THE DOG ECG AFTER LIGATURE OF THE CORONARY ARTERY (EFFECT OF POSITION OF THE FORELIMBS)

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We have shown previously [6] that in healthy dogs the electrocardiogram (ECG) depends on the position of the forelimbs. Despite the published claims of the variability of the canine ECG, we have shown that for a given position of the forefeet, the shape of the ECG is constant.

The object of the present investigation has been to determine whether the position of the front legs affects the ECG when some pathological condition such as a myocardial infarct is present, and also to study the ECG in relation to different limb positions with the animal lying on its side.

METHOD

Experiments were made on 11 mongrel dogs of various weights and ages. A double anesthetic was used. Evipan was injected intravenously, and the operation continued under oxygen-ether. The thoracic cavity was opened at the fourth left intercostal space. A ligature was then placed on the descending branch of the left coronary artery at its origin. The pericardium was opened and the vessel tied without procaine being injected into the pericardial cavity, and without subepicardial infiltration of the vessel.

The ECG was recorded on a triplex apparatus with the animal lying on its right side. Records were made before the operation, after giving the anesthetic, after opening the thoracic and pericardial cavities, after dissecting out and after ligaturing the descending branch of the left coronary artery, and during and after the tying off of this artery. ECG records were made 2, 5, 15, 30, and 60 minutes and 2, 3, 4, and 5 hours after the operation, as well as daily for several days afterwards. The greatest time for which records were made was 220 days after the ligature. During the recording the front legs were kept in a fixed position, and the effect of varying this position noted. Initially the legs were placed in position A, with one leg over the other in the midline. Recordings were made of the effect of simultaneously moving the right leg forward and the left backwards (position B) and of reversing their relative position (position C).

RESULTS

It has been previously shown in healthy dogs that these positions bring out maximum ECG changes.

In some dogs, for 2 or 3 days after the operation it was not possible to follow the ECG changes, because the typical picture of myocardial infarct was obscured by ventricular extrasystoles.

We have shown that the position of the front limbs has a definite effect on the ECG both immediately after ligature of the coronary artery, and for the succeeding days and weeks (Fig. 1). Usually marked, though individual differences appear, the Q and T waves are altered, as is also the ST interval. In the B position the ST_1 interval

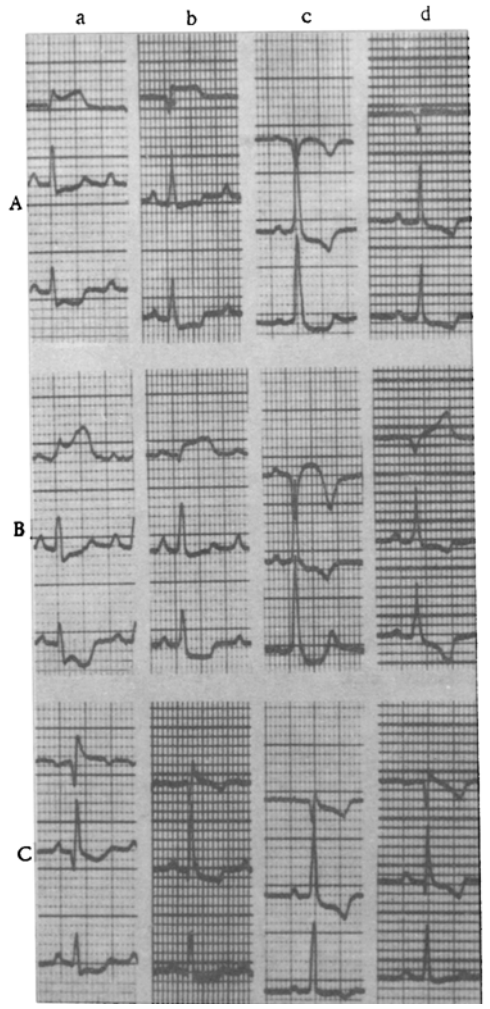

Fig. 1. Effect of changes in limb position on the ECG before and after ligature of the descending branch of the left coronary artery; standard leads.
A) Midway position with the front limbs together; B) right limb forward, left back; C) left limb forward, right back; a) position of the limb after 30 minutes; b) after 2 hours; c) after 2 days; d) 7 days after ligaturing the descending branch of the left coronary artery.

