PROGNOSTIC FACTORS FOR POSTOPERATIVE VISUAL OUTCOME IN SURGICALLY TREATED SUPRASELLAR MENINGIOMAS

UTICAJ PROGNOSTIČKIH FAKTORA NA VIDNU OŠTRINU NAKON HIRURŠKOG LEČENJA MENINGEOMA OPTOHIJAZMALNE REGIJE

Desanka GRKOVIĆ1,2 and Sofija DAVIDOVIĆ1,2

Summary

Introduction. The prognosis of postoperative visual acuity in patients with surgically treated suprasellar meningiomas is influenced not only by the size and precise localization of meningiomas in the optochiasmatic region and their compressive effect, but also by certain parameters, such as the age of patient, duration of symptoms, and preoperative visual acuity. The purpose of this study was to analyze the influence of these factors on postoperative visual acuity in the patients with surgically treated optochiasmatic meningioma as well as to determine their prognostic value in the recovery of visual function after surgery. Material and Methods. The study sample consisted of 43 patients operated for suprasellar meningioma. All tumors were diagnosed by computed tomography or nuclear magnetic resonance scans. Visual acuity was analyzed both before surgery and six months after surgery. The effects of age, preoperative visual loss, duration of visual symptoms and tumor size on visual outcome were analyzed. Results. Postoperative improvement of visual acuity was observed in 50% of eyes (68.4% of patients). Visual outcome was better in the younger patients. The patients with better preoperative visual acuity had better postoperative visual acuity outcome. Chances of achieving better postoperative visual function and favorable tumor resection outcome were inversely proportional to the increased length of history of disease and tumor size. Conclusion. Postoperative visual acuity prognosis in suprasellar meningioma surgery was favorably affected by the mean duration of symptoms of less than 24 months, tumor size less than 30 mm, and preoperative visual acuity loss below 0.1. Key words: Prognosis; Visual Acuity; Meningioma; Optic Chiasm; Neurosurgical Procedures; Treatment Outcome; Recovery of Function

Sažetak

Uvod. Prognoza u pogledu postoperativne vidne oštrine kod pacijenata operisanih od supraselarnih meningeoma ne zavisii samo od veličine i lokalizacije meningeoma u optohijazmalnoj regiji i njegovog kompresivnog efekta, već i od drugih parametara kao što su starost pacijenta, dužina trajanja simptoma i preoperativna vidna oštrina. Cilj rada je analiziranje uticaja pomenutih faktora na postoperativnu vidnu oštrinu kod pacijenata operisanih od meningioma optohijazmalne regije i utvrđivanje uticaja prognoških faktora na postoperativni oporavak vidne oštrine. Materijal i metode. Analizirano je 43 pacijenata sa operisanim supraselarnim meningeomom. Prisustvo tumora dijagnostikovano je kompjuterizovanim tomografiom ili simanjem magnetnom rezonancijom. Vidna oštrina ispitivana je pre operacije i šest meseci posle operacije. Analiziran je efekat starosti pacijenta, redukcije preoperativne vidne oštrine, dužine trajanja simptoma i veličine tumora na postoperativno poboljšanje vidne oštrine. Rezultati. Postoperativno poboljšanje vidne oštrine utvrđeno je kod 50% ispitivanih očiju (68,4 pacijenta). Vidna oštrina bila je bolja kod mlađih pacijenata. Pacijenti sa boljom vidnom oštrinom preoperativno imali su bolju postoperativnu vidnu oštrinu. Šanse za postizanje bolje postoperativne vidne oštrine obrnuto su proporcionalne dužini trajanja simptoma i veličini tumora. Zaključak. Prognoza postoperativnog poboljšanja vidne oštrine bolja je ako je, vreme proteklo od prvih simptoma do postavljanja dijagnoze manje od 24 meseca, veličina tumora manja od 30 mm i preoperativno redukvana vidna oštrina veća od 0,1. Ključne reči: prognoza; vidna oštrina; meningioma; optička hiżma; neurohirurške procedure; ishod lećenja; oporavak funkcije

Introduction

Suprasellar meningiomas account for 5 to 10% of all intracranial meningiomas [1, 2]. Meningiomas affecting the visual pathway originate from the basal meninges of tuberculum sellae, planum sphenoidale, chiasmatic sulcus and from diaphragma sellae. The subchiasmal growth of meningiomas may cause compression, elevation and dislocation of optic nerves and optic chiasma, which lead to visual function deterioration [3–6].

