Color Doppler investigation of ophthalmic artery in patients with malignant intraocular tumors

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Introduction

Real time A – mode and B – mode ultrasonography, three dimensional scanning, color Doppler imaging (CDI), computer tomography (CT) and magnetic resonance imaging (MRI) are routinely used today for display, differentiation and measurements of ophthalmic disorders.

Dopller ultrasound is a method of detecting changes in the frequency of ultrasound reflected by flowing blood, allowing estimation of blood flow velocity. This method enables to evaluate the blood flow velocity in ophthalmic artery, central retinal artery and vein and in the arteries of intraocular tumors. CDI is currently used in echocardiography for evaluation of peripheral arterial and venous disease, for evaluation of the vascular pattern of genitourinary system, and in the normal and pathologic state of abdominal organ perfusion [1].

Malignant uveal melanoma (shown on Fig. 1) and metastases (shown on in Fig. 2) are the most common malignancies of the eye in adults.
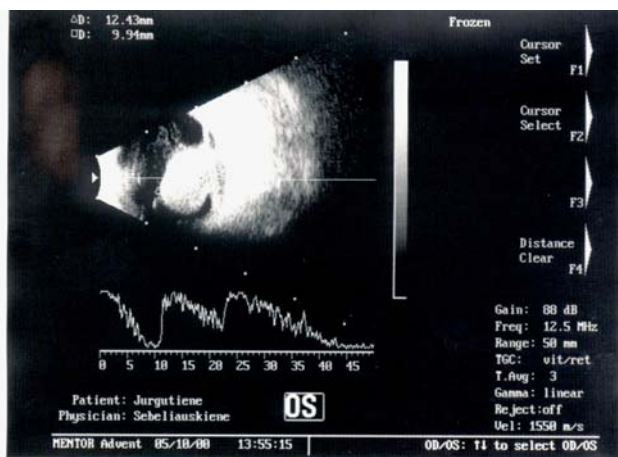

Fig. 1. **Malignant uveal melanoma. A / B scan image**

Uveal melanoma is the most letal disease in the ophthalmological practice [2]. The incidence of malignant melanoma in the world is from 0,2 to 0,8 new cases per 100000 population a year. According to the Lithuanian Cancer Registry the incidence of malignant melanoma is 0,8 new cases a year per 100 000 individuals. Every invasive examination of the patient increases the risk of metatases.
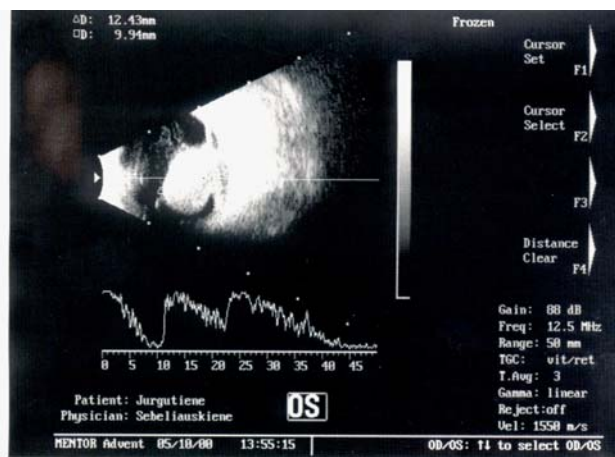

Fig. 2. **Uveal metastases from the breast cancer. A / B scan image**

That's why it is important to introduce the noninvasive methods. It is supposed that in the future in the management of intraocular tumors CDI may help to provide more precise histological diagnosis noninvasively [1, 3-5]. We have not found any references in literature about the investigations of the blood flow of ophthalmic artery of the eye with a malignant intraocular tumor.

