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Archives of Gastroenterology Research Short Communication

Ultrasounds Importance in the Clinic and Medical Diagnostics

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Abstract

Ultrasounds in medicine find applications for different pathologies depending on the type of treatment and the type of investigation in which they are used. Their use in physiotherapy is frequent where the thermal-mechanical action brings particular benefits in osteo-articular pain, tendinitis, contractures, muscle injuries. The effectiveness of ultrasound therapy is based on a high frequency cellular and intercellular massage action; the irradiated tissues enter into vibration, with consequent energy expenditure and heat production, from which the healing effect derives. Ultrasounds therapy has an analgesic, antiphlogistic, fibrolytic, muscle relaxant and metabolic circulatory stimulation therapeutic action.

The best known application of ultrasounds in medicine is the echography, a non-invasive method that allows images to highlight the internal organs, evaluating the size, density, vascularization. More detailed investigations are obtained with contrast echography or echoendoscopy, invasive investigation very useful for the diagnosis of serious pathologies. Even in surgery, the echography is useful for performing a guided surgery or for performing biopsies using a syringe with a thin needle.

Keywords: Ultrasounds, Echography, Ablative therapy, Extracorporeal lithotripsy

Ultrasounds are acoustic vibrations that are not perceived by the human ear as their frequency is greater than 20,000 Hz. They are artificially generated by the action of the electric current, whose polarity is periodically reversed, on a quartz crystal, subjecting it, by the action of the electromagnetic field created, to successive contractions and expansions. This alternation of movements generates vibrations, which, transmitted to cellular and intercellular structures, cause collisions and generate heat [1].

Use of Ultrasounds in the Diagnosis of Pathologies

The best known and most widespread application of ultrasounds in medicine is diagnostic echography, a reliable, non-invasive and very safe technique for both operators and patients. Echography is a method that allows you to obtain images of the internal organs of the human body using high-frequency ultrasound waves between 2 and 15 Megaherz by means of probes called "ultrasounds probes". Echoes from ultrasound waves are recorded and displayed on monitors; the images, displayed in real time, show the movement of internal organs and tissues and the blood flow in the vessels. The ultrasounds frequency is chosen keeping in mind that higher frequencies have greater resolving power of the image, but penetrate less deeply into the subject; lower frequency waves are more penetrating. During the exam the probe is kept in direct contact with the patient's skin with the interposition of a special gel that allows ultrasound to penetrate the anatomical segment to be analyzed [2-5].

The echography allows the visualization of the internal organs, showing position, conformation, dimensions: the superficial structures like muscles, tendons, breast, thyroid, parathyroid are exposed to high frequency ultrasound, 7-18 Mhz, to obtain a better resolution; most internal organs such as liver, kidneys are exposed to low frequency ultrasound, 1-6 MHz, which have a

greater penetrating power. High contrast echography is used for the characterization of the formation of metastases, for the characterization of lesions, including the detection of stenosis, aneurysms, fistulas, in case of renal failure or both cystic and solid renal tumors , and is performed by injection of an inert gas, generally sulfur hexafluoride, intravenously. The microbubbles of gases formed increase the echogenicity of the blood allowing the visualization of the microcirculation: this method is particularly suitable for the diagnosis of liver pathologies in which alterations of the parenchyma are visualized by the formation of nodules, very vascularized, compared to a healthy parenchyma. This method has a high diagnostic sensitivity that allows to detect even early stage tumors or small tumors with a diameter of less than 10 mm [6-9].

Elastography, a technique complementary to echography, allows you to evaluate the degree of elasticity of the tissues in a non-invasive way by means of an external electronic stimulation that simulates manual palpation. Many pathologies cause a change in tissue elasticity: benign tissues have elasticity, while rigid tissues are the expression of tumors or chronic inflammatory processes [10]. With this method it is possible to highlight the inflammatory pathologies of the gastrointestinal tract and Crohn's disease [11,12]; the elastography finds application in the differential diagnosis between benign or malignant nodules in superficial organs such as breast, thyroid, lymph nodes, prostate; it is useful for assessing liver stiffness in the case of liver fibrosis and other liver diseases [13,14].

Echocardiography is the application of ultrasounds to evaluate the size, shape and movement of cardiac structures; it allows to obtain information on the contractility of the heart, on the morphology of its valves and on the flow of blood in its cavities, both at rest and after fisic exercises or taking a drug. This technique is of great importance in the intensive care unit for patients in shock, allowing the accurate measurement of different hemodynamic variables in a non-invasive way. The doctor can evaluate different aspects of shock states, such as cardiac output and fluid reactivity, myocardial contractility, intracavitary pressures, ventricular interactions and the echocardiography is therefore an important diagnostic tool for the treatment of patients with pain chest and respiratory failure. This test proves very useful for understanding the origin of chest pain, a symptom often reported by patients. In fact, if the coronary arteries are stenotic, the blood flow under stress conditions is insufficient and the cardiac musculature contracts to a lesser extent, asynchronously and the beat can also stop. Contraction anomalies can be highlighted already by an electrocardiogram impaired, and are the first sign of heart pain. Echocardiography is used to evaluate the prognosis on people after a heart attack event, to understand the heart condition and, for people with coronary artery disease, to evaluate the advisability of a revascularization intervention by bypass or angioplasty [15-17].

