

# Correlation between ERG Response and Blood Flow in Glaucoma Patients

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Electroretinography (ERG) is a promising and highly sensitive method for early detection of function loss of viable retinal ganglion cells [4,6]. Abnormal ocular blood flow and/or vascular dysregulation are considered to play an important role in chronic tissue stress in open angle glaucoma [8]. However, only a few studies demonstrate a correlation between ocular/cerebral blood flow and electrophysiological function of the retina and optic nerve in glaucoma [1,3].

**Purpose.** To study the correlation between retinal bioelectrical response and retinal blood flow in glaucoma patients.

**Methods.** Electrophysiological data (ERG and VEP, Tomey EP-1000) was recorded in 12 POAG patients (age 59±11.3 years, mean IOP 20.3 ± 1.3 mm Hg, average RNFL 98.19 ± 15.94 μm, MD -5.86 ± 1.65 dB, PSD 4.3 ± 0.98 dB) and 10 healthy control subjects (age of 57±5.7 years). The K-index (b/a-wave amplitude of max ERG) was calculated. Color Doppler imaging of the vessels was performed using VOLUSON 730 Pro Ultrasound System (“Kretz”) with a 10-16 MHz linear probe. Blood flow velocity was measured in the ophthalmic artery (OA), short posterior ciliary arteries (sPCA), central retinal arteries (CRA), central retinal vein (CRV) and vortex vein (VV). Correlation between electrophysiological parameters and blood flow velocity was calculated using the “SPSS 11.0 for Windows” software.

**Results.** Blood flow velocity reduction in all the vessels, including veins, and the VEP and ERG amplitude decrease were obtained in glaucoma patients in comparison to the control group (Table 1-3). High correlation between ERG b-wave amplitude and arterial blood flow velocity was obtained (Table 4). We observed an increase of the K-index from 1.9 ± 0.3 in early glaucoma to 2.4 ± 0.5 in advanced stage in comparison to 2.0±0.6 in control subjects, p<0.05. Unlike the control group, POAG patients showed a correlation between the K-index and Vdiast CRV (r= - 0.6, p=0.03). Vdiast VV correlated with P100 amplitude of VEP (r=0.7.p=0.02) (Table 4).

**Discussion.** We observed significant decrease of ERG parameters and blood flow velocity (including venous). Moreover, ERG parameters and blood flow velocity in ocular vessels correlated with each other.

The ERG b/a wave ratio (K-index) is considered to be a good indicator of retinal ischemia especially in central retinal vein disorders [5,9]. We obtained a reduced K-index in early glaucoma and low blood flow velocity in CRV in glaucoma in comparison to the control group. (Fig.1). An increased K-index in advanced glaucoma might be explained as glial activation, as a response to ischemia which is critical for the initiation of cascade reactions that cause damage to retinal ganglion cells and optic nerve in glaucoma [7].

## Conclusions

1. Not only arterial, but also venous blood flow is reduced in POAG.
2. High correlation between blood flow velocity in CRA and PCA and ERG parameters demonstrates a role of blood flow in retinal function in glaucoma.
3. The obtained results might be explained as activation of glial cells during glaucoma progression and suggest the importance of venous blood flow in glaucoma pathogenesis.

## References

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Table 1. ERG parameters in glaucoma patients and the control group

	Rod ERG		Max ERG				Cone ERG			
	b-wave		a-wave		b-wave		a-wave		b-wave	
	Lat	Amp	Lat	Amp	Lat	Amp	Lat	Amp	Lat	Amp
Glaucoma	88 ± 20*	49 ± 38*	23 ± 1.5*	-81 ± 23*	45 ± 3.2*	151 ± 35*	14.9 ± 0.8	-13 ± 4.9	31 ± 1.0	52 ± 12
	70 ± 12	64 ± 12	21.5 ± 13	-92 ± 15	38 ± 4	185 ± 7	15.5 ± 0.3	-11.3 ± 4.5	30.5 ± 1.2	59 ± 7

Lat – latency (ms), Ampl. – amplitude (μV), \* - significant difference in comparison with the control group p<0.05

Table 2. VEP parameters in glaucoma

	VEP1°		VEP0.3 °	
	P100		P100	
	Lat	Amp	Lat	Amp
Glaucoma	100.5 ± 2.6	11.3 ± 3.57*	114 ± 8.9	11.6 ± 5.04*
Control	100.1 ± 1.4	18 ± 2.3	102 ± 5.3	17.2 ± 3.5

