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## Features of neuro-ophthalmic symptoms in patients with parasellar meningiomas

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**Goal.** To analyze the features of neuro-ophthalmic symptoms and study visual functions recovery following parasellar meningiomas (PM) surgery.

**Material and methods.** We have analyzed the results of treating 47 patients with PM which have been operated in the Romodanov Neurosurgery Institute in 2017 - 2021. The main group included 47 patients (94 eyes) with PM with visual disorders. Clinical-neurological and ophthalmological examination and a range of neuroimaging studies were carried out. To evaluate the visual functions, the results were analyzed according to the recommendations of the German Ophthalmological Society.

**Results.** Binocular visual disturbances have been detected in 34 (72.3%) patients. Among visual field defects, absolute bitemporal hemianopia prevailed in 14.9% of patients and a combination of relative upper quadrant temporal hemianopia with absolute temporal hemianopia in 19.2% of patients. Monocular visual disturbances have been detected in 13 (27.7%) patients. Optic nerve atrophy was found in 38 patients (80.9%): unilateral - 21 patients (21 eyes), bilateral - 17 patients (34 eyes). A probable difference was revealed in the average visual acuity: before treatment  $0.55 \pm 0.04$ , after treatment  $0.67 \pm 0.04$  ( $p < 0.05$ ) and the average total loss of sensitivity: before treatment  $11.37 \pm 0.78$  dB and after treatment  $9.14 \pm 0.79$  dB ( $p < 0.05$ ).

**Conclusions.** Parasellar meningiomas constitute a significant part of extracerebral tumors. As a result of surgical treatment, there is a significant improvement in visual acuity and visual field.

**Key words:** parasellar meningiomas; compression optic neuropathy; optic nerve atrophy

### Introduction

Meningiomas are benign tumors. They account for 20–25% of all intracranial neoplasms. Despite their morphological diversity, the slow nature of neoplasm growth prevails [1]. Meningiomas located in the parasellar region (the terms "parasellar" or "sellar and suprasellar" meningiomas are used in the literature) are rarer tumors than pituitary adenomas and craniopharyngiomas (5–15% of all intracranial meningiomas) [2–4]. This conditional topographic group of tumors, in which the influence of the optochiasmatic complex (OCC) can be observed, mainly includes tuberculum sellae and diaphragm sellae meningiomas, the anterior clinoid process, the lesser and greater wings of the sphenoid bone, and the cavernous sinus. Tuberculum sellae meningiomas are usually located in the median suprasellar position, displacing the optic chiasm backward and slightly upward, and the optic nerves laterally [4]. Compression of the structures of the anterior visual pathway by parasellar meningiomas (PM) leads to a clinical picture of the disease, the basis of which is a reduction of slowly progressing visual acuity, visual field disturbance of the bitemporal type, and the development of primary descending optic nerve atrophy.

Apart from the volumetric effect on the OCC, there is optic nerve compression in the optic nerve canal due to the peculiarities of PM spreading [5].

The difficulty of surgical removal of PM is related to their close location to the optic nerves and chiasm, as well as to the anterior cerebral and internal carotid arteries and their perforators, which are often involved in the pathological process. When the disease progresses and blindness occurs, OCC decompression usually does not improve visual functions and is one of the main causes of disability in patients, which makes early diagnosis of vision disorders essential [5,6].

**Purpose:** to analyze the peculiarities of neuro-ophthalmological symptoms and study the dynamics of recovery of visual functions as a result of surgical treatment in patients with parasellar meningiomas.

### Materials and methods

#### Study participants

The results of diagnosis and treatment of 47 patients with PM who were treated in the period from 2017 to 2021 at the Institute of Neurosurgery named after Acad. A.P. Romodanov, Ukraine were analyzed. There were 40



women (85.1%), 7 men (14.9%). The average age of the patients was (49.6±1.7) years.

The study was conducted in compliance with the principles of bioethics and was approved by the Ethics Committee of the Institute of Neurosurgery named after Acad. A.P. Romodanov, Ukraine (Minutes No. 2 dated April 14, 2021). All patients were informed about the specifics of diagnostic and treatment measures and signed the "Informed Consent" form.

