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Chapter 1 : Medical ultrasound - Wikipedia

Ultrasonography in Ophthalmology 12 Proceedings of the 12th SIDUO Congress, Iguazu Falls, Argentina, Edited by Roberto Sampaolesi.

Clinical performance measurements on ultrasonic transducers. Three-dimensional ultrasonography of ocular region. A mechanical sector scanner for ophthalmic ultrasonic diagnosis. A system for computer controlled Doppler waveform analysis. Standards in ophthalmic ultrasonography. A new instrument for axial length measurement. Improvements on computer assisted echography. Ultrasonographic observations of ocular walls. Spectral analysis for ultrasonic tissue characterization. Texture of echographic B-mode images. Numerical expression in kinetic echography. In vivo measurement of the thickness of the retino-choroidal layers by RF-signal analysis. Retinal biometry by RF-signal analysis. Re-evaluation of scleral reflectivity in quantitative echography where sclera is examined. Vitreoretinal and Choroidal Diseases. Ultrasonography as an aid in setting up an adequate therapy plan in the treatment of retinal detachment due to macular hole. Uveal effusion syndrome - idiopathic serous detachment of the choroid, ciliary body and retina. Intraocular foreign body localization by A- and B-scan echography. Echographic evaluation of bulbar phthisis. B-scan echography in 40 eyes treated by trabeculectomy. Recurrent spontaneous choroidal detachment: Intraocular Tumours and Leukokoria. Ophthalmic ultrasonography of pathologically proven ocular melanomas with a high resolution real-time small parts scanner. Analysis of a recent series cases of choroidal tumours. Echographic follow-up of choroidal melanoma after irradiation with Iodine Ultrasonically diagnosed cystic ciliary body melanomas. A mushroom shaped pigmented pseudomelanoma case report. Errors in the diagnosis of retinoblastoma. Ultrasonographic correlation in retinoblastoma. Highly reflective intraocular lesions. A case report of pigment epithelium hamartoma: Choroidal haemangioma, king size or normal size by ultrasound? Orbital and Periorbital Tumours. The orbital involvement in some paraorbital lesions. The possibilities of application of ophthalmic ultrasound equipment in some head and neck diseases. Diagnosis of orbital metastases with standardized echography. Echographic differential diagnosis of congenital cystic lesions of the orbit. Echographic patterns of an orbital myxoma and schwannoma. Lacrimal gland region disorders. Extraocular Muscles and Optic Nerve. The echobiometric measurement of the extraocular muscles in normal subjects. Echographically determined changes of the optic nerve in hypertensive retinopathy Stage IV. Echographic results in painful exophthalmos with ophthalmoplegia. Proposal of a formula for evaluating the dioptric power of the posterior surface of the cornea. Contact techniques in ocular biometry, influences of intraocular pressure and probe contact pressure. Is ultrasonic biometry associated with keratometry reliable for evaluation of refractive errors in eyes with transparent media?. Ultrasonographic measurement of the posterior coats of the eye and their relation to axial length. Post surgery depth of anterior chamber after extracapsular cataract extraction with IOL: The role of echography in adult glaucoma. Oculometric features of high myopia around the age of The reduction of error in.

Chapter 2 : The Ongoing Role of Ophthalmic Ultrasound

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Ultrasonography in Ophthalmology 12 Proceedings of the 12th SIDUO Congress, IguazÃº Falls, Argentina, Editors: Sampaolesi, R. (Ed.).

