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Health & Medicine, Nursing

Doppler Principles in Echocardiography

What is Doppler ultrasound?

Doppler ultrasound is a type of ultrasound that allows you to diagnose vessels. This method of analysis can obtain accurate information about the functioning of vascular, clinical picture, identify malfunctions (method based on analyzing the frequency changed due to the reflection of ultrasonic waves). Diagnosis is absolutely harmless to the patient - no discomfort or discomfort during the study does not test people. The survey is conducted on an outpatient basis and does not require special preparation of the patient, the use of additional equipment and contrast media.

An Invention of Doppler Effect

The Doppler effect is easy to observe in practice, when a passing car drives by with sirens . Suppose siren emits a certain tone, and it does not change. When the car is not moving relative to the observer, then he hears exactly the tone that makes a siren. But if the car will be closer to the observer, the frequency of the sound waves will increase, and the observer hears a higher tone than actually emits the siren. At the time when the car will pass by the observer, he will hear the same tone that really makes a siren. And when the car will travel further and will have to move away and stay away, the observer will hear a low tone, due to the lower frequency sound waves.

For waves (e. g., sound) propagating in a medium, it is necessary to take into account the movement of both source and receiver relative to the medium wave. For electromagnetic waves (eg , light), for the distribution of which

does not need any environment in a vacuum is only important relative motion of the source and destination.

The effect was first described by famous Austrian physician Christian Andreas Doppler in 1842.

Echocardiography with Doppler Principles

Echocardiography for the past 15-20 years is one of the main methods of cardiac imaging. Like any diagnostic test, echocardiography has its advantages and disadvantages. The widespread introduction of the method in practice due to the high level of modern equipment, the absence of adverse effects on the patient and the physician, the relative cheapness of the method in comparison with the others. The large number of research options to obtain accurate anatomic and hemodynamic information about the patient and avoid invasive procedures. The disadvantage of echocardiography is strongly linked to the qualifications of the investigator. Specialists involved in ultrasound diagnosis of the heart to be a cardiologist, an excellent knowledge of topographical anatomy of the thoracic, cardiac hemodynamics, have spatial reasoning. In the absence of any of these qualities, the researcher dramatically increases the percentage of diagnostic errors.

Echocardiography Options

1. Two-dimensional echocardiography - Preview heart on a long or a short axis in real time. Two-dimensional echocardiography (B- mode) allows real-time to estimate the size of the cavities of the heart, the thickness of the walls of the ventricles, the state of valvular, subvalvular structures, global and local ventricular contractility, the presence of thrombosis of the cavities,

etc.

2. M-mode - graphic representation of motion of the heart wall and valve leaflets over time. M- mode allowed the first real-time measures of heart rate and systolic ventricular function. Currently used as a sub-routine during echocardiography primarily for measurements. In the case where the cursor position parasternal M- mode image is strictly perpendicular to the heart, the measurements can be performed with high accuracy. If the image of the heart and the cursor positioned at an angle, all dimensions of the heart chambers are substantially overstated and could be misinterpreted. This error occurs in professionals with little work experience. Therefore, measurement should be carried out in B- mode at the end of diastole in the case of M- mode can not be applied. Currently, a number of firms suggested using anatomical M- mode, which allows to change the angle of the cursor. The graph of M- requisitioning vertical postponed distance across - time. Depending on the position of the cursor on the screen, you can get a schedule of vibration series of points along the cursor is stretched in time, i. e. track their swing in systole and diastole.

3. Doppler echocardiography - pulsed, continuous- wave, color, color M-mode, energy, fabric color, fabric switching, tissue S- mode, and so on - a method to non-invasively evaluate the parameters of central hemodynamics. The active application of the technique in medicine can be attributed to the early 80’s

Carrying Doppler implies a high technical skill in conducting two-dimensional studies, knowledge of topographic anatomy and hemodynamics of the heart.

There are following options of Echocardiographic Doppler:

- PW - pulsed wave.

- HFPW - high frequency pulsed wave.

- CW - continuous wave.

- Color Doppler.

- Color M-mode.

- Power Doppler.

- Tissue Velocity Imaging.

- Pulsed Wave Tissue Velocity Imaging.