The ophthalmic artery is investigated and described much more then other vessells of the orbita. But authors use various Dopller technics, that's why the data of the blood flow in ophthalmic artery in healthy persons are different. The body position of investigatives ussualy is not matched by investigators, while discribing the methods of doplerography, inspite of that this is important. Tthe experiments carried out in the Eye Clinic of Kaunas Medical University Hospital using ortostatic tests proves this fact [7]. There is no difference in blood velocities of ophthalmic artery between the left and right eyes and sexs [8]. The normal blood flow parameters in ophthalmic artery (cm/s) according to various authors are shown in Table 1.

The Dopller curve of the normal blood flow in the ophthalmic artery of the healthy person are shown on the Fig.3.

The aim of the study was to evaluate and analize the changes of velocity of blood flow of ophthalmic artery of patients with malignant intraocular tumors.

Table 1. **The blood flow velocities of the ophthalmic ateries after various authors**

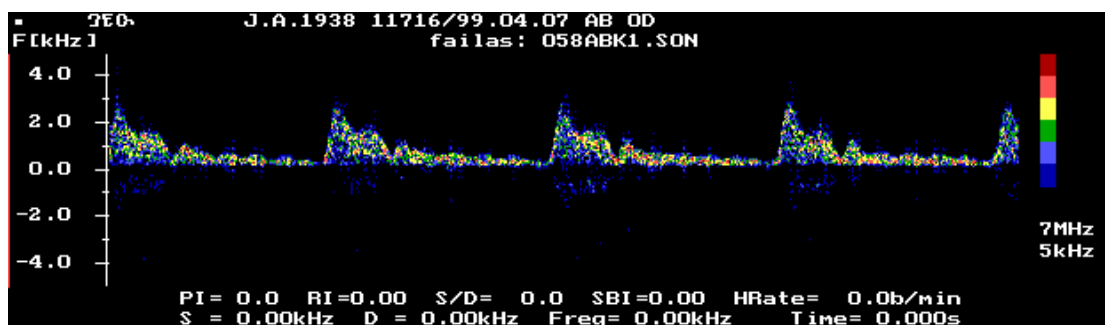| Vmax cm/s	Vdiast cm/s	Vmean. cm/s	RI	Reference
39.2±5.3	9.1 ± 2.5	—	0.77 ± 0.05	8
36.9±7.0	—	—	—	6
46.58±1.48	—	32.56 ± 2.62	—	4
35.0±11.2	8.6 ± 3.8	—	—	7
25.4±7.6	6.3 ± 2.3	—	0.75 ± 0.05	9
40.2±10.9	11.7 ± 4.0	—	—	10

Fig. 3. **Dopllerogram of an ohthalmic artery of the eye of a healthy person**

Materials and methods

Clinical data were obtained during the ophthalmological examination of patients with malignant intraocular tumors, who took a medical advise in the Eye clinic of Kaunas Medical University Hospital. Tumors parameters were obtained by A- and B-mode *Mentor™ A/B* ultrasonic diagnostic imaging system.

Dopplerography of ophthalmic artery was performed by means of the ultrasonic blood flow detector UDD - 03, developed on the bases of IBM PC 386 (Kaunas University of Technology), working in CDI mode for investigation of peripheral vessels. This instrument measures automatically maximum blood flow velocity V_{max} during systole, blood flow velocity at the end of diastole V_{diast}, PI (pulsatility index), RI (resistive index). The maximum measuring depth - 35mm, the frequency of ultrasonic waves 8 MHz, intensivity of ultrasound < 15 mW/cm². Pulsatility index PI (Gossling, 1974) for high resistivity systems is expressed like:

$$PI = V_{max} - V_{min}/V_{mean}$$

Peripherial resistivity index RI is expressed like:

$$RI = V_{max} - V_{diast}/V_{max}$$

RI is used for the vessels of low resistivity and it's theoretical value ranges between 0 and 1.

Standart method used for this investigation. Patients investigated through the upper lid in a sitting position looking down to the nose. To asses the results of patients with intraocular tumors a control group of healthy persons was formed.