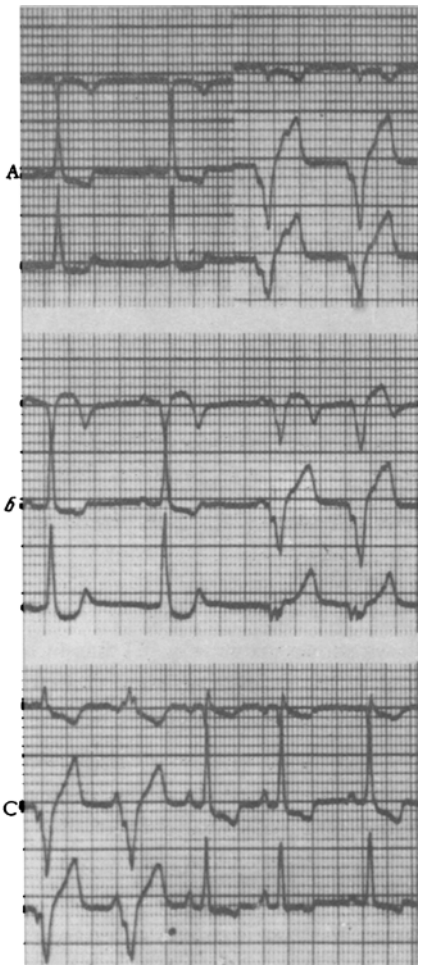

Fig. 2. Effect of changes in the position of the front limbs on the shape of the ventricular extrasystoles. Curves as in Fig. 1.

is displaced upwards, and the ST_2 and ST_3 intervals downwards. The ECG is the same as that found for myocardial infarct of the anterior wall in man. In position C there is practically no displacement of the ST interval. Only occasionally, in the first 2-3 hours after the ligature, is there a displacement of the ST_2 and ST_3 intervals downwards, and exceptionally there may be a small rise in the ST_1 interval.

Changes in the Q and T waves, which are found chiefly in Lead I and in positions B and C, are different, and sometimes occur in opposite directions. With the legs in the B position, the QS wave is deep and the negative T wave has a large amplitude.

The position of the front limbs also changes the shape of the ventricular extrasystoles. Fig. 2 shows results obtained on the second day after the ligature, when the sinus rhythm was almost completely obscured by these extrasystoles.