*Inclusion criteria*

The criteria for inclusion in the study were verified cases of PM located around the sella turcica and anteriorly from it and causing compression of the anterior visual pathway, which was accompanied by the presence of visual disorders (decreased visual acuity and/or visual field disturbances). The exclusion criteria were cases of prolonged tumor growth and concomitant ophthalmological diseases.

*Characteristics of the group*

The study group included 47 patients (94 eyes) with PM with decreased visual acuity and/or visual field defects. Tuberculum sellae and diaphragm sellae meningiomas were diagnosed in 33 (70.2%) patients, tuberculum sellae meningiomas with ingrowth into the optic nerve canal - in 9 (19.1%), meningiomas of the lesser wing of the sphenoid bone and the anterior oblique process - in 3 (6, 4%), meningiomas of the medial parts of the greater wing of the sphenoid bone and the lateral cavernous sinus wall - in 2 (4.3%). Depending on the extension into the optic nerve canal, two subgroups were distinguished: without invasion into the canal (1st, n=34) and with invasion into the canal (2nd, n=13).

*Study design*

The "Clinical protocol for the provision of medical care to patients with extracerebral basal supratentorial tumors of the cerebral membranes (meningiomas)" was used for the examination of patients (order of the

Ministry of Health of Ukraine №317 dated 13.06.2008 "On the approval of clinical protocols for the provision of medical care in the specialty "neurosurgery"). All patients underwent a complex of neuroimaging examinations: magnetic resonance imaging (MRI), computed tomography (CT) in native modes and with contrast enhancement. Based on the MRI and CT brain data, the size of the tumor, its localization, spread into the optic nerve canal, and the relationship with the surrounding neurovascular structures were evaluated. MRI was performed on an "Intera 1.5 T" tomograph (Philips, the Netherlands) with a magnetic field induction of 1.5 Tesla, and standard brain examination protocols included slices in T1WI and T2WI modes.

Neuro-ophthalmological examination included visometry, biomicroscopy, perimetry (kinetic and static), ophthalmoscopy (direct and reverse). Automatic static perimetry was performed on a "Centerfield 2" visual field analyzer (Germany).

The results of visual functions assessment were analyzed in accordance with the recommendations of the German Society of Ophthalmology [7] using tables (Fig. 1), which take into account visometry and perimetry of both eyes in any combinations. The visual acuity index and visual field defect of both eyes are combined and assigned a certain visual impairment score (VIS). This indicator allows you to compare the patient's indicators in the dynamics of observation, especially in the case of improvement of visual acuity, but deterioration of the field of vision as a result of treatment. The VIS range is from 0 to 100. To compare the perimetry data as a result of treatment, average total photosensitivity loss (MD) score obtained during automatic static perimetry using the "Threshold test neuro - 30-2" program was used.

The first ophthalmological examination was conducted on the 1st - 2nd day after hospitalization,

Visual acuity													Visual field defect													
L \ R	Visual acuity												L \ R	Visual field defect												
	1,0	0,8	0,63	0,5	0,4	0,32	0,25	0,2	0,16	0,1	0,08	0,05		0,02	0	0	2	4	5	5	5	5	5	5	5	5
1,0	0	2	4	6	8	10	12	15	17	20	22	25	27	30	0	2	4	5	5	5	5	5	5	5	0	
0,8	2	4	8	10	12	15	17	20	22	25	27	30	32	35	2	6	8	8	10	14	18	19	20	25	2	
0,63	4	8	15	17	20	22	25	27	30	32	35	37	40	42	4	8	10	12	14	16	20	21	22	27	4	
0,5	6	10	17	20	22	25	27	30	32	35	40	42	45	47	5	8	12	14	16	18	22	22	23	28	6	
0,4	8	12	20	22	25	30	32	35	37	40	42	47	50	52	5	10	14	16	18	20	22	23	24	29	8	
0,32	10	15	22	25	30	35	40	45	47	50	55	57	60	62	5	14	16	18	20	22	24	25	26	31	10	
0,25	12	17	25	27	32	40	50	52	55	57	60	65	67	70	5	18	20	22	22	24	26	28	35	40	15	
0,2	15	20	27	30	35	45	52	55	57	60	65	70	75	80	5	19	21	22	23	25	28	30	40	45	20	
0,16	17	22	30	32	37	47	55	57	60	65	70	75	80	85	5	20	22	23	24	26	35	40	45	48	25	
0,1	20	25	32	35	40	50	57	60	65	70	75	80	85	90	5	25	27	28	29	31	40	45	48	50	25	
0,08	22	27	35	40	42	55	60	65	70	75	80	85	90	92	95	0	2	4	6	8	10	15	20	25	25	0
0,05	25	30	37	42	47	57	65	70	75	80	85	90	98	100	100											
0,02	28	32	40	45	50	60	67	75	80	87	92	100	100	100												
0	30	35	42	47	52	62	70	80	85	90	95	100	100	100												