See also Acoustic attenuation for further details on modeling of acoustic attenuation and absorption. The speed of sound varies as it travels through different materials, and is dependent on the acoustical impedance of the material. An effect of this assumption is that in a real body with non-uniform tissues, the beam becomes somewhat de-focused and image resolution is reduced. To generate a 2D -image, the ultrasonic beam is swept. A transducer may be swept mechanically by rotating or swinging. Or a 1D phased array transducer may be used to sweep the beam electronically. The received data is processed and used to construct the image. The image is then a 2D representation of the slice into the body. Commonly a specialised probe that mechanically scans a conventional 2D-image transducer is used. However, since the mechanical scanning is slow, it is difficult to make 3D images of moving tissues. Recently, 2D phased array transducers that can sweep the beam in 3D have been developed. These can image faster and can even be used to make live 3D images of a beating heart. Doppler ultrasonography is used to study blood flow and muscle motion. The different detected speeds are represented in color for ease of interpretation, for example leaky heart valves: Colors may alternatively be used to represent the amplitudes of the received echoes. Modes[edit] Several modes of ultrasound are used in medical imaging. A-mode amplitude mode is the simplest type of ultrasound. A single transducer scans a line through the body with the echoes plotted on screen as a function of depth. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy. In B-mode brightness mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen. More commonly known as 2D mode now. Video is available B-flow is a mode that digitally highlights weak flow reflectors mainly red blood cells while suppressing the signals from the surrounding stationary tissue. It can visualize flowing blood and surrounding stationary tissues simultaneously. A C-mode image is formed in a plane normal to a B-mode image. A gate that selects data from a specific depth from an A-mode line is used; then the transducer is moved in the 2D plane to sample the entire region at this fixed depth. In M-mode motion mode ultrasound, pulses are emitted in quick succession â€” each time, either an A-mode or B-mode image is taken. Over time, this is analogous to recording a video in ultrasound. As the organ boundaries that produce reflections move relative to the probe, this can be used to determine the velocity of specific organ structures. This mode makes use of the Doppler effect in measuring and visualizing blood flow Color Doppler: Velocity information is presented as a color-coded overlay on top of a B-mode image Continuous wave CW Doppler: Doppler information is sampled along a line through the body, and all velocities detected at each time point are presented on a time line Pulsed wave PW Doppler: Doppler information is sampled from only a small sample volume defined in 2D image , and presented on a timeline Duplex: Using modern ultrasound machines, color Doppler is almost always also used; hence the alternative name Triplex. In this mode, two successive pulses with opposite sign are emitted and then subtracted from each other. This implies that any linearly responding constituent will disappear while gases with non-linear compressibility stand out. Pulse inversion may also be used in a similar manner as in Harmonic mode; see below: In this mode a deep penetrating fundamental frequency is emitted into the body and a harmonic overtone is detected. This way noise and artifacts due to reverberation and aberration are greatly reduced. Some also believe that penetration depth can be gained with improved lateral resolution; however, this is not well documented. Expansions[edit] An additional expansion or additional technique of ultrasound is biplanar ultrasound, in which the probe has two 2D planes that are perpendicular to each other, providing more efficient localization and detection. Doppler ultrasonography Duplex scan of the common carotid artery Doppler ultrasonography employs the Doppler effect to assess whether structures usually blood [25] are moving towards or away from the probe, and its relative velocity. By calculating the frequency shift of a particular sample volume, for example flow in an artery or a jet of blood flow over a heart valve, its speed and direction can be determined and visualized.

Color Doppler is the measurement of velocity by color scale. Color Doppler images are generally combined with grayscale B-mode images to display duplex ultrasonography images. Doppler echocardiography , the use of Doppler ultrasonography to examine the heart. Contrast-enhanced ultrasound using gas-filled microbubble contrast media can be used to improve velocity or other flow-related medical measurements. They are used as tests to help diagnose emboli , stenosis , vasospasm from a subarachnoid hemorrhage bleeding from a ruptured aneurysm , and other problems. Doppler fetal monitors , although usually not technically -graphy but rather sound-generating, use the Doppler effect to detect the fetal heartbeat for prenatal care. These are hand-held, and some models also display the heart rate in beats per minute BPM. Use of this monitor is sometimes known as Doppler auscultation. The Doppler fetal monitor is commonly referred to simply as a Doppler or fetal Doppler. Doppler fetal monitors provide information about the fetus similar to that provided by a fetal stethoscope. Contrast ultrasonography ultrasound contrast imaging [edit] Main article: Contrast-enhanced ultrasound A contrast medium for medical ultrasonography is a formulation of encapsulated gaseous microbubbles [28] to increase echogenicity of blood, discovered by Dr Raymond Gramiak in [29] and named contrast-enhanced ultrasound. This contrast medical imaging modality