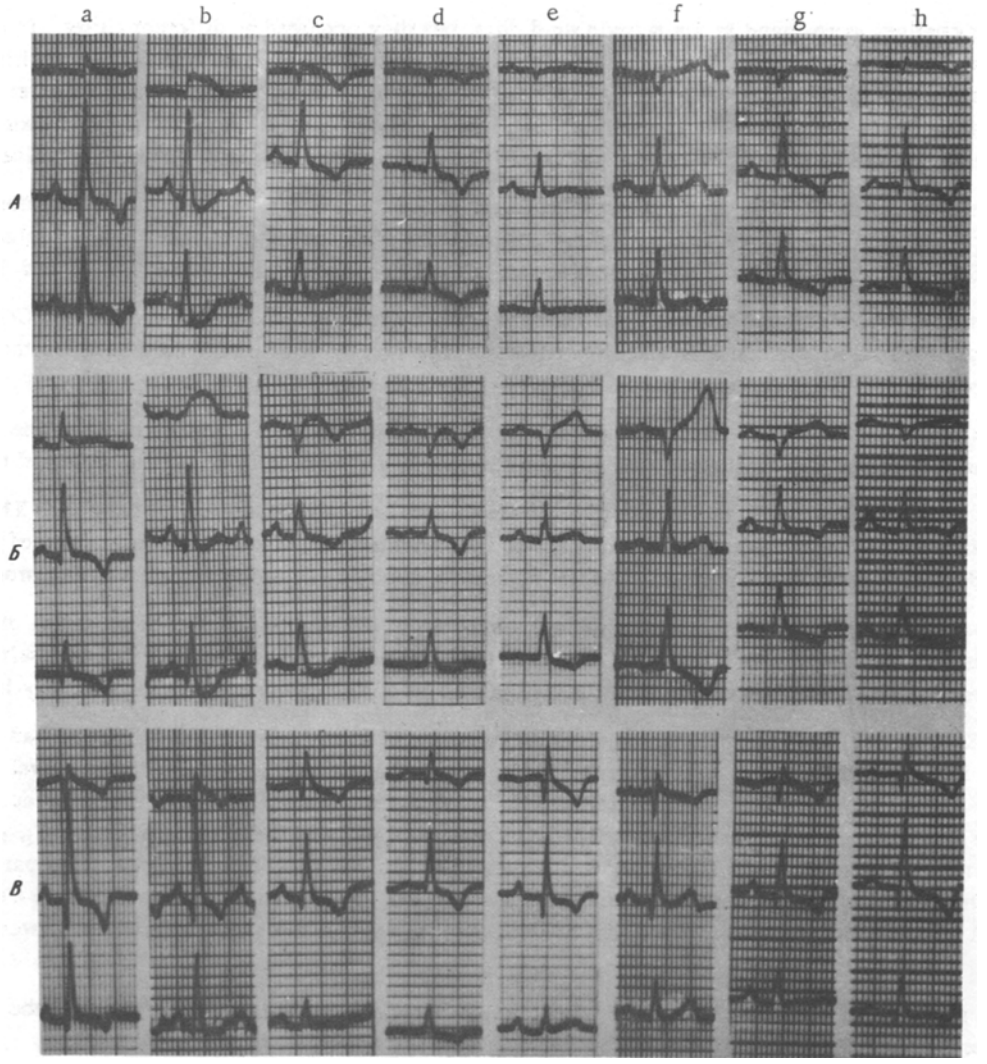

Fig. 3. Changes in the ECG following ligature of the descending branch of the left coronary artery in dogs.
a) Initial ECG; b) after 30 minutes, c) on 1st day; d) on 2nd day; e) on 9th day; f) on 26th day; g) on 36th day; h) on 56th day after ligature. A, B, C) as in Fig. 1.

Changes in the ECG following the ligature are shown in Fig. 3. The greatest change is shown for the position B. Thirty minutes after the ligature it can be seen that the ST_1 portion lies well above the line, that is to say it begins immediately at the peak of the reduced R wave and merges with the increased T wave to form a high arc. The ST_2 and ST_3 intervals are displaced below the base line. After 24 hours, ST_1 has fallen and at the same time a negative symmetrical T_1 wave with a sharp summit has formed (coronary type T wave). The T_3 peak has become positive. The ST_1 interval forms an arc directed upwards, and even by the second day after the ligature has returned to the baseline. Simultaneously with the changes occurring in the ST interval and the T wave, after 24 hours there is a deep and broad QS_1 wave. Marked changes occur by the 9th day: There is a high positive T_1 wave, T_3 has again become negative. By the 26th day T_1 has become higher (8mm), after which it gradually becomes smaller, and the ECG stabilizes with a broad QS_1 wave which may be observed for 220 days after the ligature.

In position A, the ECG changes resembled those described, but were less well shown, and by the 56th day were scarcely different from normal.

In position C the only change was in the size of T_2 and T_3, and even then the changes occurred only quite some time after the ligature was made.

Similar changes were found in the remaining 8 dogs, but they occurred at different times. In them the ST interval was well shown, and in position B was present 2 minutes after the ligature had been established. At this stage the T_1 spike was higher than the R_1. The coronary T notch was formed by the 3-7th hour after ligaturing. The high positive T wave appeared by the 4-11th day after tying the ligature, and reached its maximum value later; then the ECG began to return to normal (by the 17th day after the ligature, no change remained).