**Fig. 1.** Tables showing visual acuity and visual field defects according to the German Society of Ophthalmology guidelines for calculating the degree of visual impairment. An example is given: in a patient with a visual acuity of 0.4 in the left eye and 0.2 in the right eye, the total impairment of visual acuity is 35 points, in the case of a combination with bitemporal visual field defects of both eyes (22 points total), the visual impairment is 57 points

the second examination - on the 5th - 7th day after the operation (early postoperative period).

All patients underwent modern microsurgical interventions, their main purpose was to eliminate the mass effect of the tumor, and in 31% of cases - to perform bone decompression of the optic nerve canal.

#### *Statistical analysis*

The findings were put into an Excel database and analyzed using Statistica 6.0 software. The results of the study are presented as arithmetic mean and standard deviation ( $M \pm SD$ ). Student's t-test for unrelated populations was used to determine the statistical significance of the differences ( $p$ ) of the indicators of independent groups.

The Shapiro-Wilk test was used for the conformity verification of the distribution of quantitative characteristics with the normal law. In case of normal distribution, parametric characteristics (arithmetic mean, standard error of arithmetic mean value) and comparison methods (Student's test for independent and dependent samples) were used. In case of abnormal distribution, the Mann-Whitney U test was used.

The difference was considered statistically significant at  $p < 0.05$ .

### **Results and their discussion**

Complaints of decreased visual acuity prevailed, which progressed from 3 months to 4 years (average duration of visual disturbances -  $10.9 \pm 1.8$  months). The ratio of women to men was 5.7:1.0.

Visual disturbances (decreased visual acuity and/or visual field defects) were the main manifestation of the disease and were observed in all patients: in the 1st subgroup binocularly - in 34 (72.3%) patients (68 eyes), in the 2nd subgroup monocularly - in 13 (27.7%) (13 eyes). In all eyes of patients with reduced visual acuity, central visual field defects were detected. In 18 (38.3%) patients of the 1st subgroup with a visual acuity of 1.0, visual field defects localized paracentrally or peripherally were detected: unilateral - in 16 patients (16 eyes), bilateral - in 2 (4 eyes).

All patients of the 1st subgroup (34 (72.3%)) had binocular visual field defects, which were manifested by bitemporal hemianopsia in 32 (68.1%) and atypical visual field changes in 2 (4.2%). The following variants of bitemporal hemianopsia were registered: classical symmetric bitemporal changes in the visual field - in 13 (27.7%) patients, asymmetric bitemporal changes - in 19 (40.4%). Among 13 patients with symmetric bitemporal visual field changes, absolute bitemporal hemianopsia was found in 7 (14.9%), relative bitemporal hemianopsia in 4 (8.5%), bitemporal scotomas in 1 (2.1%), residual visual field in both eyes - in 1 (2.1%), asymmetric bitemporal changes - in 19: combination of relative upper quadrant temporal hemianopsia with absolute temporal hemianopsia - in 9 (19.2%), residual visual field with relative upper quadrant temporal hemianopsia - in 5 (10, 6%), residual visual field with absolute temporal hemianopsia - in 3 (6.4%), paracentral temporal scotoma in combination with relative temporal hemianopsia - in 1 (2.1%), paracentral temporal scotoma in combination with residual visual field - in 1 (2.1%). Atypical visual field changes were noted in 2 patients: one (2.1%) had inferior hemianopsia combined with a residual visual field,

another one (2.1%) had nasal hemianopsia combined with a residual visual field. The average visual acuity in the 1st subgroup was  $0.54 \pm 0.05$ , the average total loss of photosensitivity was  $(11.68 \pm 0.87)$  dB.