Progressive visual acuity loss and defects of certain parts of visual field are an indication for surgical treatment of meningiomas [3, 4, 7–9]. Surgical treatment of meningiomas enables decompression of optochiasmatic complex, prevents further vision function deterioration, and enables visual acuity improvement at the same time [7–12].

Ref.:
Despite constant neuromicrosurgical technique improvements, with total or subtotal tumor excision, data in the literature suggest that there is no significant postoperative visual function recovery. Therefore, many authors have analyzed different predictive factors [7, 8, 13–18], which influence postoperative visual restoration along with successful surgical technique. Some of these factors are the age of patient, time elapsed from the appearance of first symptoms until definite tumor diagnosis and surgical treatment, degree of preoperative visual pathway damage, size of the tumor itself, and its localization and adherence to other cranial structures.

The aim of the study was to analyze visual function preoperatively and after surgical treatment of meningiomas of the optic chiasmatic region, and to determine which factors, including the age of patient, duration of symptoms, degree of visual function damage, and size of the tumor, affect postoperative visual function recovery.

Material and Methods

We reviewed the medical records of patients who had been operated for meningiomas in the optic chiasmatic region at the Institute for Neurosurgery of Clinical Center Serbia, in Belgrade, Serbia, and at the Department of Neurosurgery, Clinical Center of Vojvodina, Novi Sad, Serbia, in 2002. There were 160 patients, and all of them had had brain optochiasmatic tumor detected and confirmed by magnetic resonance imaging (MRI) or computed tomography (CT) scans who were divided into additional groups of patients with suprasellar or parasellar meningiomas according to the postoperative pathohistological analysis. Transcranial surgical approach was applied in 77 (48.1%) patients and 83 (51.9%) patients were subjected to transphenoidal surgical approach. Complete tumor resection was achieved in 105 (65.6%) patients, while surgical treatment was incomplete in 55 (34.4%).

Out of 54 patients with supra- and parasellar localized meningiomas, 43 (79.6%) had positive ophthalmology anamnestic and visual field defects at ophthalmic examination. After detailed anamnesis and complete neuroophthalmic examination, those patients with different type of eye or optic nerve disease were excluded from the study. Complete neuroophthalmic examination included the visual acuity test, color vision test, visual field analysis (Goldman), pupillary reaction test, oculomotor nerve test, Hertel exophthalmometry, and ophthalmoscopy of ocular fundus. The eye examination was performed before and after surgery, on the day of hospital discharge (10 days after surgery), one month and six months after surgery.

The following prognostic and predictive factors were analyzed: the age of patient, duration of symptoms, preoperative visual function damage, and size of the tumor.

The patients were divided into two groups according to their age: those under and over the patients’ average age in the study sample.

Three groups of patients were formed based on the duration of ocular symptoms before definitive meningioma diagnosis was made: group I consisted of the patients who had preoperative symptoms lasting less than six months, in group II the symptoms lasted from six to 24 months, and in group III optochiasmatic meningioma diagnosis was made and surgery was performed more than 24 months after initial vision-related symptoms had developed. Preoperative visual acuity in the patients with surgical therapy for meningiomas in our study was also noted. Snellen charts were used to measure visual acuity (VA). According to VA level and its reduction, the patients were subdivided into four groups. Group I included the patients with normal VA (VA 1.0), the patients in group II, III and IV had mildly reduced VA (VA 0.5-0.9), moderately reduced VA (VA 0.1-0.4), and severely reduced VA (VA below 0.1), respectively.

