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 anesthetized 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.

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**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 a decrease in P wave in all the three leads initially but with further removals P showed increase in positivity while P showed diminution in positivity. The increase of Q and Q was progressive with first few removals but showed regression with further removals. The changes in 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 removal 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 usually showed progressively increased inversion while T showed decreased positivity in some while inversion in others, T 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 in hemorrhage. It is possible that the amount of hemorrhage in the

![Fig. 1](image)
Electrocardiographic Changes In Acute Hemorrhage

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 badly 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. Q2 increased in voltage either immediately after bleeding or within 48 hours which remained so even on 5th day.

In series where 20 ml of blood per kilo body weight was removed once only, the changes were more marked. P1 showed no change, P2 was depressed, and P3 increased immediately after bleeding or within 48 hours. These showed recovery in 9 to 15 days. Q1 and Q2 usually did not show any change but when it showed some increase, it returned to initial level within 48 hours. Q3 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 after removal of blood, showed recovery in some animals in 3 to 5 days, while in others these persisted 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. T1 which showed slight diminution or inversion, remained inverted even on 17th day. T2 showed inversion in some and returned to normal in 48 hours. T3 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 hemoglobin content of blood.

Szekeley (8) and Hunter (2) also did not observe any correlation 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. T1, which became inverted initially, became isoelectric after replacing the blood but did not come to the initial positive level. T2 and T3 showed more or less complete recovery in 3 days, while in one the replacement of blood had no effect.
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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 replacement 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 3rd step of removal) but
becomes immediately positive after replacement of 10 ml of blood/Kg body weight (i.e. first step of replace-
ment). 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 indicat-
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 asso-
ates (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

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