is clinically used throughout the world, [30] in particular for echocardiography in the United States and for ultrasound radiology in Europe and Asia. Microbubbles-based contrast media is administrated intravenously in patient blood stream during the medical ultrasonography examination. Thanks to their size, the microbubbles remain confined in blood vessels without extravasating towards the interstitial fluid. An ultrasound contrast media is therefore purely intravascular, making it an ideal agent to image organ microvascularization for diagnostic purposes. A typical clinical use of contrast ultrasonography is detection of a hypervascular metastatic tumor , which exhibits a contrast uptake kinetics of microbubbles concentration in blood circulation faster than healthy biological tissue surrounding the tumor. Finally, applications in quantitative perfusion [32] relative measurement of blood flow [33] emerge for identifying early patient response to an anti-cancerous drug treatment methodology and clinical study by Dr Nathalie Lassau in [34] , enabling to determine the best oncological therapeutic options. This method is based on medical computational science [38] [39] to analyze a time sequence of ultrasound contrast images, a digital video recorded in real-time during patient examination. Two consecutive signal processing steps are applied to each pixel of the tumor: Once signal processing in each pixel completed, a color spatial map of the parameter is displayed on a computer monitor , summarizing all vascular information of the tumor in a single image called parametric image see last figure of press article [40] as clinical examples. This parametric image is interpreted by clinicians based on predominant colorization of the tumor: In the first case suspicion of malignant tumor , the clinician typically prescribes a biopsy to confirm the diagnostic or a CT scan examination as a second opinion. In the second case quasi-certain of benign tumor , only a follow-up is needed with a contrast ultrasonography examination a few months later. The main clinical benefits are to avoid a systematic biopsy risky invasive procedure of benign tumors or a CT scan examination exposing the patient to X-ray radiation. The parametric imaging of vascular signatures method proved to be effective in humans for characterization of tumors in the liver. Molecular ultrasonography ultrasound molecular imaging [edit] The future of contrast ultrasonography is in molecular imaging with potential clinical applications expected in cancer screening to detect malignant tumors at their earliest stage of appearance. Molecular ultrasonography or ultrasound molecular imaging uses targeted microbubbles originally designed by Dr Alexander Klibanov in ; [43] [44] such targeted microbubbles specifically bind or adhere to tumoral microvessels by targeting biomolecular cancer expression overexpression of certain biomolecules occurs during neo-angiogenesis [45] [46] or inflammation [47] processes in malignant tumors. As a result, a few minutes after their injection in blood circulation, the targeted microbubbles accumulate in the malignant tumor; facilitating its localization in a unique ultrasound contrast image. In , the very first exploratory clinical trial in humans for prostate cancer was completed at Amsterdam in the Netherlands by Dr Hessel Wijkstra. At the stage of scientific preclinical research, the technique of acoustic radiation force was implemented as a prototype in clinical ultrasound systems and validated in vivo in 2D [50] and 3D [51] [52] imaging modes. Elastography ultrasound elasticity imaging [edit] Main article: Elastography Ultrasound is also used for elastography, which is a relatively new imaging modality that maps the elastic properties of soft tissue. For example, cancerous tumors will often be harder than the surrounding tissue, and diseased livers are stiffer than healthy ones. The high frequency thyroid ultrasound HFUS can be used to treat several gland conditions. The recurrent thyroid cyst that was usually treated in the past with surgery, can be treated effectively by a new procedure called percutaneous ethanol injection, or PEI. Metastatic thyroid cancer neck lymph nodes: The other thyroid therapy use for HFUS is to treat metastatic thyroid cancer neck lymph nodes that occur in patients who either refuse surgery, or are no longer a candidate for surgery. Small amounts of ethanol are injected under ultrasound guided needle placement. A blood flow study is done prior to the injection, by power doppler. The blood flow can be destroyed and the node become inactive, although it may still be there. Power doppler visualized blood flow can be eradicated, and there may be a drop in the cancer blood marker test, thyroglobulin , TG, as the node become non-functional. Another interventional use for HFUS is to mark a cancer node one hour prior to surgery to help locate the node cluster at the surgery. A minute amount of methylene dye is injected, under careful ultrasound guided placement of the needle on the anterior surface, but not in the node. The dye will be evident to the thyroid surgeon when he opens the neck. A similar localization procedure with methylene blue, can be done to locate parathyroid adenomas at surgery. Compression ultrasonography[edit] Compression ultrasonography is when the probe is pressed against the skin. This can bring the target structure closer to the probe, increasing spatial resolution of it. Comparison of the shape of the target structure before and after compression can aid in diagnosis. It used in ultrasonography of deep venous thrombosis , wherein absence of vein compressibility is a strong indicator of thrombosis. Results are not reliable when the patient is symptomless and must be checked, for example in high risk postoperative patients mainly in orthopedic patients. Absence of comprehensibility indicates appendicitis.