Endoscopic echography is an invasive diagnostic procedure, which integrates the ultrasound system with classical endoscopy, allowing you to study the pathologies of the digestive system, biliary tract and pancreas. With this, it is possible to perform an echography of the abdominal organs by applying a small ultrasound probe on the tip of the endoscope. This examination has a power of resolution superior to other methods in evaluating the wall of the hollow organs of the upper and lower digestive system, in the study of mediastinal lymph nodes and pancreatic parenchyma; it also allows needle biopsies of pancreatic and lymph node lesions [18-21].

Use of Ultrasounds in Therapy

The penetration capacity of ultrasounds through the tissues of the human body both at the surface and at the depth, inversely proportional to the frequency of the waves, has determined their use not only in diagnostics, but also to treat orthopedic and muscle diseases, in physiotherapy, and in aesthetic medicine [22,23]. Their activity is carried out with different actions: chemical, thermal and on blood circulation; the choice of the type of frequency varies depending on the organ and tissue to be treated and depending on the therapy required [24]. The main therapeutic effects concern the resolution of muscle contractures which benefit from the thermal effect and micro massage; fibrolytic action on the collagen of fibrous tissues which is of particular importance for the treatment of traumatic hematomas and scar tissues; action on calcifications and skin thickenings [25,26].

The ultrasounds treatment can be performed in two different ways. The direct method consists in the application of a conductive gel on the head of the device which is then placed directly on the area to be treated by performing a slow rotary movement. The indirect method is performed by immersing the area to be treated and the head of the appliance in a basin containing water at 37°C, being the areas to be treated with an irregular shape such as elbows, hands, malleoli, difficult to treat directly. The distance between the head and the application area is 2 cm and the duration of the application varies from 10 to 15 minutes depending on the method and frequency used. In addition to relieving pain, this therapy is anti-inflammatory, biostimulating at the cellular level and decontracting on the muscles.

Ultrasounds find applications in ablative therapy, a microsurgery technique that uses high intensity sound

waves to necrotize cancer cells present in some organs such as kidneys, prostate, and eliminate them. This ability to release energy in a specific area, better known as shock wave therapy, is used to reduce the size of kidney stones, lithotripsy, or to produce a rise in temperature such as to necrotize the tumor tissues and destroy them as in the case of prostate cancer or uterine fibroids. The patient undergoes anesthesia and the ultrasounds reach the tumor by means of an electrode which destroys the cancerous cells; it is also possible during the surgery to take a sample of organ tissue to perform a biopsy and better understand the type of tumor [27-29].

The lymphatic system is essential for the survival of the body, being the main seat of the interaction between foreign substances that attack the body and the defense mechanisms that are put in place to counter this aggression. The enlargement of a lymph node can be due to inflammation, infection or tumor and only through a biopsy examination can a certain diagnosis be made. Thyroid needle aspiration is a minimally invasive method that is performed by means of a very thin needle connected to a syringe, under echography guidance, and allows only the removal of cells contained in the nodule without affecting the tissue.

The echographic guide allows you to take cells even from clinically non-palpable nodules and to choose, based on the echographic characteristics, on which part of the nodule to perform the sampling for cytological analysis. For biopsy, however, a spring-activated larger gauge needle, called the core needle, is used and the tissue sample is subjected to histological analysis for tumor diagnosis [30].

The aspiration of the transbronchial needle guided by endoscopic echography is very useful in the diagnosis of malignant pleural mesothelioma being based essentially on the analysis of pleural samples [31,32]. The execution procedure is similar to that of a normal endoscopy: in this case, however, the patient is sedated with benzodiazepines and the duration of the examination is slightly longer; if it is then integrated with the Doppler mode, the evaluation can also be extended to the main blood vessels. With the help of echography, a synovial tissue biopsy can also be performed for better understand the pathogenesis of inflammatory arthropathies and evaluate the appropriate treatments [33].

Echography is the most useful, safest, most precise imaging technique for guiding needles in the organs and in the abdominal and pelvic masses, allowing adequate tissue sampling, with constant monitoring over time for biopsy, without patients suffer from consequences [34,35].

