Non-invasive Detection of Ultrasonic Doppler Signals from Renal Vessels

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Three kinds of ultrasonic Doppler flowmeter were used for the investigation: the Foetal Heart Detector (Non-direction indicated type) USD-6 “Heart tone” (Aloka); the Doppler flowmeter (Non-direction indicated type) Type 1935 (San-ei) and the specially manufactured Doppler flowmeter (Direction indicated type, Yokogawa-Hewlett-Packard).

The subject was prone. An ordinary contact compound scanning was performed on the patient’s back and ultrasonograms of the kidney were visualized. The nearest point to the renal hilum on the back was located and marked by monitoring with the scanning. When the probe of the ultrasonic Doppler flowmeter was applied to this point, the characteristic flow sounds which showed the Doppler frequency shift in ultrasonic echoes were audible. We called this point “signal detecting point (SDP)”. The maximum output of the sounds could be obtained with a slight adjustment of the ultrasonic beam direction.

The audible Doppler sounds were recorded on tape and were further visually displayed by the audiofrequency analyzer. Zero-cross count output was also recorded on paper.

We successfully obtained ultrasonic Doppler signals, presumably caused by the renal vessels, through the body surface without invasion. An outline of the method and several results are presented in this preliminary report.

METHODS

RESULTS

Records were obtained from 14 persons between the ages of 17 and 88. Ultrasonic Doppler signals presumably caused by the renal vessels could be detected in all of them on either side. The SDP on the left side ranged from the midpoint of the 1st and 2nd lumbar spines to the 3rd lumbar spine, and from 5.5 cm to 9.0 cm lateral to the midline. The SDP on the right side ranged from the midpoint of the 1st and 2nd lumbar spines to the midpoint of the 3rd and 4th lumbar spines, and from 5.0 cm to 8.0 cm lateral to the midline.

The intensity of the Doppler signal obtained was, however, so weak that audiofrequency analysis was occasionally difficult to perform because of noise, especially when the direction indicated type-flowmeter was used.

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Spectrograms after audiofrequency analysis showed a characteristic periodical wave pattern of the signal of which the maximum frequency was between 1,000 and 1,200 Hz and the minimum between 400 and 600 Hz (Fig. 1). Changes on zero-cross count output demonstrated a periodical curve in one phase of which the maximum frequency was between 600 and 900 Hz (Fig. 2).

DISCUSSION

The ultrasonic Doppler flowmeter has been widely used in physiological experiments. Its clinical application, however, is still limited mainly because of technical problems, although it has been successfully used in studies of the superficial vessels, the aorta or the heart. No report has been published concerning Doppler signals from the human renal vessels except in cases of the transplanted kidney.

It is most likely that the Doppler signals we describe here were caused by the renal vessels for the following two reasons: the signals were obtained without exception when the probe was applied to the nearest point from the renal hilum as determined by ultrasonography; no signals were audible when the probe was shifted even a few millimeters from that point.

Occasionally, however, we obtained Doppler sounds presumably not caused by the renal vessels but by other vessels from various parts of the back. It is important, accordingly, to ascertain the location of the renal hilum by means of ultrasonography to eliminate this contamination.

The information quality of the Doppler signals we obtained is still poor. Some additional evaluation may be necessary for a more definitive assessment of the value of this procedure. There is the possibility, however, that this procedure will become an entirely new diagnostic technique to clarify hemodynamics in the renal vessels and the kidney without invasion.

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