All patients of the 2nd subgroup ( $n=13$ , 13 eyes) with monocular visual impairment on the contralateral eye had visual acuity of 1.0 and no visual field defects. All patients of this subgroup had unilateral visual field defects: absence of defects in one eye was combined with a residual visual field in 6 (12.8%) patients, with temporal hemianopsia (complete, partial) in 2 (4.3%), with paracentral temporal scotoma - in 2 (4.3%), with nasal hemianopsia - in 2 (4.3%), with amaurosis - in 1 (2.1%).

Blindness was observed in 4 (8.5%) patients (4 eyes), was unilateral in nature (2 patients in each subgroup). Optic nerve atrophy was detected in 38 (80.9%) patients: unilateral - in 21 (21 eyes), bilateral - in 17 (34 eyes).

In the postoperative period, the first examination was performed on the 5th-7th day after decompression of the OCC and optic nerve. The dynamics of visual acuity and visual field were assessed using VIS. Improvement of visual functions was observed in 33 (70.2%) patients, recovery to normal - in 3 (6.4%) of them. Deterioration was observed in 7 (14.9%) patients, absence of changes in 7 (14.9%). Unilateral amaurosis was observed in 4 patients: in 3 of them, blindness occurred due to surgery (patients with significant impairment of visual functions), in 1 patient the indicators did not change as a result of surgery. Improvement of visual functions was recorded in 3 patients with amaurosis before surgery. A statistically significant difference was found in the average indicators of visual acuity: before treatment -  $0.55 \pm 0.04$ , after treatment -  $0.67 \pm 0.04$  ( $p < 0.05$ ) and the average total sensitivity loss: before treatment -  $(11, 37 \pm 0.78)$  dB, after treatment -  $(9.14 \pm 0.79)$  dB ( $p < 0.05$ ). Average indicators before treatment: visual acuity in the 1st subgroup -  $0.54 \pm 0.05$ , in the 2nd subgroup -  $0.56 \pm 0.06$ , total sensitivity loss - respectively  $(11.68 \pm 0.87)$  and  $(10.45 \pm 0.93)$  dB ( $p > 0.05$ ). After treatment, the best result was obtained in the 1st subgroup: the average visual acuity after treatment was  $0.7 \pm 0.06$  ( $p < 0.05$ ), the average total loss of sensitivity was  $(8.11 \pm 1.2)$  dB ( $p < 0.05$ ). In the 2nd subgroup, improvement was obtained after treatment, but it was statistically insignificant ( $p > 0.05$ ).

Parasellar meningiomas are characterized by long-term (several years) gradual development of visual disturbances, which play a leading role in the clinical picture of the disease [8]. According to the literature, most patients have asymmetric bitemporal visual field changes, which is associated with compression of the anterior parts of the chiasm and the spread of the neoplasm into the optic canal [9,10].

Binocular visual disturbances in our series were found in 34 (72.3%) patients, monocular - in 13 (27.7%), which is consistent with the data obtained by Arun Palani et al. (2012) - 61 and 39% of vision disturbances, respectively [8].

Optic nerve atrophy is observed in 75-92% of patients with PM [7,9 11]. This is consistent with the data obtained in our study (80.9%).

The primary goal of surgery is the total removal of the tumor with improvement or preservation of visual

function compared to the initial indicators [10]. In our study, as a result of surgical treatment aimed at removing the neoplasm and decompressing the visual pathway, improvement of visual functions was observed in 70.2% of patients, deterioration - in 14.9%, no changes - in 14.9%, which does not differ significantly from the data of other authors (improvement in 50 and 66% of patients, no change in 17 and 28%, deterioration in 10 and 25% [12,13]), but A. Palani et al. (2012) noted improvement in 27% of patients, deterioration in 7.3%, which does not correspond to the data obtained in our study [8].

### Conclusions

Parasellar meningiomas constitute a significant proportion of extracerebral tumors. The PM ingrowth into the optic nerve canal is an unfavorable factor regarding the prospect of visual acuity and visual field recovery. As a result of using modern methods of surgical treatment, there is a statistically significant improvement in visual acuity and visual field.

### Information disclosure

#### *Conflict of interest*

The authors declare no conflict of interest.

#### *Ethical approval*

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

#### *Informed consent*

Informed and voluntary written consent to participate in the study was obtained from all patients.

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