CASE REPORTS

Colour Doppler imaging in the demonstration of an orbital varix

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Abstract

Colour Doppler imaging (CDI) is a recent development in ultrasonography. It allows simultaneous two-dimensional structural imaging and Doppler evaluation of blood flow. Quantitative information on flow velocity is obtained by pulsed Doppler spectral analysis, the colour information being used to choose the vessel of interest. Using this technique the authors examined a patient with an orbital varix previously diagnosed by clinical findings and computed tomography. Dynamic evaluation with real-time direct imaging of flow facilitated the diagnosis of this orbital disorder without the need for any contrast material. This technique may prove to be a useful adjunct to computed tomography for the evaluation of suspected vascular lesions of the orbit.

Primary orbital varices are relatively uncommon congenital vascular anomalies.¹⁻⁵ The orbital varix is defined as a pathological enlargement of one or several venous channels. Orbital varices are usually diagnosed in the first three decades of life,⁶ have no sex predilection, and are generally unilateral, though a bilateral case has been reported.⁷

Affected patients typically present with intermittent unilateral proptosis that can be accentuated by straining, coughing, the Valsalva manoeuvre, and positional increase of venous pressure in the head and neck region.⁸ Rarely these patients present with severe pain, sudden orbital haemorrhage, and visual loss, necessitating surgical excision of the varix.⁹⁻¹³

In addition to a physical examination the diagnostic tests for orbital varices include orbital computed tomography with a Valsalva manoeuvre^{6 14-16} and orbital venography.¹⁷⁻¹⁹ We examined a patient with a large orbital varix by means of colour Doppler imaging (CDI). CDI is a relatively recent advance in diagnostic imaging that is used to study vascular disorders throughout the body and represents an alternative to invasive vascular studies such as venography and arteriography.²⁰⁻²² Guthoff *et al.* have recently applied Duplex scanning and CDI to the eye, and they demonstrated the usefulness of this technique to depict blood flow in intraocular tumours.²³ The same group measured central retinal artery and central retinal vein blood flow

by duplex sonography.²⁴ While Duplex scanning without colour information can detect flow in larger vessels under two-dimensional B-scan control, in the orbit the diameters of most vessels are below the B-scan resolution. Therefore flow information cannot be obtained accurately and selectively in these small vessels. Recently CDI was used to detect and quantify muscle movements by measuring frequency shift during voluntary saccades.²⁵

Patient and methods

The colour Doppler unit used for our study (QAD 1, Quantum Medical Systems, Inc, Issaquah, Washington) has 5.0 and 7.5 MHz linear phased transducers. The estimated in-situ peak temporal average (SPTA) intensities in the colour imaging mode (provided by Quantum Medical Systems) are 2-3 mW/cm² for the 7.5 MHz transducer. When spectral analysis is performed the SPTA intensity is approximately 25 mW/cm². In the spectrum analysis mode the SPTA intensity exceeds slightly the limits of 17 mW/cm² currently suggested by the Food and Drug Administration guidelines, so that spectrum analysis with pulsed Doppler was performed only for a short time, approximately 30 seconds.

Depending on the direction of flow with respect to the transducer, the flow is displayed in either red or blue. The colours can be arbitrarily assigned, but by convention, and in this study, flow towards the transducer is depicted as red and away from the transducer as blue. When the eye and orbit are examined through the eyelids, the ultrasound beam is almost parallel to the orbital and ocular vessels; thus most arterial flow is depicted in red. Arteries can usually be distinguished from veins by noting the pulsatility of the former. Pulsed Doppler spectral analysis also helps to distinguish between pulsatile arterial and non-pulsatile venous flow and allows quantification of data. When the ultrasound beam is at an angle of 90° to a vascular structure, or if a vessel contains only stagnant blood, no Doppler flow information is obtained and the structure is shown in grey scale display only.

Our patient was a 38-year-old woman who had positional proptosis of the left eye and classic findings of an orbital varix on computed tomography.^{5 26} A contact gel (Aquasonics) was

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Figure 1: Vertical scan toward the temporal orbit. The patient starts to perform a Valsalva manoeuvre. Deep in the orbit there is a well circumscribed structure with flow towards the ultrasound probe, depicted in red.

