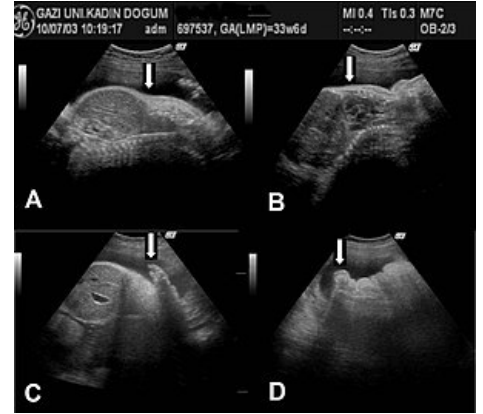


Ultrasound (ultrasonography)

Ultrasound is a periodic change in pressure in the environment with a frequency higher than the upper limit of human hearing, i.e. higher than 20 kHz.

Ultrasonic vibrations can be created by three types of generators:

1. **mechanical** (small tuners, whistles: low frequency and power),
2. **magnetostrictive** (oscillations around an iron rod in the magnetic field of an electromagnet that is powered by alternating current: high power, but frequency only up to 100 kHz; use in dentistry and surgery),
3. **piezoelectric** (a plate of quartz is connected to electrodes with an alternating voltage, so it oscillates at the same frequency as the voltage, changing electrical energy into mechanical energy that vibrates the surrounding environment: use for diagnostic and therapeutic purposes).



Example of USG examination – Achondrogenesis

Properties

The high frequency causes a **very short wavelength of** ultrasound waves, but at higher intensities, pressure changes in the order of **MPa** occur (danger of damage to cell nuclei). At the interfaces of different tissues (with different speed of sound propagation), there is a partial change in the direction of wave propagation and their **reflection** (analogous to the law of refraction of light) → **use in diagnostics**.

$$R = \left(\frac{z_1 - z_2}{z_1 + z_2} \right)^2 \cdot 100$$

. 100 R = percentage of the reflected energy of the incident wave, from 1 to 2 = the acoustic impedance of the two environments.

Effects

- **Thermal effects** – the energy of the wave is directly proportional to its f^2 . Considerable absorption is at the interface of tissues with different acoustic impedance (soft tissue X bone = periosteal pain).
- **Mechanical** – the passage of an ultrasonic wave through the environment results in local pressure changes (MPa/mm).
- **Physico-chemical** - ultrasound has dispersive effects, which means that with its help we prepare fine suspensions, emulsions, foams, etc., and also **coagulation** - it serves, for example, to purify gases.
- **Biological** - up to an intensity of 3 W/cm², ultrasounds have rather **biopositive** effects: acceleration of metabolic exchange, etc., above 3 W/cm² result in **irreversible morphological changes** - breaking of the cell nucleus, thermal coagulation of proteins.

Diagnostic uses of ultrasound

Diagnostic ultrasounds work with frequencies of **3-10 MHz** (subcutaneous probes around 7 MHz).

Ultrasounds generate an **acoustic pulse** that propagates at the speed of sound in a given environment, and upon impact, part of its energy is **reflected**. The crystal then **detects** the signal reflections and determines the size of the **echo**, and the **depth of the** reflection from the time delay.

- **A-image:** linear record of reflections depending on depth.
- **B-image:** rotation of the A-image by 90°, the size of the echo at a certain depth is proportional to the saturation of the points in the line on the screen → by composing many straight lines next to each other, a two-dimensional image moving in time is created.
- **M-image:** point saturation can be recorded over time on running paper; important in evaluating the mobility of individual sections of the heart.

With higher wave frequency, **resolution increases**, but **absorption** also **increases** (imaging depth decreases).

Therapeutic uses of ultrasound

When treating with ultrasound, devices with a frequency of 0.8–1 MHz with an intensity of 0.5–3 W/cm² at an exposure of 10 min are most often used.

Therapeutic effects: deep thermal effect, pain relief, release of long-lasting local muscle tension, increase in local blood circulation, increase in metabolism. It is mainly used for joint and nerve inflammations .

In dentistry , small-amplitude vibrations (hundredths of mm) are used to remove tartar.

Links

Related Articles

- Ultrasound/Diagnostic applications of ultrasound
- Doppler echocardiography
- Doppler ultrasonography
- Piezoelectric phenomenon
- Ultrasonography (2nd Faculty of Medicine, UK)

External links

- Ultrasound (Czech Wikipedia)
- Ultrasound (English Wikipedia)
- Janík Václav: Ultrasonography. Multimedia support for the teaching of clinical and health disciplines: Portal of the 3rd Faculty of Medicine of the UK [online] 14.3.2011, last update 23.11.2011 [cit. 2011-12-22] Dostupný z WWW: <<http://portal.lf3.cuni.cz/clanky.php?aid=92>>. ISSN ISSN 1804-3143
- echopedia.org (https://www.echopedia.org/wiki/Main_Page)

Source

- KUBATOVA, Senta. *Biofot* [online]. [cit. 2011-01-31]. <<https://uloz.to/!CM6zAi6z/biofot-doc>>.