An Attempt on the Intracardiac Phonocardiography

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Phonocardiogram is usually recorded from the chest wall but when such is picked up from the oesophagus, some components are obtained more clearly, such as the auricular sound.

A vibration that is perceived as the heart sounds is assumed to receive a certain amount of damping, such as resorption and reflection, on its way from the heart to the chest wall, and distorted to some extent. It seemed of physiological and clinical significance to pick up the prototype of the heart sounds from the oesophagus, or better still, from the cardiac cavity itself, rather than from the chest wall.

It would also be of clinical interest to obtain a phonocardiogram from various parts of the heart to which a catheter could be introduced. For this purpose, it would necessitate the use of a miniature microphone that could be attached to the tip of a catheter, but since such device was unavailable, following method was employed.

The method of a condenser microphone using the body as one pole, devised by Koizumi and Hinohara for picking up the heart sounds from the oesophagus, was adapted with some modifications. To the tip of the catheter or a plastic tubing, a metal stick, (a diagram of which is shown in Fig. 1) was attached and well insulated. Under a fluoroscopic observation, the tube was introduced into the heart cavity (to the dog) and this

Fig. 1. Construction of the tip of catheter.
was connected to the grid of an oscillator circuit shown in Fig. 2. It was assumed that the dielectric change that must occur by the vibration, which is thought to be the cause of the heart sounds, should then be transferred by frequency modulation to an oscillogram or be perceived directly as a sound through a loud-speaker.

The experiments were carried out on dogs and the oscillograms were taken with limb lead or intracardiac unipolar lead electrocardiograms. The recorded results are given in Figs. 3. By this means, a recording was obtained of a distinct vibration which occurred synchronously with the heart sounds that are usually recorded from the

Fig. 2. Wiring diagram of our circuit.

Fig. 3. The catheter tip in the right ventricle of a dog (urethan narcosis). Continuous tracing. Marked respiratory fluctuation of first sounds is shown. 
Upper curve. Ecg. 2 lead.
Middle curve. Intracardiac Pcg. by "amplitudentreue Abstimmung."
Lower curve. Intracardiac Pcg. by "gehörsähnliche Abstimmung."
Intracardiac Phonocardiography

Intracardiac phonocardiography was studied in the chest wall as the auricular, first, second, and third sounds. Moreover, the heart sounds thereby obtained were found to possess the same characteristics as those of the heart sounds taken from the chest wall, i.e., the second sound is of higher frequency, is split, and has a vibration assumed to be due to the opening of atrioventricular valve, and the third sound is composed of vibrations of comparatively low frequency. The intracardiac auricular and first sounds were found to fluctuate with respiratory phases.

The phonocardiogram recorded from the chest wall during this stage did not give distinct tracings of auricular and third sounds. These sounds were obscure too on the tracing in A. pulmonalis. With equal amplification a trace of first sound was detected on the tracing in V. cava sup. When the amplification was too high, some mesosystolic vibration was detected besides the above in r. ventricle.

While such intracardiac catheter was introduced, the catheter was probably in frequent contact with inner wall and valve of the heart. However, no abnormal auscultative observations were detected. It was at first feared that some such artifact might appear on the intracardiac cardioogram by the introduction of the catheter into the heart cavity, but no such facts became evident when the degree of amplification was of a suitable dimension. The vibration that might be caused by such artifacts would probably be of a very low energy compared to the vibrations caused by the first and second sounds, therefore we could not
hear by a stethoscope. But when the tip of a catheter is near the atrio-ventricular valve, occasionally a great amplitude of the vibration appears. This is probably due to abrupt contact with the valve.

It follows, therefore, that if the size of the metal stick attached to the tip of the catheter and the degree of amplification were of a suitable dimensions, it would not be difficult to obtain an accurate intracardiac phonocardiogram, in the meaning of the prototype of the heart sounds.

The recording of intracardiac phonocardiogram is being continued with belief that it is of a great significance in physiology and clinical medicine. This method is naturally applicable to human beings.

The circuit shown in Fig. 2 is now being examined as to its fidelity in reproduction of the phenomenon.

**Summary**

The intracardiac phonocardiography, in the meaning of the prototype of the heart sounds, was obtained by means of a condenser microphone using the body as one pole.

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**References**

2) Hinohara, S., ibid., 1940, 6, 117.