According to the size of optochiasmatic meningioma, the patients were divided into the group below 30 mm tumor size, group from 31 to 70 mm, and group above 70 mm tumor size.

Our data were classified and statistically analyzed. A possible correlation of factors that were observed in our sample was obtained by stochastic test of correlation. $X^2$ test was used for a possible influence of these predictive factors on postoperative results.

Statistical analysis was performed by Statgraphics v. 3.0. software.

Results

Out of 54 patients with supra-or parasellar tumor location, 43 (79.6%) had changes in their ophthalmology status, 32 (74.4%) were women and 11 (25.5%) were men. The average age of patients in our sample was 53.3 years, their age ranging from 36 to 71 years. The average age of women and men was 51.8 and 57.4 years, respectively.

In clinical manifestation of suprasellar meningiomas, the most important subjective complaint of the patients was visual disturbance with a reduction in VA, starting usually in one eye, and then affecting the other eye as well. Out of 43 patients, 41 (95.3%) reported VA deterioration. Monocular VA reduction was noted in 16 patients (37.2%). Binocular VA reduction was recorded in 25 (58%) 43 patients, being asymmetrical in 18, and symmetrical in 7 patients.

Headache, as a subjective complaint, either affecting the vision or not, was recorded in 9 patients (20.9%). Neurological complaints, such as mild mental or motor dysfunction, vertigo, epileptic attack, hyposmia, were present in a much lower de-

**Abbreviations**

CT – computed tomography  
MRI – magnetic resonance imaging  
VA – visual acuity
gree (from 2.3 to 9.3% of patients) in addition to oculomotor paresis with subjective complaints of diplopia and proptosis.

Time interval from the development of initial symptoms to making diagnosis and radiological confirmation of optochiasmatic meningioma was from 2 months to 11 years (21.5 months on average). The diagnosis was made within the first 6 months in 18 out of 43 patients (it took 2 months to make it in 4 patients after the occurrence of symptoms), from 7 months to 2 years in 17 patients, and more than two years in 8 patients.

The origin and precise anatomic localization of meningioma insertion were radiographically defined by MRI or CT scans of the head, and confirmed during brain surgery. The most frequent localization of meningioma was tuberculum sellae (27.9%), followed by the inner end of small wings of sphenoid bone (23.2%) with two cases of tumor evasion to the cavernous sinus and with two cases of propagation of tumor into the orbit. Planum sphenoidal and processus clinoideus were the origin of tumor in 18.6% of patients, and meningiomas of olfactory region were found in 9.3% of the cases.

The size of tumor, defined by its biggest diameter, was measured during MRI or CT scan recording. We had the precise tumor size noted in 40 of our patients. Tumors of medium size (30 to 70 mm) were the most dominant and they were found in 23 patients (57.5%), 13 patients (32.5%) had small tumors less than 30 mm in size and tumors bigger than 70 mm were present in 4 patients (10%).

As for our hypothesis that six months postoperative VA of our patients was equal to preoperative VA, the following results were obtained according to the data analyzed with t-test. Our statistical t value was 5.78527, for p=4.35 x 10^{-7}. In this case, with p<0.01, we can discard our hypothesis as false with 99% safety interval. And we can confirm that there was a statistically significant difference between preoperative and postoperative VA in surgically treated optochiasmatic meningiomas. Our patients had significantly better VA six months after meningioma surgery in the chiasma region.

The influence of predictive factors of optochiasmatic meningioma surgery on postoperative visual acuity outcomes:

**Age of patient**

The improvement in VA six months after surgery was observed in 30% of patients under 53.3 years of age, and in 34.6% of those over 53.3 years of age (Graph 1).

X² test showed X²=0.04 for p=0.8364. Since p>0.05, we can discard the hypothesis that the changes of VA after meningioma surgery are in correlation with the age of patient. Therefore, the age of patient did not significantly influence the postoperative VA outcome in our sample.