Figure 3: The varix is maximally expanded. Diffuse low level echoes fill the lumen. No flow information is depicted, since the blood at the height of the Valsalva manoeuvre is stagnant.

applied to the closed eyelids, and horizontal and vertical scans through the eye and orbit were performed in a standard fashion.

Results

To allow better orientation the V-shaped optic nerve shadow was displayed first. Within this

shadow the pulsating central retinal artery and the accompanying central retinal vein were identified. Deeper into the orbit the main branch of the ophthalmic artery was also seen. No abnormalities in the echographic pattern of the eye and orbit were noted. On request the patient performed a Valsalva manoeuvre. In the superotemporal orbit there was a slowly expanding vascular space with marked flow toward the transducer and therefore demonstrated in red (Fig 1). On relaxation the size of the lesion slowly decreased, with flow away from the transducer, depicted in blue (Fig 2). During the extension of the varix displacement of the optic nerve was noted. On maximal dilation no colour information was obtained, indicating the cessation of blood flow (Fig 3).

Pulsed Doppler spectral analysis of the varix demonstrated that influx and efflux were non-pulsatile and continuous – characteristic for venous flow (Fig 4). When the vein collapsed on expiration, flow was seen to increase in velocity and was directed away from the ultrasound probe (Fig 5). Normal-appearing extraocular muscles were seen.

Discussion

Colour Doppler imaging (CDI) allows colour encoded flow data of a vascular structure to be displayed simultaneously on a conventional real-time grey scale B-mode image. This requires a highly sophisticated processing of the returning echoes. In conventional B-mode imaging the amplitude of the returning echoes is converted into a two-dimensional image, and frequency shifts of moving acoustic reflectors are ignored. With CDI the ultrasound signal is detected and analysed in real time for changes in echo ampli-

Figure 2: With the decrease in intrathoracic pressure the varix empties. Flow is directed towards the orbital apex away from the ultrasound probe and therefore depicted in blue.

Figure 4: Spectral analysis of the varix demonstrates the filling phase (above baseline) and the drainage phase (below baseline). Both show continuous flow patterns without pulsations characteristic for venous flow.

tude, frequency, and phase shift. The results are displayed as a composite image of two-dimensional grey scale with superimposed colour encoded flow information.^{21 22 27} Recent articles^{28 29} have stressed the importance in the examination of anatomical and functional disorders in the cerebrovascular system in newborns. As it is often difficult to differentiate certain vascular lesions, such as capillary haemangiomas, cavernous haemangiomas, orbital varices, and arteriovenous malformations³⁵ from solitary non-vascular epithelial or lymphoid lesions, CDI may prove to be particularly useful.

Although intermittent pulsating exophthalmos is rather characteristic and in many cases diagnostic of an orbital varix, imaging of the varix is mandatory for confirming the diagnosis and to demonstrate the extent of the lesion.

In the past orbital venography was traditionally used to diagnose and demonstrate the location of orbital varices.^{30 31} However, severe adverse reactions have been reported with this technique.³² In many cases plain computed

tomography (CT), contrast enhanced computed tomography, and magnetic resonance imaging (MRI) fail to diagnose an orbital varix unless a Valsalva manoeuvre is performed during the examination.²⁶

Since most cases of uncomplicated varices are not treated and surgical management is advocated only when complications occur, we believe this new ultrasonic technique is preferable to standard A- and/or B-scan ultrasonography. Although these conventional ultrasound techniques have been shown to depict an orbital varix they do not directly demonstrate the blood flow.³³⁻³⁵ CDI appears to be a simple procedure for definitive diagnosis of an orbital varix. If, however, surgical intervention is being considered, further studies as axial and coronal computed tomography with a Valsalva manoeuvre and perhaps an orbital venogram should be employed to assist in surgical planning.

We believe that colour Doppler imaging carries great promise for the study of other ocular and orbital vascular diseases. Further studies in this field are under way in our departments to explore the potentials of this new technique.

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Figure 5: The varix is almost collapsed. In the residual lumen a very high frequency shift is detectable.

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