Conclusions

Ultrasounds play an important role in medicine for their ability to provide both kinetic and thermal energy. Similarly to sound waves they spread in materials, including biological tissues, without making transformations, but with different intensity depending on the medium they pass through. The attenuation of the intensity while they moving through the human body is linked to the different density of the tissues, bone, fat, muscle, which an ultrasounds beam encounters in our body. The use of ultrasounds in the medical field is very wide: from use to diagnose diseases or the origin of a disorder: echography, flowmetry, doppler; to therapy: ablative surgery using high intensity focused ultrasounds, lithotripsy, used for the treatment of urinary stones, physical therapy used for body rehabilitation.

The most widespread and best-known application of ultrasounds in medicine is diagnostic echography, a method that is risk-free for operators and extremely safe and reliable for patients.

Some therapeutic applications of ultrasounds exploit the possibility of releasing energy at a specific point, as in the case of lithotripsy which is used to reduce the size of kidney stones. In the case of ablative surgery it is possible to focus the ultrasounds in an area to produce a thermal rise such as to necrotize the tumor tissues and destroy them. Using a less intense heating on the tissues,the ultrasounds are used in physiotherapy to repair bone fractures and lesions of tendons or for the treatment of scars.

Conflict of Interest

The author declares no conflict of interest.

References

1. Miller DL, Smith NB, Bailey MR, Czarnota GJ, Hynynen K, Makin IR, et al. Overview of therapeutic ultrasound applications and safety considerations. Journal of Ultrasound in Medicine. 2012 Apr;31(4):623-34.

2. Bravo-Merino L, González-Lozano N, Maroto-Salmón R, Meijide-Santos G, Suárez-Gil P, Fañanás-Mastral A. Validity of the abdominal echography in primary care for detection of aorta abdominal aneurism in male between 65 and 75 years. Primary Care. 2019 Jan; 51 (1): 11-7.

3. Heckman JD, Ryaby JP, McCabe J, Frey JJ, Kilcoyne RF. Acceleration of tibial fracture-healing by non-invasive, low-intensity pulsed ultrasound. JBJS. 1994 Jan 1;76(1):26-34.

4. Vaccaro M, Moschiano F. A woman with abdominal pain and headache. Neurological Sciences. 2009 May 1;30(1):141.

5. Evola G, Caruso G, Caramma S, Dapri G, Spampinato C, Reina C, Reina GA. Tubulo-villous adenoma of the appendix: A case report and review of the literature. International Journal of Surgery Case Reports. 2019 Jan 1;61:60-3.

6. Seitz K, Bernatik T, Strobel D, Blank W, Friedrich-Rust M, Strunk H, et al. Contrast-enhanced ultrasound (CEUS) for the characterization of focal liver lesions in clinical practice (DEGUM Multicenter Trial): CEUS vs. MRI–a prospective comparison in 269 patients. Ultraschall in der Medizin-European Journal of Ultrasound. 2010 Oct;31(05):492-9.

7. Clevert DA, D'Anastasi M, Jung EM. Contrast-enhanced ultrasound and microcirculation: efficiency through dynamics–current developments. Clinical Hemorheology and Microcirculation. 2013 Jan 1;53(1-2):171-86.

8. Clevert DA, Minaifar N, Weckbach S, Jung EM, Stock K, Reiser M, et al. Multislice computed tomography versus contrast-enhanced ultrasound in evaluation of complex cystic renal masses using the Bosniak classification system. Clinical Hemorheology and Microcirculation. 2008 Jan 1;39(1–4):171-8.

9. Greis C. Quantitative evaluation of microvascular blood flow by contrast-enhanced ultrasound (CEUS). Clinical Hemorheology and Microcirculation. 2011 Jan 1;49(1-4):137-49.

10. Dietrich CF, Jenssen C, Arcidiacono PG, Cui XW, Giovannini M, Hocke M, Iglesias-Garcia J, Saftoiu A, Sun S, Chiorean L. Endoscopic ultrasound: Elastographic lymph node evaluation. Endoscopic Ultrasound. 2015 Jul;4(3):176.

11. Gilja OH, Hatlebakk JG, Ødegaard S, Berstad A, Viola I, Giertsen C, Hausken T, Gregersen H. Advanced imaging and visualization in gastrointestinal disorders. World Journal of Gastroenterology: WJG. 2007 Mar 7;13(9):1408.

12. Migaleddu V, Quaia E, Scano D, Virgilio G. Inflammatory activity in Crohn disease: ultrasound findings. Abdominal Imaging. 2008 Sep 1;33(5):589.

13. Fischer T, Sack I, Thomas A. Characterization of focal breast lesions by means of elastography. Fortschr Röntgenstr 2013; 185: 816-823.

14. Barr RG. Liver Elastography Still in Its Infancy. Radiology. 2018; 288(1):107-108.

15. De Backer D. Ultrasonic evaluation of the heart. Current Opinion in Critical Care. 2014 Jun 1;20(3):309-14.

16. Noritomi DT, Vieira ML, Mohovic T, Bastos JF, Cordioli RL, Akamine N, et al. Echocardiography for hemodynamic evaluation in the intensive care unit. Shock. 2010 Sep 1;34(7):59-62.

