PERMANENT SET-UP FOR RECORDING THE KINETOCARDIOGRAM (KCG) IN ANIMALS

I. E. Oranskii and A. A. Sukhanov

Sverdlovsk Scientific Research Institute of Convalescence and Physiotherapy (Director, Candidate of Medical Sciences V. V. Orlov, Scientific Director – Candidate of Medical Sciences S. I. Serov)
(Presented by Active Member AMN SSSR V. V. Parin)

Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 55, No. 6, pp. 113-116, June, 1963
Original article submitted September 19, 1962

Kinetocardiography was used to record the ultralow-frequency vibrations of the precordial zone of the thoracic cavity. In clinical practice [1, 2, 4, 5] this method presents a picture of the kinetic function of the heart and of the phasic structure of the contractions.

The use of kinetocardiography experimentally enables us to obtain a deeper understanding of hemodynamics, and so to form a model of the pathology of the circulatory system.

The method constituted an arrangement for recording the KCG over a long period.

Method of recording. The KCG was recorded by means of an element sensitive to acceleration; we have described this device previously [3]. The element has also been used in the clinical investigations [2]. Later it was found possible to record the KCG of animals. For this purpose the receiving portion of the element was fixed to a slightly convex plate of perspex measuring 8 × 4 cm. The plate was fixed by Mendeleev's grease on to the skin of the thorax at the level of the V-VI ribs (Fig. 1). The skin had previously been shaved.

To reinforce the attachment of the element to the thoracic skeleton an elastic belt is placed round the thorax in such a way as not to interfere with respiration.

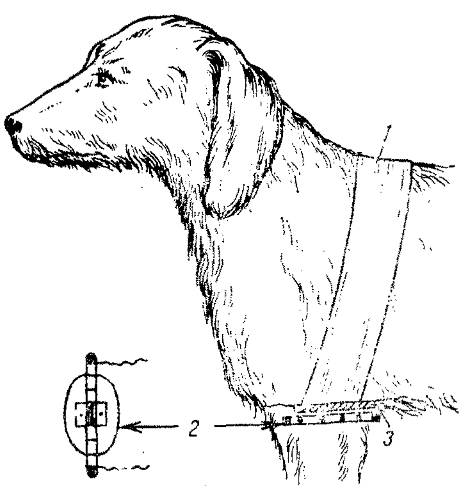

Fig. 1. Diagram to show attachment of element. 1) Elastic belt; 2) element; 3) perspex plate.

The output of the element is taken to a 2-channel electrocardiograph, and arranged so that a movement of the element downwards causes a downward deflection.

The second channel was usually used to record the ECG, though alternatively the arterial piezogram (Fig. 2) could be substituted. Simultaneous recording of both parameters enables the waves of the KCG to be more rapidly identified.

We recorded the KCG of healthy dogs at rest and under conditions of altered venous return (induced by application of an abdominal bandage).

To study changes of the KCG in relation to disturbances of rhythm we infected adrenaline intravenously, a procedure which is known to induce ventricular extrasystoles and atrioventricular block.

Our investigations showed that the KCG of a healthy animal differs little in its shape or time course from that of a healthy man, as described previously [2].

In each cardiac cycle there are two sets of clearly identifiable waves. The first includes h, i, j, k, and l waves, and the second s, t, u, and v waves.

Synchronous recording of the ECG and piezogram of the carotid artery together with the KCG showed that the h wave corresponds to the isometric contraction; it is retained in ventricular extrasystoles, though it is then reduced in amplitude. The j wave corresponds to the phase of maximum expulsion of blood, the interval k – s to the period of slowed expulsion, and the u wave to the moment of closure of the semilunar valve of the aorta and to the incisure on the sphygmogram of the carotid artery.

The f wave is due to contraction of the atria, because it disappears during extrasystoles when there is no P wave in the ECG. The formation of the f wave through the contraction of the atria is especially clearly shown in atrioventricular block. Then when PQ is 0.18 sec, 0.006 sec after the P wave of the ECG a set of waves is formed in the KCG which is characteristic of atrial contraction (see Fig. 2).