Lat – latency (ms), Ampl. – amplitude (μV), \* - significant difference in comparison with the control group p<0.05

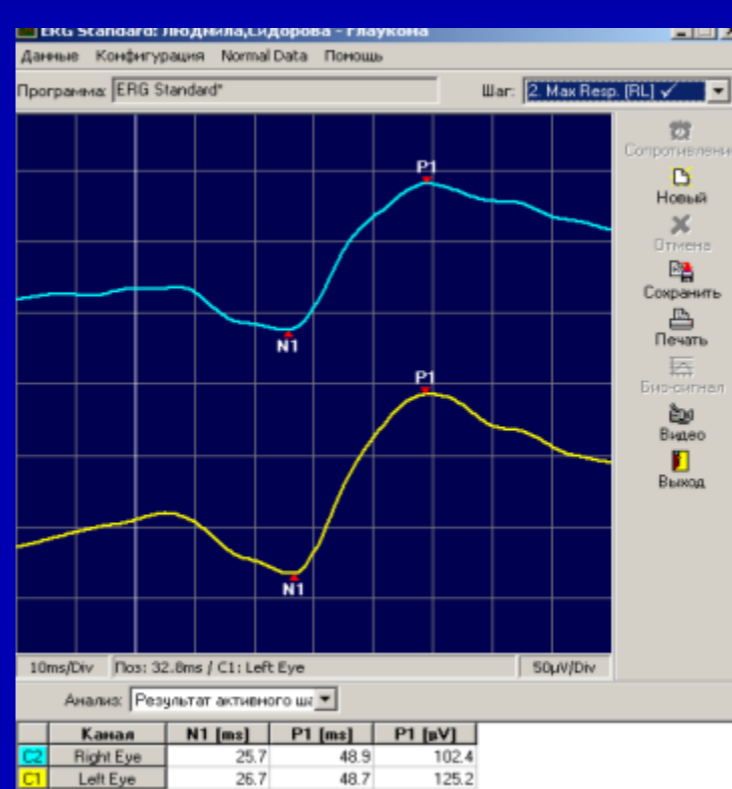
Table 3. Blood flow velocity in ocular vessels

Vessel/Parameter (cm/sec)	OA	CRA	sPCAlat	sPCAmid	CRV	VV
V syst.	32.5 ± 4.9*	10.2 ± 2.7*	11.8 ± 2.9	10.2 ± 3.2*	5.3 ± 0.9	4.8 ± 0.9*
control	36.3 ± 5.3	13.1 ± 3.2	12.7 ± 2.9	12.3 ± 3.2	5.9 ± 1.3	5.1 ± 2.1
V diast.	8.7 ± 2.3	2.1 ± 1.7*	3.3 ± 1.8*	3.3 ± 1.9	2.8 ± 1.4*	1.7 ± 1.7*
control	9.1 ± 2.9	3.8 ± 1.6	4.8 ± 1.9	3.8 ± 2.8	4.3 ± 2.9	2.9 ± 0.9
V mean	16.9 ± 3.2*	5.2 ± 1.7*	6.2 ± 2.2*	5.9 ± 2.3*	3.8 ± 0.7*	2.9 ± 1.2*
control	19.3 ± 1.9	6.8 ± 2.3	8.1 ± 3.2	6.8 ± 3.5	5.1 ± 2.6	3.6 ± 1.5

