OCULAR BLOOD FLOW ASSESSEMENT BY COLOR DOPPLER IMAGING IN GLAUCOMA

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Abstract: *Altered perfusion of the optic nerve head is a pathogenetic factor in glaucomatous optic neuropathy.Besides increased intraocular pressure, disturbed microcirculation in the optic nerve had no doubt contribution of the glaucomatous optic neuropathy progression.Colour Doppler imaging measures the blood flow velocities and vascular resistivity in retrobulbar vessels.The use of this investigation reported lower velocities in ophthalmic artery, central retinal artery and short posterior ciliary artery and increases in downstream vascular resistance of the vessels of glaucoma patients compared with healthy controls.*

Rezumat: *Alterarea perfuziei nervului optic este factor patogenetic în neuropatia optică glaucomatoasă. În afara creşterii tensiunii intraoculare, modificările circulatorii la nivelul nervului optic contribuie în mod cert la progresia neuropatiei optice glaucomatoase. Ecografia Doppler color măsoară velocităţile sanguine şi rezistenta vasculară în vasele retrobulbare. Utilizarea acestei investigaţii a evidenţiat o scădere a vitezelor sanguine în artera oftalmică, artera centrală a retinei şi arterele ciliare scurte posterioare şi o creştere a rezistenţei vasculare în aceste vase la pacienţii cu glaucom comparativ cu subiecţii sănătoşi.*

SCIENTIFIC ARTICLE OF BIBLIOGRAPHIC SYNTHESIS

The potential role of vascular factor in glaucomatous optic neuropathy(GON) pathogenesis have been, over the past 100 years, and still is theme for research and debate. GON appears in patients with normal ocular tension and progression appears in subjects with normal ocular tension with therapy.

Ocular blood flow measurements in glaucoma subjects have been subjects for many populational-based studies and their findings have showed reduced ocular perfusion pressure in glaucoma patients.

Baltimore eye Survey Study, Egna Neumarkt Glaucoma Study, Long Island Case Control Study, Barbados Eye Study and ProyectoVER are representative populational-based studies which consistently identified the importance of vascular factor in glaucoma.(1)

A variety of blood flowmetric technologies have being developed: Color Doppler Imaging, Fluorescein and ICG angiography, Sacnning Laser Angiography (SLA), pulsatile ocular blood flow, Laser Doppler flowmetry (LDF), Blue field entoptic Phenomenon, Doopler Optical Choerence Tomography. (2) The use of CDI to measure blood flow parameters in retrobulbar vessels has became increasingly more common because has several advantages compared to other technologies. Within the eye, CDI can evaluate the ophthalmic artery, central retinal artery and short posterior ciliary arteries (temporal and nasal groupings) to provide blood flow velocities and estimates of downstream vascular resistance.

In its current state, CDI measures not net flow but blood flow velocities like: Peak systolic velocity (PSV), End diastolic velocity (EDV), pulsatility index(PI) and vascular resistivity index(RI) described by Pourcelot.(3)

Retrobulbar vessels examination with CDI is similar with B-scan ultrasound of the eye and orbit.CDI is an ultrasound technique that combines B-scan grayscale imaging of anatomical detail, color representation of blood flow and pulsed Doppler measurement of blood flow velocities.The motion of blood through the vessels is represented by the superimposition of color upon the familiar Bscan grayscale image of the eye's structure.

For motion toward the probe the code is red –orange-yellow, for motion away from the probe the code is blue.
Green is used for abnormal high velocities which indicate turbulence.

The technique:

The subject is in supine position and the probe is placed on the closed eyelid after application of sterile ultrasound coupling gel.

It is used linear or sectorial ultrasound with frequencies 7, 5-10MHZ and is obtained transversal or sagital section through orbit.

- the operator identified the desired vessel based on anatomical location;
- a sampling window of pulsed Doppler is applied on the vessel;

The velocity curves are graphed by the device: velocity on Y- axis against time on the X- axis. The velocity waveform differs between vessels, and may be used to confirm the vessel being inspected. Then, the technician identifies the peak systolic and end diastolic velocities from the velocity wave form and resistivity index is automatically calculated by the device.