Records obtained in position C, apart from two cases where there was a small displacement downwards of the ST interval, showed no change. In a few dogs, immediately after the ligature there was a displacement of the ST_2 and ST_3 intervals downwards, and there was sometimes a change in the value of the T_2 and T_3 portions.

ECG changes recorded in position A after ligature could be followed only when the initial ECG in this position was approximately the same as that in position B. The greater the resemblance between the curves in the A and B positions, the better were the changes in position A shown.

In most of the experimental group, comparatively little change in the ECG was caused by the anesthetic, opening of the thorax and pericardium, dissecting out the coronary artery, or by the actual tying of the ligature.

During the anesthetic and after the ligature, no respiratory arrhythmia showed on the ECG. This effect was ascribed to diffuse myocardial damage [5] and is not to be attributed to blocking the termination of the vagus nerve. In 2 dogs the respiratory arrhythmia did not recur until the 86th day after ligaturing the coronary artery.

Our results throw doubt on the validity of interpretations of ECGs obtained with myocardial infarcts where there has been no control over the position of the front legs. We will now compare briefly our results (chiefly those obtained in position B) with various other investigations into ECG changes following coronary ligature.

V. G. Zhil'tsov [2] made a study which was continued for 10 months after such a ligature had been made. In the initial ECG, T_1 and T_2 waves were present; Q_1 was absent, but Q_2 and Q_3 present; T_3 was level with the baseline; the $ST_{1, 2, 3}$ intervals lay on the baseline. Six hours after ligature, ST_2 and $_3$ were displaced downwards by more than 2 mm. By the 21st day, a deep Q_1, Q_2 wave developed, and there was a negative $T_{1, 2}$, and $_3$. An ECG taken 9 months later showed a more negative T_1 wave, which was reduced in Lead III. Comparison of these results with the ECG changes obtained in our experiments suggests that the author's first two ECGs were recorded in positions A or B, and subsequently in position C, which would explain the great differences between the results obtained.

Results obtained by B. A. Lapin [4] may be explained in a similar way; immediately after the ligature, he found changes typical of myocardial infarct, but later records did not differ from normal.

The results of our experiments do not agree with those of I. G. Kopteva and her coworkers [3]; the first two changes they recorded after ligature of the coronary artery showed a marked Q_1 wave and a negative T_1. In our experiments the first change affected the ST interval, and at the same time there was an increase in T_1, and only later did the deep Q and negative T_1 appear.

Although in some of our experiments there was some change in the ECG during the operation, it did not appear that any such change was appreciable before the ligature was tied, as has been claimed by G. N. Aronov [1] (appearance of coronary T wave, displacement of ST interval downwards). In our view, these changes occur because the operation causes an alteration in the position of the heart. In our experiments we never found a single case of an ECG being changed by the coronary artery being dissected out, or any differences between the traces recorded before, during, and after coronary ligature. Immediately after the ligature had been tied, isolated or grouped ventricular extrasystoles occurred.

The observations described agree with those of Wegria and his coworkers [8], who found that after completely freeing the coronary artery, marked changes in the ECG always occurred; this was confirmed by Lengyel [7], who found that after ligaturing there was always an increased T wave, which only later became negative. However, unlike us, both authors found an initial change in the T wave and only later in the ST interval. In our experiments, both changes occurred at the same time, or else the shift of the ST interval occurred before the change in the T wave.

Our results indicate that position B is the best for studying the change in the ECG following ligature of the descending branch of the left coronary artery. Changes in the ST interval probably constitute the principal sign of myocardial damage, because they were not found in healthy dogs, while the Q and T waves may vary in normal animals according to the position of the front legs.

SUMMARY

Changes in the ECG were studied on 11 dogs after ligating the descending branch of the left coronary artery.

Changes in the position of the front limbs altered the Q and T waves, and had a considerable effect on the ST interval. It is therefore of importance to maintain the front legs in a fixed position when recording the electrocardiogram.

Changes in the ECG after myocardial infarction are most marked when the dog lies on the right side with the right front leg forward and the left back.

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