Chapter 4 : Ophthalmologic Ultrasound - EyeWiki

Get this from a library! Ultrasonography in Ophthalmology Proceedings of the 12th SIDUO Congress, IguazÃº Falls, Argentina, [Roberto Sampaolesi] -- The 12th Congress of SIDUO took place in Iguazu Falls, Argentina, where participants could enjoy the scenery of the magnificent Falls.

This work is published and licensed by Dove Medical Press Limited The full terms of this license are available at https: By accessing the work you hereby accept the Terms. Non-commercial uses of the work are permitted without any further permission from Dove Medical Press Limited, provided the work is properly attributed. This article has been cited by other articles in PMC. Abstract The use of focused ultrasound to obtain diagnostically significant information about the eye goes back to the s. This review describes the historical and technological development of ophthalmic ultrasound and its clinical application and impact. Ultrasound, like light, can be focused, which is crucial for formation of high-resolution, diagnostically useful images. Focused, single-element, mechanically scanned transducers are most common in ophthalmology. Specially designed transducers have been used to generate focused, high-intensity ultrasound that through thermal effects has been used to treat glaucoma via ciliodestruction , tumors, and other pathologies. Linear and annular transducer arrays offer synthetic focusing in which precise timing of the excitation of independently addressable array elements allows formation of a converging wavefront to create a focus at one or more programmable depths. Most recently, linear array-based plane-wave ultrasound, in which the array emits an unfocused wavefront and focusing is performed solely on received data, has been demonstrated for imaging ocular anatomy and blood flow. While the history of ophthalmic ultrasound extends back over half-a-century, new and powerful technologic advances continue to be made, offering the prospect of novel diagnostic capabilities. Medical ultrasonography, however, relies on frequencies in the MHz millions of cycles per second range. Like light, ultrasound can be focused, which is advantageous both for diagnostic and therapeutic applications. This report will review the use of focused ultrasound in ophthalmology. Ultrasound technology has its beginning with Paul Langevin who, toward the end of the First World War, developed echo location as a means for detecting enemy submarines. Langevin excited a piezoelectric quartz crystal with a high-voltage transient to generate and transmit a pulse of ultrasound through seawater. Given the directional orientation of the acoustic pulse, the time interval between transmission and echo reception, and the known speed of sound in seawater, the range and direction to the target could in principle be determined. While this technology came too late to be applied during the First World War, it was extensively used and further developed by all sides during the Second World War. Medical ultrasonography, an outgrowth of wartime sonar technology, rapidly developed in the postwar era. The rapid expansion and contraction of the quartz crystal in response to a transient voltage spike was communicated to the seawater in which it was submerged. The resulting longitudinal acoustic pulse then propagated through the sea, returning echoes if it encountered a solid object, such as a ship or submarine. When such echoes returned to and interacted with the transducer by compressing and decompressing the piezoelectric crystal, the process was reversed, generating small voltages that were then amplified for detection. Modern medical ultrasound is based on the same general principles. Thus, ultrasound images can be thought of as depicting density variation rather than density itself, as does an X-ray. A medium in which density is constant will therefore produce no internal echoes no matter if the density is high or low. Transducer and probe design The piezoelectric element of medical transducers is most often a ceramic material such as lead zirconate titanate, although polymeric polyvinylidene fluoride is used in high-frequency applications. There is ongoing interest in the development of nontoxic, environmentally friendly, lead-free piezoelectric materials for medical ultrasound. In single-element transducers, which are the most common configuration in ophthalmology, the emitted ultrasound can be focused either by curvature of the element itself most common with polyvinylidene fluoride or use of a lensing material most common with lower frequency ceramic piezoelectric materials. Single-element transducers thus have a fixed focal length. In such probes, the transducer is mechanically pivoted to sweep out two-dimensional sector B-scans.