We investigated the both eyes of 32 patients with malignant intraoculat tumors in the Eye clinic of Kaunas Medical University Hospital from November 1997 till November 2000 and 55 eyes of 27 healthy emmetropic volunteers of the control group. An average age of the patients was 58 ± 15 years, an average age of persons in the control group was 50 ± 14,6 years. 64,5% of patients were older then 50 years. We graded tumors according to the TNM – classification (T – diameter and height of tumor, N – presence of lymphatic spread, M – presence of spread in other organs): T1 – no more than 3,0 mm height, T2 – from 3,1 to 5,0 mm height, and T3 – more than 5,0 mm height. We found out that the most patients were with T3 tumors - 21 person. For the 20 patients tumor was localized posterior to equator (posterior segment of the eye, see Table 2).

For all the patients with T3 (tumor's height is more then 5 mm) tumors were localised anterior to equator. The average of tumor height of those patients was 7,26±3,06 mm.

Retinal detachment (complication) was diagnosed to 2/3 of patients (66,6%) For 23,3% of patients complications were not found. Haemorages to the vitreous was diagnozed for 2 patients.

27 patients were treated: for 22 patients the eye with malignant tumor was enucleated (removed). Brachitherapy (local X-ray treatment with radioactive Ru/Rh – 106 plaque) was applied to 5 patients. 5 not treated patients followed-up at the Eye Clinic. Cell morphology results of enucleated (removed) eyes are shown in Table 3.

Table 2**. The distribution of patients according to tumor's height and localisation**

Height	T1		T2		T3	
Localization	Number of patients	%	Number of patients	%	Number of patients	%
Posterior to equator	1	3,3	9	26,7	10	33,3
Anterior to equator	-		-		11	36,7

Table 3. **Distribution of eyes according to cell morphology results**

Cell morphology	Number of eyes	%
Spindle cells	12	54,6
Mixed cells	3	13,6
Epitelioid cells	4	18,2
Metastatic carcinoma	3	13,6
Total	22	100,0

Correlation between clinical data and ophthalmic artery blood flow parameters.

Ophthalmic artery blood flow parameters of patients and healthy persons are shown in Table 4. The average of systolic blood flow velocity in ophthalmic artery was the lowest for persons of the control group. For the eyes with the malignant intraocular tumor it was a bit more higher. The highest systolic blood velocity was in an ophthalmic artery of the patient's contralateral not affected eye. The highest diastolic blood flow was in the eyes with the malignant intraocular tumor. The pulsatility index (PI) was a bit more lower in the patients (both eyes). The peripheral resistivity index (RI) for the patients and for the persons of the control group did not differ.

We obtained that the highest systolic blood flow velocity in ophthalmic artery was in the eyes with malignant epithelioid cell tumors (X=53,8 cm/s), and the lowest systolic blood flow velocity was in the eyes with mixed cell tumors (X=52,2 cm/s). The systolic blood flow velocity in an ophthalmic artery of the eye with the metastatic carcinoma (X=48,3 cm/s) was significantly lower than in the contralateral eye (X=61,3 cm/s) (p = 0,038).

We found a strong correlation (r=0,67) between systolic blood flow velocity in an ophthalmic artery in patient's affected and contralateral eye. An average inverse correlation (-0,3) between a systolic blood flow velocity in an ophthalmic artery of the affected eye and tumor's height was found.

Fig. 4 shows dopllerogram of an ophthalmic artery of the eye with the malignant intraocular tumor.

Table 4. **Ophthalmic artery doplerography data ($\overline{X} \pm SD$) of the patients (both eyes) and persons of the control group**

