10 *minutes, after* 48 *hours and on* 5*th day of the removal of blood. It will be seen that Q wave appears, ST segment is raised, and T-wave is inverted in* 48 *hours* (3). *These changes persist on* 5*th day* (4). *The decrease in the voltage of P and deepening of T-wave in Lead II is also seen* (3) *which also persist on* 5*th day. This shows that some of the E.C.G. changes may take some time to develop.*

ST segment in lead I, which was raised after bleeding, returned to the initial level after 48 hours in some cases, while in others it remained elevated even on 5th day. ST segment in lead II showed slight elevation after bleeding but returned to initial level within 48 hours. In lead III, ST segment remained elevated even on 7th day. T_1 remained inverted even on 7th day. T_2 showed partial recovery within 48 hours while T_3 did not show any well marked changes.

In series where 20 *ml* of blood per kilo body weight was removed once only, the changes were more marked. P_1 showed no change, P_2 was depressed, and P_3 increased immediately after bleeding or within 48 hours. These showed recovery in 9 to 15 days. Q_2 and Q_3 usually did not show any change but when it showed some increase, it returned to initial level within 48 hours. Q_1 showed increased voltage either immediately or within 48 hours which persisted even on the 17th day.

ST segment in Lead I (Fig. 3) which was elevated either immediately or within 48 hours of removal of blood, showed recovery in some animals in 3 to 5 days, while in others these persist-

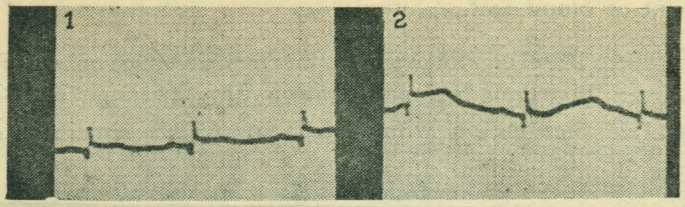

Fig. 3

Shows the effect of removal of 20 ml of blood per Kg. body weight in Lead I. The tracings have been taken initially before removal and 10 minutes after removal of blood.
It will be seen that ST segment is markedy raised and T-wave becomes wider and prominent.

ed even up to the 17th day. ST segment in Lead II though showed slight depression within 48 hours, returned to normal in 5 to 11 days. ST segment in Lead III, where it showed depression, showed complete recovery in some dogs in 9 days. T_1 which showed slight diminution or inversion, remained inverted even on 17th day. T_2 showed inversion in some and returned to normal in 48 hours. T 3 returned to normal in 5 to 13 days.

These observations indicate that if the amount of blood loss is more, the changes in ST segment and T wave are usually irreversible. Scherf *et al* (7) observed recovery of E.C.G. changes after some days even though the hemoglobin level was same or even showed fall and suggested that the E.C.G. changes were due to disturbance in blood volume, rather than to hemoglobin content of blood.

Szekeley (8) and Hunter (2) also did not observe any corelation between ECG and severity of anemia. However, in our experiments T wave has shown either nil or very sluggish recovery even on the 17th day. This may possibly be due to greater blood loss in our cases.

In the experiments where the blood was removed in 3 stages of 10 *ml/kg* at 10 minutes intervals and then replaced in 3 stages of 10 *ml/kg* at 10 minutes interval (Fig. 4), it was observed that the P and Q waves in all the three leads returned to their initial level. ST segment which was raised in lead I returned to its initial level with the first replacement of 10 *ml* of blood per kilo. ST segment in lead II did not show any effect when blood was removed but showed depression when 10 to 20 *ml* of blood is replaced per kilo. In lead III, ST segment showed depression after removal of blood, but became isoelectric after replacing first 10 *ml* of per kilo blood. However, in one it remained depressed even when entire quantity was replaced. One died suddenly with the last replacement of blood while in another the electrocardiogram became of bizarre pattern. T_1 which became inverted initially, became isoelectric after replacing the blood but did not come to the initial positive level. T_2 and T_3 showed more or less complete recovery in 3 dogs, while in one the replacement of blood had no effect.