Chapter 5 : Focused ultrasound in ophthalmology

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This study shows that it still has a valuable place. Ophthalmic ultrasound has evolved from its introduction into the clinical setting in to the current A- and B-scan contact and immersion techniques which are widely used for the characterization of intraocular and orbital pathology. Fundamental Principles The fundamental physical principle underlying diagnostic ultrasound is the generation of sound waves at frequencies above the range of human hearing greater than 20, Hz or 20 KHz by the vibration of a thin crystal in the tip of the probe which is stimulated by pulses of electric current. The waves of sound then propagate through a medium and are reflected by tissue interfaces back to the resting crystal that is then made to vibrate, generating electrical impulses that are amplified and processed to show a pattern on an oscilloscope screen. The B-scan brightness amplitude probe contains a transducer which sweeps back and forth at an average rate of 25 oscillations per second. It generates sound waves at a frequency of 10 MHz. This produces a series of echoes that are processed like pixels on a computer screen to generate an image. Higher frequency B-scan probes of up to 60 MHz are used for immersion scanning of the anterior segment. The diagnostic A-scan time amplitude probe generates sound waves at a frequency of 8 MHz and these are processed to display vertical lines, which represent tissue interfaces. Recently the predominance of echography has been challenged by partial coherence interferometry as applied in the IOLMaster. In these cases an immersion MHz B-scan displays the cornea and the staphyloma in the same image. A vector A-scan is then superimposed on the B-scan and aligned with the center of the staphyloma to allow an accurate axial length measurement. This capability is very important in the current clinical paradigm of following smaller lesions over time, planning radiation treatment, and monitoring response to treatment. Value in Detecting Pathology Echography is essential in the evaluation of the internal globe in cases of media opacity. Pathological conditions such as retinal detachment and intraocular tumors are most accurately and cost-effectively diagnosed by ultrasound. There are a number of reports in the literature of unsuspected intraocular tumors that were not discovered until after cataract surgery. In one, researchers reviewed 21 cases of cataracts that had been removed in the presence of unsuspected choroidal or ciliary body melanomas. It should definitely be performed in patients who have a dense unexplained unilateral cataract. In another review of cases of clinically unsuspected intraocular tumors, three of the six cases identified were anterior tumors that could only have been detected by immersion ultrasound of the anterior segment. The authors emphasize the potentially serious consequences of evisceration in the presence of an intraocular malignancy. A-scan provides the unique capacity to characterize the internal structure of intraocular tumors that is highly correlated to the tissue characteristics of the lesion. The quantitative spike height and regularity and kinetic rapid spike movement criteria provide high specificity and sensitivity in the evaluation of ocular lesions. This technique began to be used more extensively in the s and the rate of specificity for the diagnosis of choroidal melanoma increased significantly. The B-scan is complementary to the A-scan in the analysis of intraocular processes because of its ability to display topographic features such as the shape and anatomical relationship to other structures. It is very sensitive to the presence of high reflective material, such as intraocular foreign bodies of various types, and in detecting calcium, such as that seen in optic nerve head drusen. Its role in the evaluation of orbital pathology has largely been supplanted by the continually evolving CT and MRI technologies. The A-scan provides unique information about orbital lesions beyond that supplied by topography-based studies such as B-scan and radiologic imaging. However, it potentially conveys much more diagnostic information than the B-scan. It provides information about the internal structure of intraocular and orbital tumors that is often highly correlated to the pathological diagnosis. Broad-Based Study Undertaken A study addressed the impact of echography on the evaluation and management of posterior segment disorders. The group summarized the accuracy of the ultrasound diagnosis as compared to the final clinical or pathological findings in the context of the impact of these diagnoses on the management of the respective pathological conditions. This study presents the diagnostic findings of 1, consecutive patients referred to an ophthalmic echographic specialty practice over a month period ending in January All patients were included with the exception of those referred for routine biometry prior to cataract surgery. This analysis will help to provide an overview of the types of patients referred for diagnostic ultrasound and the diagnostic accuracy of this particular imaging modality. Ultrasound examinations were categorized into nine general areas See Table 1. These nine categories were then subdivided into clinical results including: These patients were all examined by the same well-experienced, board-certified ophthalmologist who had completed a fellowship in ophthalmic ultrasound. The echographic equipment consisted of the Innovative Imaging V1 unit with a dedicated mHz B-probe, a mHz immersion B-probe and a separate 8-mHz diagnostic A-probe. All patients were examined during the same session by both the A-scan and the B-scan except for those with anterior segment lesions iris, lens and ciliary body in whom the immersion technique was utilized with either a or mHz probe. Findings Table 1 lists the specific findings by the nine categories. Some of the issues that related to each of these groups are: This included 23 with the diagnosis of choroidal or ciliary body melanoma and 24 referred as nevus. One hundred and sixty-six patients were referred only with the diagnosis of fundus lesion. In this group echography further clarified the diagnosis by specifying nevus in , and malignant melanoma in five. Fourteen patients were referred with a clinical impression that was altered by the echographic findings. This eye underwent a needle biopsy with non-specific findings that were not consistent with a melanoma. None of these eyes showed evidence of tumor growth in the 16 month time period of this study. Three percent in this group had distended optic nerve sheaths consistent with increased intracranial pressure as quantified by A-scan measurements of a reduction in nerve sheath thickness by the degree test See Figure 7. Three of these