Pulsed Wave or PW. Graphic allotment of pulse- wave Doppler blood flow reflects the nature of this particular point in setting the reference volume. Installation point of control volume is called the baseline. By vertically Graph delayed flow rate horizontally - while. All streams at a particular point of the sensor arranged to move the chart above baseline, all flows which move from the sensor - is below the zero line. In addition to the shape and nature of blood flow in the chart can be fixed clicks opening and closing valve leaflets, additional signals from the chords and walls of the heart valves. Pulse Doppler velocity has a limit (not more than 2. 5 m / s), so it fails to register streams having high speed.

HFPW - high frequency pulsed wave. Several control volumes are placed one after the other at different depths. This allows you to detect blood flow velocity is greater than 2. 5 m / s.

CW - Continuous Wave Doppler. Allows you to record high-speed streams.

The disadvantage is that the chart records all flows along the beam path. CW Doppler technique allows you to make calculations of pressure in the cavities of the heart and great vessels in a particular phase of the cardiac cycle, to calculate the degree of importance of the stenosis, etc.

CW is the basic equation Bernoulli's equation, which allows to calculate the pressure difference or pressure gradient using the equation to measure the difference in pressure between the two chambers in the presence of normal and abnormal, high-speed flow.

Color Doppler. Color Doppler is the analog of pulse Doppler, where the direction and speed of blood flow charted a different color. Since the blood flow to the sensor taken chart red from the sensor - blue. Turbulent blood flow mapped blue- green- yellow.

Color M-mode. Comparison of M- modal mode and color Doppler during the cursor over a particular plane, allows to understand the phases of the cardiac cycle and abnormal blood flow.

Power Doppler. Used to record low rate of blood flow, so in cardiology, he has not yet found the active application. When using power Doppler blood flow direction is lost. Currently Power Doppler is used in combination with contrast agents for myocardial perfusion studies.

Tissue Velocity Imaging. The principle of this method is based on mapping the direction of the fabrics in different colors. Thus red to indicate the movement sensor blue - the sensor. By studying the direction of movement of the walls of the left and right ventricles in systole and diastole by TVI can discover hidden areas of violation of local contractility. The combination of two-dimensional study in TVI mode with M- modal increases the accuracy of

diagnosis.

Pulsed Wave Tissue Velocity Imaging. Allows you to graphically evaluate the nature of the ventricular wall motion in a particular given point. Isolated systolic component, early and late diastolic Doppler components. This option allows the mapping of the myocardium and increases the accuracy of diagnosis in patients with coronary heart disease.

Thus, Doppler techniques allow a large volume of information without the use of invasive methods.

4. Transesophageal echocardiography (mono -, bi-, and multi-). The study of the heart through the esophagus using special sensors. Informative method is very high. A contraindication is the presence of stricture of the esophagus.

5. Stress echocardiography (using exercise, transesophageal electrical stimulation or drug load). It is widely used in patients with coronary heart disease.

6. Three-dimensional and four-dimensional modeling of the heart - computer image analysis and the construction of three-dimensional image of the heart chambers, valve, blood flow, etc.

7. Intravascular ultrasound - investigation of the coronary arteries using a special intravascular probe of small diameter. Invasive ultrasonic method. Used in conjunction with coronary angiography.

8. Contrast echocardiography - used for staining of right heart chambers with suspected defect, or the left chambers of the heart for the study of myocardial perfusion. Informative method of contrasting the left chambers of the heart is comparable to myocardial scintigraphy. A positive factor is the

absence of radiation exposure to the patient. Negative factors include the invasive nature of the method and the high price of the drug.

Modern Echocardiographic Devices

Currently, the market offers ultrasonic devices range from simple to highly complex with the possibility with the possibility of three-and four-dimensional modeling.

The heart screening can be made at any ultrasonic unit, with the appropriate cardiac probe and B- and M- modes. It is possible to use low-cost ultrasound scanners. Diagnostic level and the percentage of errors in this case are largely dependent on the skill of.

Modern echocardiography should include, in addition to the B- and M- mode, color Doppler, pulsed wave Doppler and CW Doppler. In the presence of pathology, only CW Doppler will measure high-speed streams of pathological, to make all necessary calculations and measurements to assess hemodynamics.

The volume of information received depends on the ability sensor. Intravascular sensors are used in parallel with the angiographic study, surgeons used.

Modern technology (Tissue Doppler, contrast) can many times improve information content of the study, especially in patients with pathology of the myocardium.

Conclusions

Modern echocardiography has a broad spectrum of diagnostic procedures. Echocardiographic ultrasonic devices include devices from inexpensive to

high-end. We can properly orient on the market of ultrasound equipment by participating in congresses and conferences, as well as reading magazines and books on ultrasound.

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