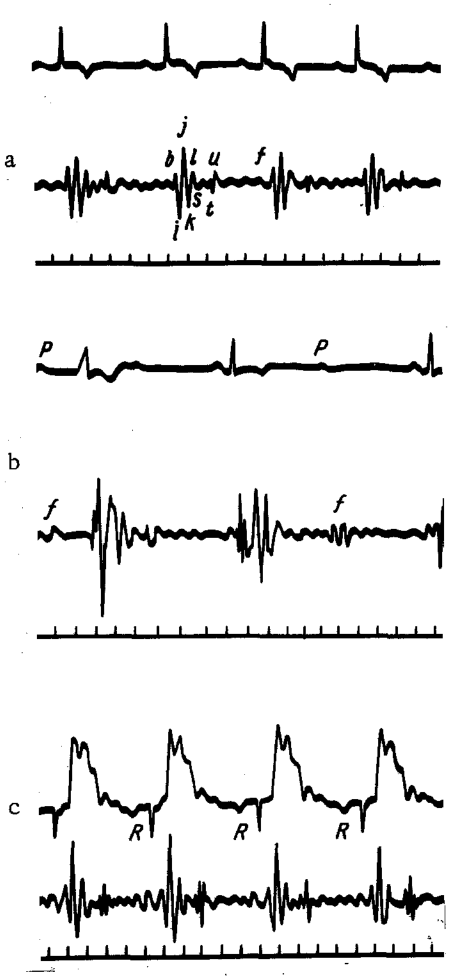

Fig. 2. Synchronous recording of the ECG, piezogram from the carotid artery, and KCG of the dog Rose. a) Record at rest: above – ECG, below – KCG; b) 20 sec after the intravenous injection of adrenaline (0.2-1:1,000). Rhythm disturbed (atrioventricular block, extrasystole). The f wave can be seen on the KCG, and corresponds to contraction of the auricle; c) record at rest: above – piezogram of the carotid artery with superimposed R notch, below – KCG.

Tables 1 and 2 indicate the durations of waves measured, whether horizontally between the two adjacent peaks or from the R wave of the ECG; they are close to the values for healthy human subjects and are to some extent related to the heart rate.

As we have shown previously, during ventricular extrasystoles there is no appreciable change of the parameters of the KCG.

The amplitude of the KCG waves measured vertically from the base line remains fairly constant during the different respiratory phases but varies greatly with alteration of venous return. Thus when an abdominal bandage was applied the amplitude of the j wave increased considerably (Table 3). Here the probable cause is an increased flow of blood into the right ventricle and a corresponding increase in the force of the reaction.

SUMMARY

A method for recording the kinetocardiogram (KCG) is described. We described the main parameters of the KCG waves, their

TABLE 1. Duration of Waves of the KCG (in sec)

Pulse frequency	h	j	k – s	u	u – h
Normal rhythm:					
75	0.04	0.04	0.10	0.03	0.60
90	0.04	0.05	0.12	0.03	0.42
120	0.05	0.05	0.14	0.03	0.24
150	0.04	0.05	0.12	0.03	0.22
With extrasystoles:					
100	0.04	0.03	0.12	0.03	0.30
130	0.04	0.03	0.10	0.03	0.20

TABLE 2. Time of Occurrence of KCG Waves Relative to the R Wave of the ECG

Quantity	Rh	Rj	Ru
Mean values	0.038	0.070	0.23
±σ	0.007	0.017	0.01

TABLE 3. Attitude of KCG Waves (in mm)

Conditions of experiment	h	i	j	k	u
quiet breathing	5,6±0,7	10±0,7	8,6±1,25	6,6±1,6	4±0,75
application of abdominal bandage	3,2±0,8	7,4±1,4	26,4±0,32	17,2±0,81	8±0,9

correlation with the phases of the cardiac cycle, changes induced by application of an abdominal bandage, and their relation to certain disturbances of the cardiac rhythm.

LITERATURE CITED

1. L. B. Andreev, Klin. med., No. 5 (1961), p. 12.
2. I. E. Oranskii, Ter. arkh, 9 (1961), p. 65.
3. A. A. Sukhanov, I. E. Oranskii, N. F. Smirnov, et al., Byull. éksper. biol., No. 8 (1960), p. 116.
4. C. M. Agress, L. G. Fields, Am. J. Cardiol, 4(1959), p. 184.
5. L. Rosa, Z. gess. inn. Med., Bd. 11, S. 282 (1956).

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.