had confirmation of this on lumbar puncture with a high opening pressure. Two were felt to have idiopathic optic nerve sheath dilation. One patient in the incorrect echography group was a year-old child who was diagnosed as having an optic nerve glioma by echography that later proved to be a meningioma on biopsy. One patient had a UGH uveitis-glaucoma-hyphema syndrome caused by a sulcus-fixated intraocular lens rubbing on uveal tissue See Figure 5. No cause for the pain was found in 65 percent of patients; 15 percent had clinical findings clarified or altered by echography. One patient referred with pain had the echographic diagnosis of borderline thickening of the lacrimal gland, possibly consistent with dacryoadenitis. However on radiographic studies and subsequent orbital exploration he was diagnosed with a non-specific bony lesion which had not been detected by ultrasound. Ten patients were found by echography to have diagnoses not noted by the referring clinician, including: Two patients with proptosis were incorrectly diagnosed by echography. The follicular centers separated by sclerotic septae in this case were echographically similar to the multiple cavernous spaces in an orbital hemangioma See Figure 11, p. The other case was diagnosed as adenocystic carcinoma of the lacrimal gland and proved to be a pleomorphic adenoma benign mixed cell tumor on pathological examination. Two patients were found by ultrasound to have diagnoses that were not proposed by the referring clinician. The other patient was highly myopic with a staphyloma, which was felt to be the basis for his diplopia. In the negative echographic findings group, 22 patients had no echographic cause for diplopia and subsequently underwent neurological evaluation and neuro-imaging, which was negative in 15 of these patients. These clinical diagnoses were verified by echography and no other abnormalities were detected. Forty patients had corneal opacities or crystalline lens opacities with no vitreoretinal abnormalities noted on echography. Fifty-seven patients had unexpected findings such as vitreoretinal traction; shallow retinal detachment; advanced optic nerve cupping; intraocular foreign body; dislocated crystalline lens; dislocated IOL; intumescent lens; choroidal detachment; and cyclitic membrane found on echography. These conditions were generally not detectable by light-based examination techniques and could only be identified by ultrasound, as in a case of an IOL with amorphous material on the lens which was culture-proven to be Propionebacter acnes See Figure 8. Five patients had echographic diagnoses that were unexpected by the referring clinician. Two of these were iris cysts, one was a foreign body, one was an iris melanoma, and one was an elevation of the temporal iris caused by a dislocated IOL haptic. Three patients referred with an iris elevation had no detectable lesion by echography. Echography confirmed the clinical impression in these cases. Ten of the patients had clarifying echographic findings such as shallow retinal detachment and staphyloma. Twenty-two patients in the miscellaneous category had no echographically detectable abnormalities. One of them was diagnosed by echography as having a lesion adjacent to the lacrimal gland, but lacrimal gland biopsy revealed low-grade dacryoadenitis and did not confirm another lesion. No diagnostic echographic findings were present in patients. Clinical impressions were clarified or altered by echography in patients. Five patients were incorrectly diagnosed by echography. The confirmation of the clinical diagnosis is important especially when invasive therapy is proposed such as radiation or enucleation in the case of choroidal or ciliary body malignant melanoma. Also, the echographic confirmation of the clinical impression of entities such as optic nerve head drusen can obviate the need for more extensive testing. However, in our current medical system, there are strong pressures to practice defensive medicine by ordering diagnostic tests to support the clinical judgment. Sixty-five of the patients referred for evaluation of a blurred disc were found to have calcified optic nerve head drusen. Forty-six of these were suspected by the referring clinician, but 19 were unsuspected and underwent various degrees of evaluation from radiologic imaging studies including MRI and CT scan to neurological examinations and lumbar puncture. In patients with blurred discs in this study, 7. Negative ultrasound findings occurred in 75 of the patients with blurred discs or 51 percent. Most of these patients were ultimately diagnosed as having anomalous optic nerve heads on the basis of the subsequent clinical course or normal radiologic findings. It could be argued that echography added additional unnecessary expense in the evaluation of these patients, but given the greater costs of neuro-imaging studies ultrasound is a more cost-effective type of defensive medicine. The use of diagnostic A-scan in this group facilitated the evaluation of optic nerve sheath thickening, which is useful in identifying patients with true papil-ledema due to increased intracranial pressure. The greatest percentage of negative ultrasound findings, 65 percent, occurred in those patients with the complaint of eye pain. Various types of pain are common symptoms in ophthalmic and optometric practices. Echography is a reasonable ancillary test to consider in such cases because it is rapid, non-invasive and relatively inexpensive. Thirteen percent of these patients had unexpected findings detected by echography. Two of them had echographic findings unrelated to the symptom of pain one shallow retinal detachment and one dystrophic choroidal calcification. Limitations The highest percentage of unexpected findings 57 out of patients or about 40 percent occurred in the category of opaque media. This finding often resulted in surgical intervention, which is generally more effective when performed in a timely fashion See Table 2. The five patients incorrectly diagnosed by echography included one patient characterized as an optic nerve glioma, which later proved to be a meningioma. The second was a histologically proven pleomorphic adenoma of the lacrimal gland that was called an adenocystic carcinoma by echography. The fourth was called a probable dacryoadenitis by ultrasound and proved to be a bony lesion on biopsy. The fifth was diagnosed as a lesion adjacent to the lacrimal gland by echography, but proved to be a low grade dacryoadenitis on biopsy. The echographic examinations in this study were almost all performed with the use of both a B-scan probe and a separate A-scan probe for each patient examination. The ability to characterize the internal structure of intraocular and orbital lesions and to quantitate their thickness is heavily dependent on the standardized diagnostic A-scan, as developed by Karl C.