The CDI has several advantages compared to other hemodynamic assessment technologies allowing hemodynamic data to be obtained in eyes with poor optical media like cataract, vitreous hemoragies, synchysis, small pupil and is a noninvasive

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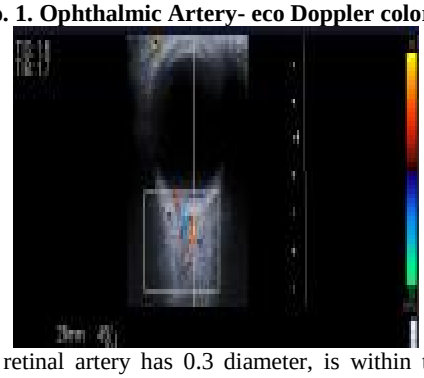
method. The CDI has limitations: the device is expensive and reproducible data requires an experienced and good skill technician because excessive pressure on the glob during examination may raise the intraocular pressure changing the velocities being measured.

Ultrasound anatomy and normal values

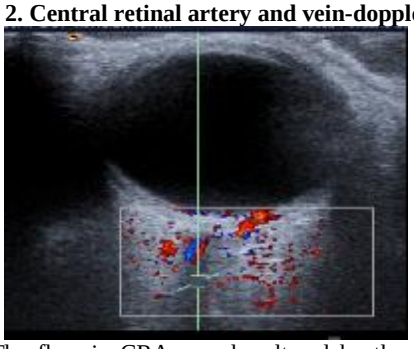
1. Ophthalmic artery is lateral and below the optic nerve.It is low resistance flow like internal carotid.PSVis 30+/- 4 cm/sec si RI= 0.75

Figure no. 1. Ophthalmic Artery- eco Doppler color



2.Central retinal artery has 0.3 diameter, is within the central portion of the optic nerve at 5-10mm behind the globe, next to central retinal vein.PSV =12+/- 2cm/sec si RI = 0,72

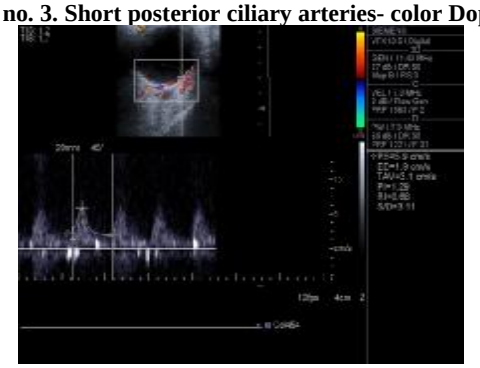
Figure no. 2. Central retinal artery and vein-doppler color



The flow in CRA may be altered by the intraocular pressure (IOP), rise of the IOP determines lowering PSV and lower/ disappearance of diastolic flow.

3.Short posterior ciliary arteries 6-8 in number, branches from CRA and are divided in nasal in temporal group.They realized the aspect of diffuse hypervascularization with CDI.PSV in short ciliary arteries is 10-12+/- 4 cm/sec.RI is 0,68.

Figure no. 3. Short posterior ciliary arteries- color Doppler



Ophthalmic veins superior and inferior pass lateral by the ophthalmic artery through superior orbital fissure and superior ophthalmic vein is seen more frequent on CDI.

Central retinal vein is seen near the central retinal artery within the optic nerve at 5-10mm behind the globe. PSV in ophthalmic and central retinal vein is 6-8cm/sec.

In glaucoma PSV and EDV levels in CRA, OA and SPCA are reduced and downstream vascular resistance of the vessels of glaucoma patients are increased compared to healthy controls.

Many studies showed that reduced flow velocities of the retrobulbar vessels are present in NTG compared with healthy controls, but the precision to detect a patient with NTG has not been evaluated. The blood flow velocities of retrobulbar vessels have been correlated to functional defects in glaucoma and are associated with interocular differences in asymmetric visual field defects. As a consequence, the ability of CDI to discriminate glaucomatous pathology from healthy eyes remains unknown. In 1997, Yamazaki and Drance performed a retrospective study showing patients with progressive NTG exhibit lower blood flow velocities of the CRA and PCA compared to patients with stable visual fields. Galassi et al published similar results in 2003 in a prospective study. Patients with progressive primary open-angle glaucoma (POAG) exhibited significantly lower EDV and increased RI of the OA compared to patients with stable visual fields. Martinez and Sanchez prospectively investigated the prognostic value of CDI of the OA and PCA in a 3-year follow-up study in POAG patients. The risk of future progression increased with higher RI in the OA and short PCAs.

The power to identify NTG using CDI reaches 48% sensitivity at 90% specificity. The ability of CDI to discriminate glaucomatous pathology from healthy eyes remains unknown. The validity of retrobulbar haemodynamics to identify patients at higher risk for progression in glaucoma needs further evaluation in prospective longitudinal studies.

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