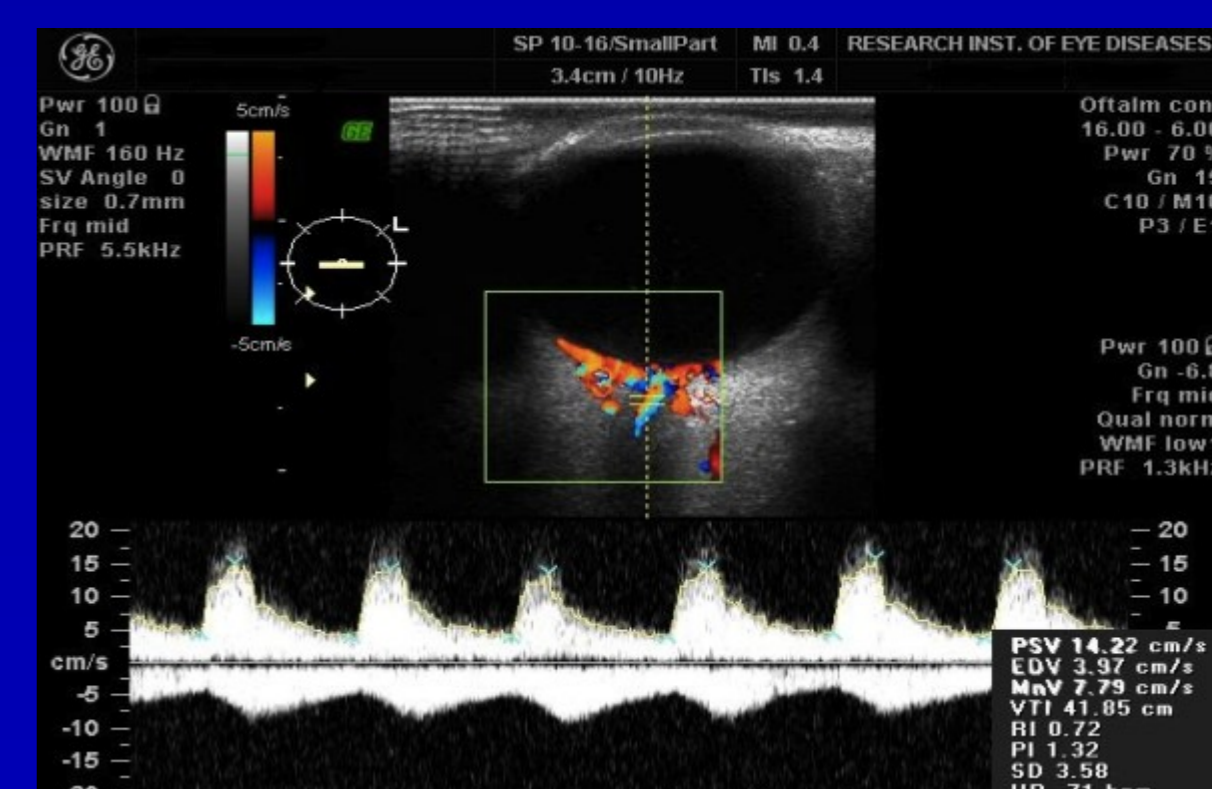
The control group data is given in italics..\* - significant difference in comparison with the control group p<0.05

Table 4. Correlation between electrophysiological parameters and ocular blood flow velocity in glaucoma

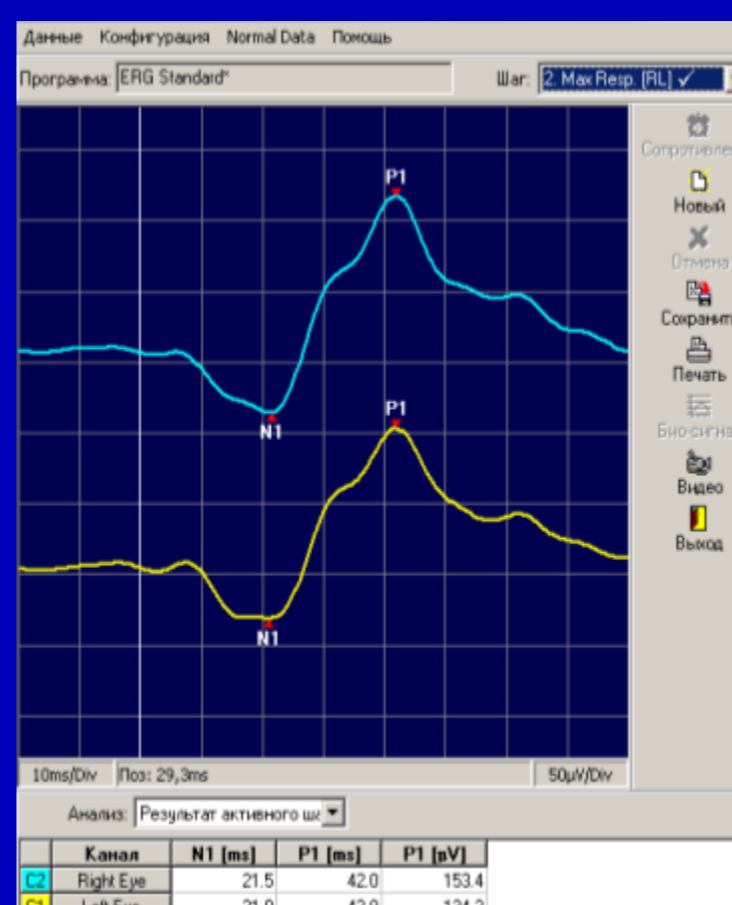
	V syst CRA	V diast CRA	V syst med	V diast med	V diast CRV	V syst VV
Ampl b-wave max ERG	r = 0.7 p=0.004	r = 0.6 p=0.02				
Ampl b-wave cone ERG			r = 0.6 p=0.007	r = 0.7 p=0.007		
K index (b-wave/a-wave)					r = - 0.6 p=0.03	
P100 ampl VEP (1°)						r = 0.7 p=0.02