Chapter 6 : Ultrasonography in Ophthalmology 12 : Roberto Sampaolesi :

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The principles of ocular ultrasound are the same as other applications of this technology. Sound waves are generated at a frequency greater than 20, Hz 20 kHz , and reflected back to the transducer by tissue in its path. When the sound wave returns, a piezo-electric crystal in the transducer vibrates, resulting in electrical impulses that are translated into an image or other data [2]. Ultrasound b-scan exam being performed on a patient. In contrast, lower frequency waves penetrate more deeply but have worse resolution. Ultrasound waves, like other waves, have predictive behaviors based on properties of the medium they travel through. For instance, sound waves have higher velocity when traveling through solids than through liquids [3]. When sound waves travel between tissue interfaces with different acoustic impedance, or densities, they can either scatter, reflect, or refract. Some sound is absorbed by tissue as well. Sound waves that return to the transducer are called echoes, and ultrasound imaging zones can be hyperechoic, hypoechoic, or anechoic. There are two main types of ultrasound used in ophthalmologic practice currently, A-Scan and B-scan. In A-scan, or time-amplitude scan, sound waves are generated at 8 MHz and converted into spikes that correspond with tissue interface zones. In B-scan, or brightness amplitude scan, sound waves are generated at 10 MHz. The data collected by the transducer produces a corresponding image. Other uses include the measurement of tumors including choroidal melanomas [2] [5] , visualization of lens dislocation [5] , and detection of retinal detachment. Ultrasonography is especially useful in cases in which the fundus is obscured from visualization by slit lamp and laser interferometry IOL Master , as in patients with dense cataracts [2] [4]. In this population, the use of ocular ultrasonography may result in earlier detection of ocular melanoma [2]. The benefits of ultrasound include improved visualization of structures obscured by opaque substances,such as dense cataracts or vitreous hemorrhage. Second, real time information is available to the practitioner regarding conditions such as retinal detachment. Finally, ultrasound is safe, does not expose the patient to radiation, is widely accessible, and is low cost. Disadvantages include a high level of inter-operator variability [4] , which does not plague other forms of imaging including optical coherence tomography, CT, and MRI. A-Scan A-scan, or amplitude scan, is one method used for ocular assessment via ultrasound. The tear film is an adequate agent for acoustic transmission, thus absolving the need for ultrasound coupling jelly [4]. In A-scan, a single sound beam is sent from the transducer [3]. Echoes that return to the transducer are converted into a series of spikes with height proportional to the strength of the echo [4]. The strength of the echo depends on several factors. The first is the properties of the two tissues at an interface. If the interfaces are very different, the echo will be of higher amplitude resulting in a taller spike. If the interfaces are similar, the spike will be short. Spike height is also impacted by the angle of the sound wave hitting the interface. When the transducer is held such that the angle of incidence is higher, some echoes will not return to the transducer. As a result, the spike height is lower. As can be imagined, other factors impact how well the sound wave returns to the transducer such as the smoothness or regularity of the interface and the density of the structure through which the sound passes. Denser objects absorb more energy, thus retinal spike height decreases when dense cataracts are present to impede signal return to the transducer [3]. Measurements derived from the A-scan include spike height, regularity, reflectivity, and sound attenuation. A-scan has the ability to characterize internal tumor structure and composition based on the aforementioned data. Furthermore, vascular pulsations can be visualized as small oscillations of a spiking pattern, which are useful to note in cases of choroidal lesions such as melanoma [4] [2] [6]. Eye length in the axial dimension can also be obtained by measuring the distance between specific spikes. Interpretation of A-Scans is summarized in the table below. The first spike, which is always the tallest, represents where the probe interface meets the cornea [3] [4]. There are then two spikes separated by a short distance, representing the anterior and posterior lens. After these spikes, there is usually a flat line representing the vitreous. When a retinal or vitreous detachment occurs, extra spikes appear in this flat region, with variable amplitudes depending on the lesion. Retinal detachment results in a high amplitude spike, whereas vitreous detachment results in a low amplitude spike. Choroid detachment, in contrast, produces a high amplitude spike with double peaks. Distal to the flat vitreous region, a series of spikes that progressively decrease in amplitude are normally seen. These represent the retina, sclera, and orbital tissues such as fat, in order. The gain, or input sensitivity, of an A-scan alters the size of the resultant spikes. A proper balance is required when selecting gain as weak signals or smaller lesions are more visible when the gain is high, but noise increases as well, thereby reducing resolution. It is recommended to begin with high gain to detect small lesions, and then to reduce the gain to improve sharpness of the image [4]. B-Scan B-scan, or brightness scan, is another method used for ocular assessment via ultrasound. It can be performed directly on the anesthetized eye. In cases of trauma or in children, B-scan can be performed over the eyelid with coupling jelly. Measurements derived from B-scan include visualization of the lesion, including anatomic location, shape, borders, and size. It can be used for a detection of a wide-range of pathological structures, including retinal or choroidal detachment, foreign bodies, calcium, and tumors [4] [2]. Echoes in B-scan are converted to dots with brightness intensity that is proportional to the echo amplitude. For example, high amplitude echoes appear as hyperechoic white , and absent echoes appear black anechoic. It is especially useful in imaging of tumors of the anterior orbit, myositis with associated EOM tendon thickening, and visualization of the superior ophthalmic vein in carotid cavernous fistulas [4] [2]. Similar to A-scan, high gain results in good sensitivity, but poor resolution. It is essential that lesions are centered in the image to obtain the best quality possible. Retinal Detachment and Other Uses of B-scan in the Emergency Room Retinal detachment is an ophthalmologic emergency that can result in severe loss of vision. A variety of etiologies exist for this condition, including proliferative diabetic retinopathy, penetrating trauma, advancing age, serous fluid accumulation in inflammatory eye pathology, and a complication after cataract surgery [7] [8]. Direct observation of a detached retina can be impeded by a variety of factors, including an associated large vitreous hemorrhage, narrow anterior angle precluding mydriatic application, periorbital trauma, or lens opacification. In the aforementioned cases, and others, ocular ultrasonography can be used to delineate underlying pathology of visual symptoms [7]. To use B-scan for evaluation of retinal detachment cases in the emergency room, Teismann et al. A normal appearing retina should be continuous. If detachment is present, fluid will begin to separate the retinal epithelium its attachment to the globe. This will create a thick, oscillating, hyperechoic structure in the case of retinal detachment. The patient may have to move his or her eyes while you are scanning to ensure visualization is complete. Other forms of eye pathology can appear similar on ultrasonography, including posterior vitreous detachment and vitreous hemorrhage. If retinal detachment is suspected based on imaging or clinical history, referral should be made to ophthalmology within 24 hours, as noted above [7]. Research has shown that bedside ultrasound in the ED can be effectively used for the diagnosis of ocular pathology, as exemplified by Blaivas et al. In this study, 61 patients presenting with ocular trauma or acute visual changes within 48 hours of symptom onset underwent B-scanning. Patients with binocular symptoms indicative of neurologic pathology were excluded. Bedside ultrasound images were analyzed for presence of vitreous hemorrhage or detachment, retinal detachment, central retinal artery and vein occlusion by Doppler ultrasound , globe rupture, intraocular foreign bodies, lens dislocation, and retrobulbar hematomas. Results were compared to a gold standard of CT of the orbit, ophthalmologist diagnoses, or both. Of course, care should be taken to avoid vitreous fluid leakage in cases of penetrating eye injury, and caution should be exercised when applying ultrasound equipment to the eye. Ocular Ultrasound for Choroidal Lesions Choroidal nevi are benign lesions that are fairly common in the Caucasian population, ranging from 4. Imaging is essential for the delineation and measurement of the aforementioned lesions, as imaging characteristics are predictive of disease aggressiveness. For example, basal diameter and lesion thickness have been found correlated with metastasis and mortality of choroidal melanoma. Combined A-scan and B-scan ultrasonography are essential in the characterization of these lesions. Imaging is also important as when taken together with risk factors, lesion characteristics can help guide their treatment. If the lesion is not suspicious, it should be re-imaged every 6 months for a year, then annually for stability of the lesion. More frequent imaging is required with increased risk factors or high-risk features on imaging [9]. Another difficulty in analyzing choroidal melanocytic lesions includes the differentiation of primary choroidal melanomas from metastases from distant sites. Metastases had significantly lower height to base ratio than melanomas 0. On ocular ultrasound, osteomas are highly reflective, acoustically dense masses with irregular elevation. Because of their high density, calcification and shadowing is typically seen on B-scan [4] [11]. Additional Resources American Academy of Ophthalmology. American Academy of Ophthalmology, Role of Ultrasonography in evaluation of orbital lesions. Gujarat Medical Journal 68 2:

