A SIMPLE METHOD FOR PHONOCARDIOGRAPHY IN SMALL LABORATORY ANIMALS

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Numerous publications have appeared recently dealing with studies of sound phenomena in the human heart, but the problems of phonocardiography in laboratory animals have been treated in altogether inadequate fashion in the literature.

Phonocardiography is a simple and available method for recording cardiac activity, permitting us to obtain an objective idea of the rhythm of cardiac contractions, the duration of the cardiac cycle, the principal phases of cardiac contraction (systole and diastole), and the character and intensity of heart sounds and murmurs.

The method of phonocardiography is especially valuable in experimental studies, since it allows observations to be made on the cardiac activity of any animal, without subjecting it to operative interference.

The method of phonocardiography which we use is extremely simple and available to any physiological laboratory, and permits quite accurate measurement of the duration of the cardiac cycle, systole, diastole, heart sounds—and murmurs, if there are any.

The device which picks up the sound vibrations and transforms them into electrical impulses is an electromagnetic telephone transmitter. We have used the following types: a) "TON-1 octave," with an impedance of 2,200 ohms; b) "TON-1 octave," with an impedance of 50 ohms, and c) a miniature type—"TG-7," with an impedance of 50 ohms.

The transmitter, with its diaphragm directly exposed, is applied to the body of the animal being examined at the point where it is desired to record the sound. It is not necessary to remove the hair to record the sound.

When the animal is fastened in its stand (operating table) on its abdomen, the transmitter is conveniently secured in a special opening in the table, such that the diaphragm stands $1\text{-}^{1}/_{2}$ mm above the surface of the stand. Contact of the animal's body with the transmitter diaphragm is adequate and constant during the experiment, on account of the animal's weight and fixation.

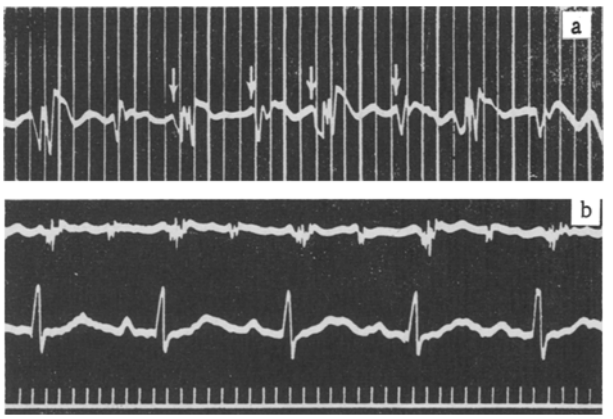

Fig. 1. a) Phonocardiogram of rabbit. Recorded with ÉKPS; pickup — telephone transmitter TG-7, 50 ohms; time marker, 20 milliseconds. b) Phonocardiogram (above) and electrocardiogram (below) of rabbit. Recorded with MPO-2; pickup — telephone transmitter TON-1, 50 ohms; time marker, 20 milliseconds.

When the animal is fixed in the supine position, the transmitter is conveniently fastened with a simple cloth belt tied with laces.

To improve and stabilize the fixation of the transmitter, one can sew a rubber cuff into the belt, to which slight additional pressure, not more than 100 mm of water, is applied after the belt is tied.

Transmitter "TON-1," with an impedance of 2,200 ohms, and the cable to the amplifier, must be shielded. Low-impedance transmitters and their cables may be left unshielded.

The electrical impulses from the transmitter are passed directly to the input of the amplifier without being filtered. We have used, with equal success, an ÉKPS electrocardiograph (Fig. 1, a) and a system consisting of a UIPP-2 DC amplifier (with alternative AC

and coupling), an MPO-2 eight-loop oscillograph (Fig. 1, b). In the latter case the signal, amplified five to ten thousand times, was supplied to the loop oscillograph through the low-impedance output.

Use of the type UIPP-2 amplifier and the MPO-2 oscillograph permits simultaneous recording of the electrocardiogram, which simplifies the interpretation of the phonocardiogram and extends the range of the investigation.