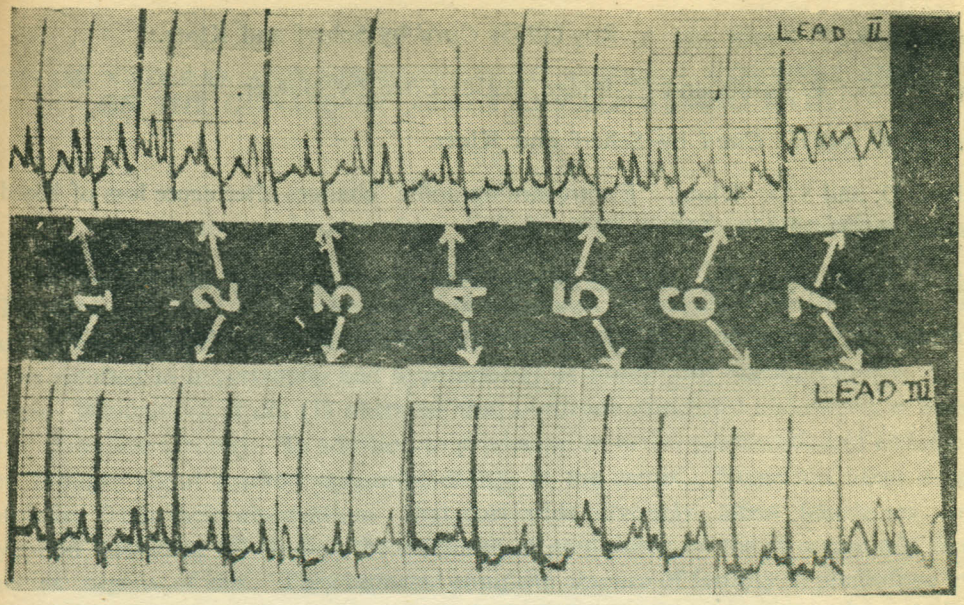

Fig. 4

Shows the effect of removal of 10 *ml of blood/Kg body weight* 3 *times i.e. upto* 30 *ml of blood per Kg. of body weight and then its replacment in Lead II and III.* 1 *is initial tracing* 2, 3 *and* 4 *have been taken after removal of blood* 10 *ml/Kg each time at an interval of* 10 *minutes.* 5, 6 *and* 7 *are after replacing the blood in* 3 *steps each of* 10 *ml/Kg body weight at intervals of* 10 *minutes.*

T-waves in both the leads show progressive depression and immediate recovery after replacement. It should be noted that T becomes inverted after removal of 30 *ml/Kg of blood (i.e. after the* 3*rd step of removal) but becomes immediately positive after replacement of* 10 *ml of blood/Kg. body weight (i.e. first step of replacement). E.C.G. tracing after the last replacement becomes suddenly of bizarre pattern in this case and the dog expires.*

This indicates that if the blood volume is restored immediately after hemorrhage, the ST segment shows more or less complete recovery, while changes in T-waves, which are due to myocardial damage, show complete recovery in some and partial recovery in others indicating that the changes are reversible only if the blood volume is restored within certain time before permanent damage occurs to the myocardium. This view is supported by Marchal and associates (3) who also observed that ST depression and T wave inversion after massive hemorrhage were corrected by saline or blood transfusions. The bleeding experiments of Radnai (5) and Marchal and associates (4) also support this view. However Scherf *et al* (7) reported that the alterations in the E. C. G. were unaffected by blood transfusion.

REFERENCES

1. Dack, S., E. Corday and A.M. Master. The heart in acute hemorrhage. A clinical and electrocardiographic study. *Amer. Heart. J.* **42**:161, 1951.

2. Hunter, A. The heart in Anemia. *Quart. J. Med.* **15**:107, 1946.

3. Marchal, G., P. Soulie and A. Roy (1935) *Cited* by Scherf and Klotz.

4. Marchal, G.; P. Soulie and C. Bauge (1938) *Cited* by Hunter.

5. Radnai, P. (1935) *Cited* by Scherf and Klotz.

6. Scherf, D. and S.D. Klotz. Electrocardiographic changes after acute loss of blood. *Ann. Intern. Med.* **20**:438, 1944.

7. Scherf, D., H. Reinstein and S.D. Klotz (1941) *Cited* by Scherf and Klotz.

8. Szekeley, P. Electrocardiographic findings in anemia. *Brit. heart J.* **2**:1, 1940.