17. Perera P, Lobo V, Williams SR, Gharahbaghian L. Cardiac echocardiography. Critical Care Clinics. 2014 Jan 1;30(1):47-92.

18. Puli SR, Reddy JB, Bechtold ML, Antillon D, Ibdah JA, Antillon MR. Staging accuracy of esophageal cancer by endoscopic ultrasound: a meta-analysis and systematic review. World Journal of Gastroenterology: WJG. 2008 Mar 14;14(10):1479.

19. Puli SR, Reddy JB, Bechtold ML, Antillon D, Ibdah JA, Antillon MR. Staging accuracy of esophageal cancer by endoscopic ultrasound: a meta-analysis and systematic review. World Journal of Gastroenterology: WJG. 2008 Mar 14;14(10):1479.

20. Ribaldone DG, Bruno M, Gaia S, Saracco GM, De Angelis C. Endoscopic ultrasound to diagnose pneumatosis cystoides intestinalis (with video). Endoscopic Ultrasound 2017; 6(6):416-417.

21. Membrillo-Romero A, Gonzalez-Lanzagorta R, Rascón-Martínez DM. Evaluation of the levels of amylase and lipase after biopsy by aspiration with fine needle guided by endoscopic ultrasound in pancreatic lesions. Surgery and Surgeons. 2017 Sep 1; 85(5):387-92.

22. Ter Haar G. Therapeutic applications of ultrasound. Progress in Biophysics and Molecular Biology. 2007 Jan 1;93(1-3):111-29.

23. Azuma Y, Ito M, Harada Y, Takagi H, Ohta T, Jingushi S. Low-intensity pulsed ultrasound accelerates rat femoral fracture healing by acting on the various cellular reactions in the fracture callus. Journal of Bone and Mineral Research. 2001 Apr;16(4):671-80.

24. Kreider W, Crum LA, Bailey MR, Sapozhnikov OA. A reduced-order, single-bubble cavitation model with applications to therapeutic ultrasound. The Journal of the Acoustical Society of America. 2011 Nov;130(5):3511-30.

25. Mallow M, Nazarian LN. Greater trochanteric pain syndrome diagnosis and treatment. Physical Medicine and Rehabilitation Clinics of North America. 2014 May;25(2):279-89.

26. Crevenna R, Kéilani M, Wiesinger G, Nicolakis P, Quittan M, Fialka-Moser V. Calcific trochanteric bursitis: resolution of calcifications and clinical remission with non-invasive treatment. A case report. Wiener Klinische Wochenschrift. 2002 May;114(8-9):345-8.

27. Tricard T, Tsoumakidou G, Lindner V, Garnon J, Albrand G, Cathelineau X, et al. Ablative therapies in kidney cancer: indications. Progress in Urology. 2017 Nov 1; 27 (15): 926-51.

28. Chua T, Faigel DO. Endoscopic Ultrasound-Guided Ablation of Liver Tumors. Gastrointestinal Endoscopy Clinics. 2019 Apr 1;29(2):369-79.

29. Li D, Kang J, Madoff DC. Locally ablative therapies for primary and metastatic liver cancer. Expert Review of Anticancer Therapy. 2014 Aug 1;14(8):931-45.

30. Baek JH. Current status of core needle biopsy of the thyroid. Ultrasonography. 2017 Apr;36(2):83.

31. Frates MC, Benson CB, Charboneau JW, Cibas ES, Clark OH, Coleman BG, Cronan JJ, Doubilet PM, Evans DB, Goellner JR, Hay ID. Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. Radiology. 2005 Dec;237(3):794-800.

32. Tikkakoski T, Lohela P, Taavitsainen M, Hiltunen S, Ihalainen J, Päivänsalo M, et al. Thoracic lesions: diagnosis by ultrasound-guided biopsy. RöFo. 1993;159(5):444-449.

33. Najm A, Orr C, Heymann MF, Bart G, Veale DJ, Le Goff B. Success rate and utility of ultrasound-guided synovial biopsies in clinical practice. The Journal of rheumatology. 2016 Dec 1;43(12):2113-9.

34. Khati NJ, Gorodenker J, Hill MC. Ultrasound-guided biopsies of the abdomen. Ultrasound Quarterly. 2011 Dec 1;27(4):255-68.

35. Hoshi K, Irisawa A, Shibukawa G, Yamabe A, Fujisawa M, Igarashi R, Yoshida Y, Abe Y, Imbe K. Validation of a realistic, simple, and inexpensive EUS-FNA training model using isolated porcine stomach. Endoscopy International Open. 2016 Sep;4(09):E1004-8.