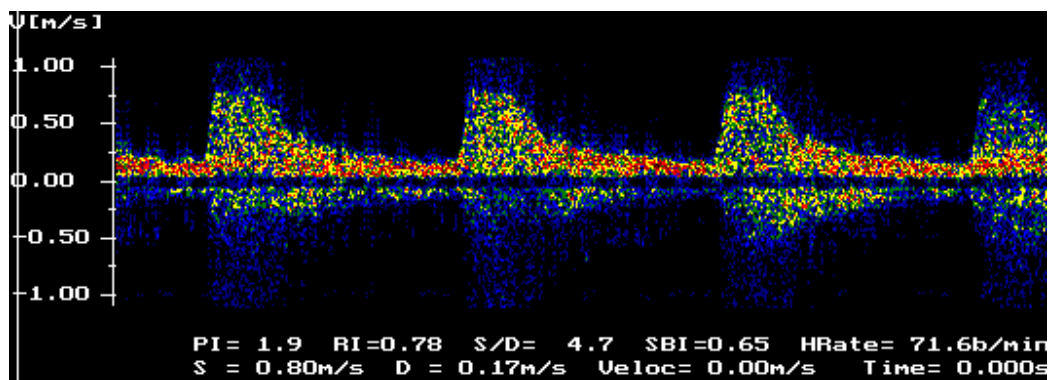| Variable	Control group N=55 eyes	Patient group (eyes with tumor) N =32 eyes	Patient group (healthy eyes) N =32 eyes
Systolic V (cm/s)	51,8 ± 14,8	53,8 ± 17,7	55,4 ± 19,1
Diastolic V (cm/s)	10,8 ± 8,1	11,3 ± 7,2	10,9 ± 8,3
PI	2,6 ± 1,1	2,2 ± 1,0	2,2 ± 0,9
RI	0,85 ± 0,2	0,8 ± 0,2	0,8 ± 0,2

Fig. 4. **Ophthalmic artery dopllerogram of the eye with the malignant intraocular tumor**

Intraocular tumors are highly vascularised. It is typical to find microvessel's loops and networks in it [12]. It is possible to differentiate choroidal hamangioma, melanoma and metastases dependent to localisation of microvessels. Vessels are seen within hemangiomas at the base of melanomas. Choroidal metastases are flat and plaque – like, surrounded by vessels [13]. Thus, combining the clinical features, real – time sonography and CDI characteristics, it should be possible to advance more precise differencial diagnosis in each case.

Conclusions

1. The systolic blood flow velocity of ophthalmic artery in the eye with malignant intraocular tumor is higher than in the healthy eyes.

2. A strong correlation was (r=0,67) between the systolic blood flow velocity in ophthalmic artery of the eye with malignant tumor and contralateral eye of the patient was found.

3. An inverse correlation was (r= -0,3) between the systolic blood flow in ophthalmic artery of the eyes with malignant tumors and the tumor's height was determined.

4. The ophthalmic artery doplerography is noninvasive, comfortable for the patient investigation, giving additional information for evaluation of tumor vascularity, cell morphology and height.

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Ligonių su piktybiniais akies vidaus augliais akinės arterijos doplerografinis tyrimas

Reziumė

Ištirtos 32 ligonių, kurie kreipėsi į KMUK Akių ligų kliniką dėl piktybinio akies vidaus auglio nuo 1997 m. lapkričio mėn. iki 2000 m. lapkričio mėn., abi akys ir 55 sveikos kontrolinės grupės asmenų akys. 64,5% ligonių buvo vyresni nei 50 metų amžiaus. Nustatyta, kad sistolinis kraujo srovės greitis akies su augliu akinėje arterijoje (X±SD=55,4 cm/s ±19,1) didesnis nei kontrolinės grupes asmenų sveikose akyse (X±SD=51,8 cm/s ±14,8). Aptikta glaudi koreliacija tarp kraujo srovės greičio sistolės metu akinėje arterijoje ligonio akies su augliu ir sveikos akies (r=0,67). Nustatyta vidutinė atvirkštinė koreliacija tarp ligonio kraujo greičio akies su augliu akinės arterijos sistolės metu ir auglio aukščio (r=-0,3).

Išvada: ultragarsinis doplerinis akinės arterijos tyrimas gali teikti papildomos informacijos, įvertinant auglio stadiją, histopatologiją, vaskuliarizacijos laipsnį bei pasirenkant gydymo taktiką.