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Tele-ophthalmology for the monitoring of choroidal and iris nevi: To investigate the validity and safety of tele-ophthalmology evaluations as a clinical assessment tool when performed by an ophthalmologist to detect lesion growth in patients with low-, medium-, and high-risk choroidal and iris nevi. Retrospective observational pilot study. All patients had a dilated fundus or anterior segment photography, A- and B-scan ultrasonography or ultrasound biomicroscopy UBM , and spectral domain optical coherence tomography SD-OCT depending on the nature of their lesion Canadian Journal of Ophthalmology. More Than Meets the Eye. Orbital cellulitis is an uncommon ophthalmological emergency in children, but rapid emergency department ED diagnosis is essential. A year-old boy presented to our pediatric ED with left orbital cellulitis secondary to pansinusitis. Emergency bedside ocular ultrasonography was used to evaluate and expedite his management. Besides inflammatory changes observed on ultrasound of his affected orbit, the patient had an elevated optic disc height and increased nerve sheath diameter, which were not commonly reported in published literature on orbital cellulitis Journal of Emergency Medicine https: To investigate the differences in biometry data of eyes with unilateral congenital cataract and the contralateral normal eyes in pediatric patients. Data of visually significant unilateral congenital cataract patients who had cataract surgery in the ophthalmology department at Semmelweis University between and were collected Journal of Cataract and Refractive Surgery https: To assess intra-correlations between lens density based-on Scheimpflug Imaging System, power used during surgery, surgery duration, and endothelial cell loss in eyes with nuclear cataract. Prospective cross-sectional observational study. The objective lens density and endothelial cell density were measured using the Scheimpflug system and specular microscopy, respectively Saudi Journal of Ophthalmology: Official Journal of the Saudi Ophthalmological Society https: This study was performed to examine the usefulness of B-scan ocular ultrasound images for the diagnosis of optic perineuritis. A year-old woman developed nonpainful blurred vision in her left eye. At the first ophthalmological consultation, she had optic disc swelling and choroidal folds in both eyes and subretinal fluid in the left eye. She was referred to our clinic 1 month after symptom onset. At the first visit to our clinic, she still complained of blurred vision American Journal of Ophthalmology Case Reports https: Ophthalmologic examination showed reduced visual acuity, pseudohypopyon, and iris irregularity. Ultrasound biomicroscopy and aqueous humor cytology confirmed leukemic infiltration. Lesions were treated with intravitreal methotrexate, which has not been described previously for acute lymphoblastic leukemia. Journal of Pediatric Ophthalmology and Strabismus https: The paper describes the possibilities and the clinical utility of three-dimensional 3D ultrasonography in the avian eye. The healthy eyes of 44 patients six various raptor, three psittacine bird and four other bird species were examined using the Voluson i ultrasound unit GE Healthcare, Austria in combination with a high-resolution 18 MHz linear probe. Physiological findings should be demonstrated to obtain a clinical basis for the evaluation of pathological ocular findings In the conservative management of retinoblastoma, detection of tumor activity beneath large, calcified tumors presents a challenging aspect of care as local consolidation is limited in this area. Routine imaging modalities, including magnetic resonance imaging, B-scan ultrasound, and optical coherence tomography, are also limited in providing appropriate surveillance for recurrent disease.

Chapter 8 : A-scan ultrasound biometry - Wikipedia

Ultrasonography in Ophthalmology 11 Proceedings of the 11th SIDUO Congress, Capri, Italy, av Numerical expression in kinetic echography.-