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Contrast-enhanced ultrasound in the diagnosis of orbital space-occupying lesions

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AIM: To summarise the sonographic findings and assess the feasibility of contrast-enhanced ultrasound (CEUS) as an imaging method for the diagnosis of orbital space-occupying lesions.

MATERIALS AND METHODS: This was a prospective study of 53 patients who underwent orbital ultrasound at Xijing Hospital. Two-dimensional ultrasound, colour Doppler flow imaging (CDFI), and CEUS imaging were obtained and compared in patients with orbital haemangioma, pseudotumour, melanoma of the choroid, and retinoblastoma.

RESULTS: CEUS imaging cannot only visualise the location, shape, border, acoustic properties of a lesion, and interactions between the lesion and surrounding tissues, but also display the microvasculature and tissue perfusion within the lesion. The information obtained from CEUS imaging is valuable for diagnosis and differential diagnosis of orbital space-occupying lesions.

CONCLUSION: CEUS imaging allowed better visualisation of the lesions, enabled detection of vascular changes, increased the signal-to-noise ratio, and increased the sensitivity of detection of changes in perfusion in the microcirculation. It has relatively high sensitivity and specificity in the diagnosis of orbital space-occupying lesions and increases the accuracy of diagnosis.

Introduction

Ultrasound applications have grown more diverse as the underlying technology has developed.[1] Ultrasound has become one of the most important non-invasive diagnostic procedures in ophthalmology, which is indispensable for many intraocular and orbital diseases.[2] Contrast-enhanced ultrasound (CEUS) imaging improves the assessment of blood flow within lesions and has considerable differential diagnostic capabilities, which makes it a powerful tool for the diagnosis of orbital space-occupying lesions.[3–5] The present study was undertaken to describe and analyse the ultrasonic findings in 52 patients with orbital diseases and to explore the diagnostic value of CEUS in eye space-occupying lesions.

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Materials and methods

Patients

Fifty-two patients with orbital diseases were recruited and treated with two-dimensional ultrasound and CEUS between June 2014 and June 2015. There were 23 male and 29 female patients, ranging in age from 6 to 72 years old. There were 25 cases involving the left eye, 29 cases involving the right eye, and two cases involving both. The operations performed and the results assessed were from a same experienced physician. The final diagnoses were confirmed by surgery and pathological examinations. This study was approved and granted by the Xijing ethics committee and informed consent was obtained from all the patients.

Imaging

The diagnostic ultrasound machine was an Acuson Sequoia 512 (SIEMENS MEDICAL SOLUTIONS USA, INC). A 15L8W and a 4C1 probe were used in this study. The contrast agent was SonoVue (Bracco, Milan, Italy).

Two-dimensional ultrasound imaging was performed to observe the location, shape, borders of lesions, and acoustic characteristics of lesions (presence and absence of internal echoes and sound attenuation, etc.). Blood flow within the lesion was examined using colour Doppler flow imaging (CDFI). CEUS was then performed using SonoVue as the contrast agent. According to the manual, 5 ml 0.9% sodium chloride solution was injected into the bottle and the bottle was shaken until the powder and solvent had completely dispersed. The contrast agent (2.4 ml) was bolus injected into the cubital fossa vein and then flushed with 5 ml 0.9% sodium chloride solution. The entire imaging process took approximately 5 minutes. The time to peak, wash-in and wash-out of the contrast agent in the lesion were recorded and saved for offline analysis.

Results

Benign lesions

Haemangioma (n=19)

Two-dimensional ultrasound imaging showed regular oval or round lesions with smooth, well-defined borders, homogeneously distributed slightly to moderately increased internal echoes, and moderate sound attenuations (Fig 1a). CDFI indicated rich blood flow (Fig 1b). CEUS imaging demonstrated strong nodular enhancement at the periphery of the lesions (Fig 1c). The pools of enhancement expanded in the centripetal pattern and progressed to completely fill in the lesions (Fig 1d). Haemangiomas showed sustained enhancement relative to surrounding normal tissue (Fig 1e). Overall, haemangiomas showed a slow wash-in and slow wash-out pattern on contrast-enhanced ultrasound imaging.

Inflammatory pseudotumours (n=3)

In two-dimensional ultrasound images, inflammatory pseudotumours appeared heterogeneously hypoechoic and irregular in shape. Tumour margins were relatively sharp (Fig 2a). CDFI indicated rich blood flow (Fig 2b). On CEUS imaging, the lesions demonstrated rapid homogeneous hyperenhancement (Fig 2c) and sustained a level higher than in the surrounding tissue during later stages (Fig 2d–e). Overall, the enhancement of contrast agents showed rapid wash-in and slow wash-out modes. The CEUS findings were closely correlated with histopathological observations, which were characterised by sporadic necrosis and infiltration of a large number of chronic inflammatory cells.

Calcification (n=1)

Two-dimensional ultrasound images showed homogeneous hyperechoic lesions with regular shapes and well-defined margins (Fig 3a). CDFI indicated no blood flow (Fig 3b). In CEUS images, calcification showed “filling defects”, which means that no enhancement was observed (Fi. 3c–d).

Malignant neoplasm

Melanoma of choroid (n=24)

Two-dimensional ultrasound imaging showed oval, semicircular, mushroom-shaped, or flat lesions with extrusions into the vitreous body. The lesions had smooth, sharp margins. They were heterogeneously iso- or hypoechoic, and showed slightly attenuated posterior echoes (Fig 4a). CDFI indicated rich blood flow within the lesions, which often extended from the posterior wall of globe into the lesion (Fig 4b). Arterial blood flow was detected and the blood flow rate increased significantly. In the CEUS images, the contrast agent reached the lesion quickly (Fig 4c) and the signal intensity peaked rapidly (Fig 4d). The lesion appeared hyperenhancing; however, the wash-out of the contrast agent from the lesion was also rapid (Fig 4e). Overall, the contrast agent showed a rapid wash-in and rapid wash-out pattern. CEUS demonstrated areas of filling defect as well as areas of enhancement in four cases of choroid melanoma. The filling defects correlated to areas of necrosis on the histopathology specimens.

Retinoblastoma (RB n=5)

Two-dimensional ultrasound images showed lump- and map-shaped lesions with jagged edges, heterogenic echoic signals, and uneven distribution. Hyperechoic spots, patches, and irregular anechoic areas were common (Fig 5a). CDFI showed rich blood flow signals in the peripheral areas and centres of the lesions (Fig 5b). In CEUS imaging, the signals from the contrast agents were initially detected from central retinal artery at the posterior wall of the globe and branched rapidly into the lesion (Fig 5c). The signals increased rapidly, reached a hyper-enhancement plateau (Fig 5d), and then dropped rapidly (Fig 5e). The signal intensity gradually decreased to a level lower than in

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