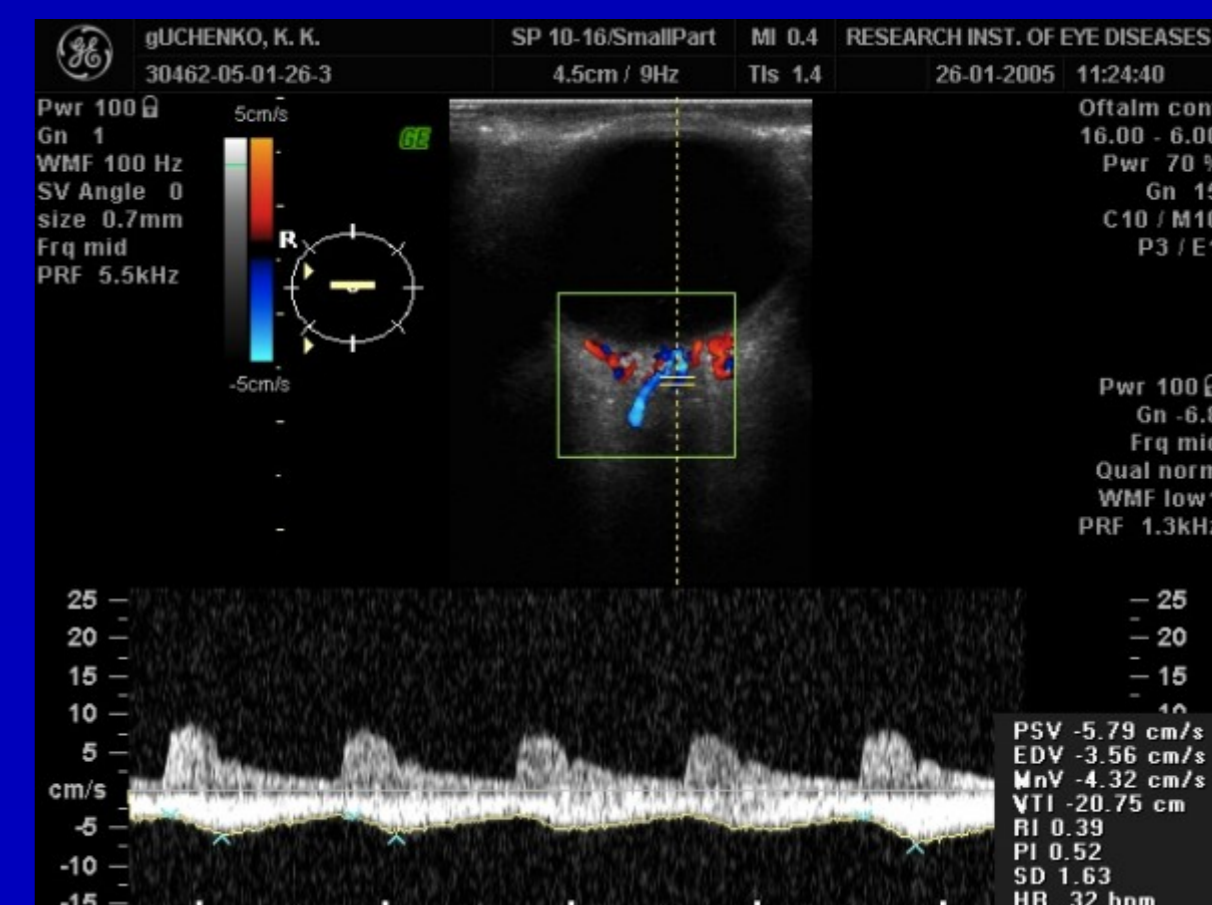
maxERG in a control group patient  
b/a wave ratio (K-index) = 2.0



CRA and CRV in a control group patient (note: normal Doppler spectrum demonstrates high blood flow velocity)



maxERG in glaucoma  
Note: high amplitude of b wave  
b/a wave ratio (K-index) = 2.4



CRA and CRV in glaucoma  
(reduced blood flow velocity is shown)

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