**Size of Tumor**

An impairment of postoperative VA was found in only 8.8% of patients with tumor size less than 30 mm after six-month follow up. No change in VA was observed in 29.4% of cases, while the highest percentage of patients (61.8%) had postoperative VA improvement.

A significant (over 20%) VA improvement (more than two lines at Snellen chart) was observed in 44.1% of patients having 31-70 mm tumor size; 44.7% patients had no change in postoperative VA, and 44.7% of patients had improved VA.

There was no change in postoperative VA in the patients having a tumor exceeding 70 mm (Graph 2).

As for the patients with tumor size less than 30 mm, 55% of them had improvement of postoperative VA, 22% of them stabilized VA at least in one...
eye, and only 5% had an impairment of postoperative VA; whereas 37.5% of patients with tumors 31-70 mm had an improvement, no change was found in 36.8% of them, and 6.2% of these patients had an impairment of postoperative VA. An impairment of VA was noted in 50% of patients having tumors of 70 mm or larger, mortality being as high as 50%.

According to $X^2$ testing, $X^2$ was 11.95 for $p=0.043$.

With $p<0.05$, it was confirmed that there was a statistically significant direct influence of preoperative tumor size on postoperative VA six months after optochiasmatic meningioma surgery.

Duration of Symptoms

Visual acuity improvement was confirmed in 61.1% of the patients having had the symptoms for less than 6 months before meningioma surgery, with a significant VA improvement of more than 20% (two Snellen chart lines) in 41.7% of cases. The overall VA postoperative improvement was observed in 50% of the patients having had symptoms for 7 months to two years, with two chart lines gain in 23.3%. VA improvement was observed in 10 patients having had symptoms for more than two years before meningioma surgery, no improvement occurred in 60%, and VA impairment was recorded in 30% of cases (Graph 3).

Visual acuity was improved in 75% of patients with symptoms lasting less than 24 months, with up to 1.0 VA improvement in at least one eye in 28.6%.

With $X^2$ test, our $X^2$ was 16.74 for $p=0.0103$. Therefore, with $p<0.05$, we suggest that there is a significant direct influence of duration of symptoms before meningioma surgery on postoperative VA in our patients.

Degree of Preoperative Visual Reduction

It was found that 94.4% of eyes with normal preoperative VA remained stable and showed no impairment of VA six months after surgery. Out of 38 eyes with mild or moderate preoperative VA impairment (09 to 0.1), 81.6% showed improved or stable postoperative VA, comparing to 58.6% of patients who had a significant reduction of preoperative VA.

The overall VA postoperative improvement was observed in 38 eyes, being mild, moderate and significant preoperative VA reduction in 45.8%, 33.3% and 20.7% of these eyes, respectively (Graph 4).

By $X^2$ test, we gain $X^2=12.32$, for $p=0.0035$. Since in this analysis $p<0.05$, we concluded that preoperative VA in brain tumor surgery was a significant prognostic factor, and directly contributed to better postoperative VA in the patients with chiasmatic meningioma.

Discussion

According to data available in literature, the age of patient at the time of meningioma surgery has limited influence on postoperative visual function [7–9, 16]. Though some authors emphasize that patients younger than 40 at the time of surgery show better postoperative visual function recovery compared to patients over 60 and more years of age [2, 15, 17]. In our data sample, we did not find a statistically significant difference in postoperative visual recovery between two different age groups. Postoperative VA was improved by two or more Snellen chart lines in 33.3% of the patients under 40 years of age, whereas VA improvement was observed in 16.7% of the patients over 60 years of age.

These results may be interpreted as follows: the predominant reason for VA reduction in the patients with compressive optic neuropathies is ischemia of nerve fibers, which is more efficiently repaired after cranial surgery with a better microcirculation recovery after chiasmal or optic nerve decompression in younger individuals than in older patients with meningiomas [15].