In the opinion of most investigators, the heart sounds of man are produced by vibrations of about 100 cps: According to N. N. Savitskii, the frequency is 40-80 cps [2]; according to I. I. Savchenko, 50-100 cps [3]; and according to A. I. Koblents-Mishke, not greater than 100 cps [1].

The heart sounds of laboratory animals consist of vibrations whose frequencies are on the same order.

Our pickup transmitter (TON-1 and TG-7), if fastened to the animal in a fixed position and tightly enough transform sound vibrations with frequencies of from 80 to 300 cps without perceptible distortion of amplitude relationships. The phonocardiograms of various animals are registered quite distinctly (rabbit—Fig. 1; white mouse white rat, guinea pig, and kitten—Fig. 2).

Determination of the first and second sounds on the phonocardiogram ordinarily presents no difficulties. In all the animals investigated (rabbits, guinea pigs, cats, white rats, mice), as a rule, the phonogram of the first sound is more complex, contains more waves, and has a lower frequency characteristic, greater wave amplitude, and longer duration.

With our method, sound phenomena of all frequencies picked up by the transmitter and recording system are recorded.

For most chronic experiments on animals it seems useless to us to complicate the method by including filters for separate recording of sound vibrations of different frequencies. The use of filters is necessary for investigating heart murmurs and for finer differentiation of the auditory phenomena of the heart.

Prolonged experience (a year) with the use of this method allows us to recommend it as simple and dependable for work with laboratory animals.

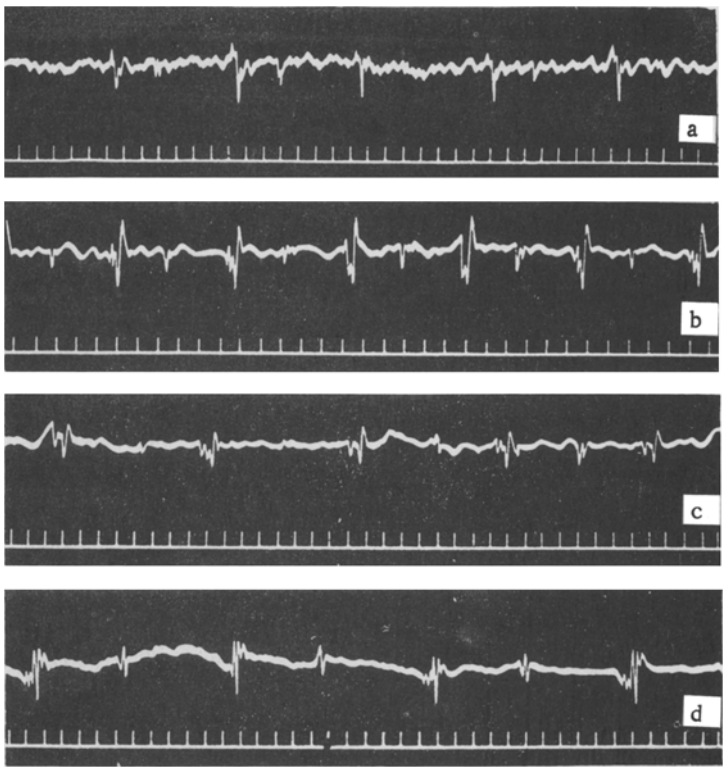

Fig. 2. Phonocardiograms of small laboratory animals. a) White mouse; b) white rat; c) guinea pig, two days old; d) kitten, two weeks old. Recorded with a MPO-2; pickup — TON-1 transmitter, 50 ohms; time marker, 20 milliseconds.

SUMMARY

The author presents a simple method of phonocardiography with various telephone transmitters (50 and 2200 ohms resistance) employed as pick-up. The phonocardiograms were recorded with the aid of an electrocardiograph or a loop oscillograph.

LITERATURE CITED

[1] A. I. Koblents-Mishke, in the book: Materials for Sharing Experience and Achievements on Scientific Frontiers 2 (27), p. 3 (Moscow, 1958) [In Russian].

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[3] I. I. Savchenko, Bestnik Rentgenol. i Radiol. 2, 69 (1952).