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High-resolution, three-dimensional, and contrast-enhanced ultrasonographic findings in diseases of the eye☆

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KEYWORDS
Ultrasound;
Contrast-enhanced ultrasound;
3-Dimensional ultrasound;
Orbit;
Eye.

Abstract *Objectives:* To review the contrast-enhanced ultrasound (CEUS) and 3D ultrasound findings (3D-US) in various pathologies involving the eye and orbit and to compare them with high-resolution US (HRUS) findings.
Background: CEUS is a valid diagnostic tool for study several districts. There are numerous pathological conditions of the eye in which CEUS can be very helpful or detrimental.
Image Findings: We review a wide range of ocular lesions, traumatic (retinal and choroidal detachments) and malignant (choroidal melanoma, tumors inside and outside the muscle cone) evaluated alternatively with CEUS and 3D and compare these findings with those obtained with HRUS. Dysthyroid orbitopathy is not included in this review.
Conclusion: CEUS plays a central role in the differentiation of detached retina (vascular) and vitreous membranes (avascular). It is also helpful in the assessment of tumor of the eye, in planning treatment for choroidal melanoma, and in assessing orbital masses for neovascularization. HRUS is highly effective in the detection of traumatic and non-traumatic lesions of the eye, but it is less effective for the assessment of orbital lesions. The 3D module has increased the diagnostic value of CEUS. CEUS is cost-effective and can be used when CT and MR cannot be performed.

Sommario *Obiettivi:* Illustrare i reperti ecocontrastografici (CEUS) e di ecografia in tre dimensioni (3D) di un ampio spettro di patologie del globo oculare, confrontandole con l'ecografia ad alta risoluzione (HRUS).
Introduzione: La CEUS è un valido strumento nella valutazione di numerosi distretti corporei. Nella patologia del bulbo oculare esistono una serie di situazioni in cui la CEUS può essere dirimente o molto utile.

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Imaging: In questo lavoro presentiamo uno spettro di lesioni traumatiche (distacchi di retina e della coroide) e di patologia maligna del bulbo oculare (melanoma della coroide, tumori intra- ed extra conali) valutate con CEUS ed ecografia 3D. I risultati sono stati confrontati con HRUS. L'orbitopatiadistiroidea è stata esclusa dal presente studio.
Conclusione: CEUS gioca un ruolo centrale nella diagnosi differenziale tra distacchi di retina (vascolari) e membrane vitreali (avascolari). Inoltre CEUS è molto utile nella valutazione dei tumori bulbari, nel percorso terapeutico del melanoma della coroide e nella valutazione della neovascolarizzazione delle lesioni orbitarie. HRUS è molto efficace nel riconoscimento di lesioni traumatiche e non traumatiche, ma non è utile nella valutazione delle lesioni della parete dell'orbita. L'utilizzo delle ricostruzioni 3D ha aumentato la confidenza diagnostica della CEUS. Infine, CEUS ha un ottimo rapporto costo-beneficio e può essere utilizzata quando la TC e la RM non possono essere eseguite.

Introduction

Ultrasound has long been used to evaluate pathology of the ocular bulb or eyeball [1—3]. In particular, the development of new techniques such as contrast-enhanced ultrasound (CEUS) and three-dimensional reformatting (3D) of US images has firmly established the validity of this method in the field of ophthalmology. The objectives of our study were to examine the possible applications of CEUS and 3D-US reconstructions in the study of lesions involving the eyeball or orbit (in particular, retinal detachment and neoplastic lesions) and to compare these new methods with conventional ultrasound in the field of ophthalmology.

Examination technique

Normal anatomical findings and color Doppler evaluation

The examination is performed with the patient lying on the table in the supine position. The eyes are closed and the lids covered with a thick layer of sterile gel. Evaluation of eye movements may be useful for diagnosis, and to this end the patients may be asked to follow the movements of a penlight or other light source with the contralateral eye. For optimal exploration of the chambers of the eye and the orbit, high-frequency, high-resolution probes are needed (a minimum of

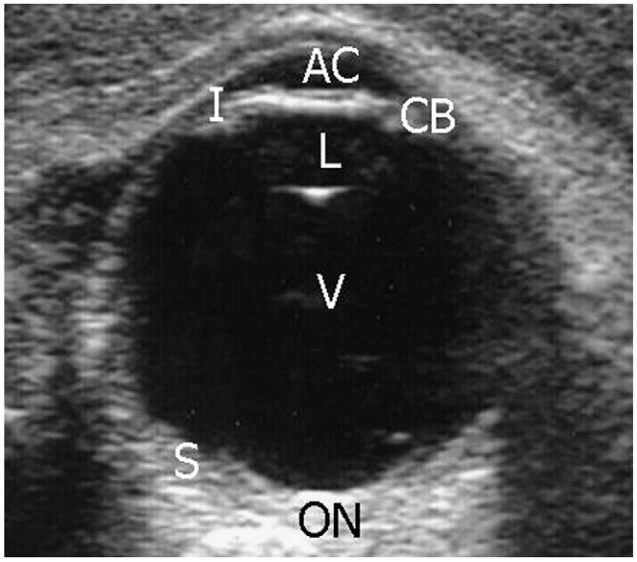

Fig. 1 Normal anatomy of the eye, axial scan. AC = anterior chamber, L = lens, I = iris, CB = ciliary body, V = vitreous humor, S = sclera; ON = optic nerve.

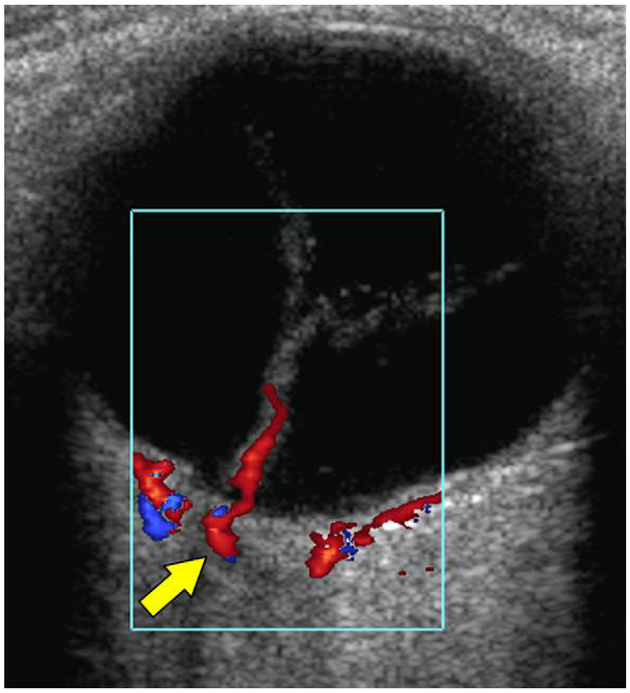

Fig. 2 The easiest vessels to evaluate are those located at the end of the optic nerve. The ophthalmic artery (arrow) is located medially to the optic nerve and has a high resistance. The superior ophthalmic vein is located in the superomedial quadrant of the orbit and can be visualized in 90% of patients. It has continuous, low-resistance flow. The inferior ophthalmic vein is a smaller-caliber vessel and for this reason it is visualized less frequently. The central retinal artery and vein run parallel to the center of the distal segment of the optic nerve. Ultrasound diagnosis of complete detachment of the retina is generally easy because the retina remains anchored to its two attachment points (the optic nerve posteriorly and the ora serrata anteriorly).