In our results, the degree of preoperative VA reduction has a statistically significant influence on the postoperative VA recovery. The better the preoperative VA, the better postoperative VA is in ot-
pochiasmatic meningioma surgery. 94.4% of eyes with preoperative VA of 1.0 by Snellen chart had the same postoperative VA in the six month follow up. There was an improvement of VA in the postoperative period in 79.2% of 38 eyes with mildly and moderately reduced preoperative VA (0.9–0.1). In the first 6 months after surgery, a postoperative VA improvement was observed in only 20.8% of patients with severe preoperative VA damage due to tumor compression.

Our data are in accordance with data of other authors, where the importance of preoperative VA status and its possible reduction are important contributing factors for the postoperative VA recovery [7, 8, 15–11]. For instance, Zevgardis et al. [15] found the postoperative VA recovery in 77.7% of patients with the preoperative VA above 0.2 Snellen chart compared to 45.8% of eyes with an improvement in patients with the preoperative VA below 0.2.

There are suggestions that patients with less severe preoperative visual loss present the involvement of optic nerve and chiasma with tumor to a lesser degree intraoperatively [7, 15, 18]. Therefore, the postoperative chances for visual improvement after surgical decompression are bigger.

A slow, gradual progression of visual function defects, headaches, neurological deficits, or mental changes in a great number of patients contributes to the late or delayed diagnosis of tumor with a loss of valuable time. Meningiomas of optochiasmatic regions are precisely detected most frequently at the time when VA in one eye is already significantly damaged, and the tumor has a reached bigger size [6, 14, 15, 18, 19].

Due to its slow growth and gradual progression of invasion in other nearby tissues, especially if meningiomas are situated in mute, non functional neurolological zones, meningiomas of optochiasmatic regions are usually without any clinical symptoms and manifestations for a long period. There is usually a transitory, mild, monocular visual function reduction, with gradual peripheral visual field narrowing. These symptoms are often misdiagnosed and over seen both by the patient and ophthalmologist.

A proper diagnosis of intracranial tumor of optochiasmatic region is most often not made until the other eye is affected, and/or VA in the primary eye is significantly reduced [6, 14, 20].

On the other hand, such signs and symptoms, which are in a way nonspecific vision-related, may be underestimated both by the patient and ophthalmologist, or they may be misdiagnosed as retrobulbar neuritis or ischaemic optic neuropathy. Systemic corticosteroid therapy may improve VA and vision related complaints, which masks proper diagnosis of meningioma. Therefore, every case with a mild and transient VA improvement, or with a lack of response to systemic corticosteroid therapy, must be regarded as a warning sign of compressive lesion of optic nerve or chiasmal region, and it should warrant a proper and prompt neuroimaging diagnostics (MRI or CT head scan).

Nowadays, in the era of advanced MRI or CT diagnostics, most authors emphasize a non-justified prolonged time interval between first meningioma symptoms until tumor diagnosis [8, 15, 21–23]. Most of the papers published in last several years suggest that average time interval and duration of tumor symptoms is longer than 24 months [14, 15, 21, 23, 24]. Some authors state that this time interval may be even 30 to 39 months [6, 20], while, according to some of data, the average time of diagnosis of meningioma is less than 24 months - 15 months and 13 months according to Pucner [18], Zevgardis [15], respectively.

It has been suggested by our data analysis that an average time interval between first symptoms and meningioma diagnosis is 21.5 months, ranging from 2 months to 11 years. According to our data, longer time until meningioma diagnosis is established is an unfavorable prognostic factor for better postoperative visual function recovery. In our group of patients, those patients who had had symptoms for less than 24 months, a postoperative VA improvement was noted in 75% of the cases, with VA of 1.0 by Snellen chart in one eye at least in 28.6%. Those patients who had had symptoms for more than 24 months presented with significantly worse VA after six months after surgery.

In their earlier works Pucner et al. [18], Ohta et al. [14], as well as Lee et al. [5], have given evidence that the duration of symptoms below 2 years, especially below 6 months before diagnosis of meningioma and subsequent surgery, enables quicker and more successful postoperative VA recovery after surgical decompression and evacuation of suprasellar meningioma.

All possible pathogenic mechanisms for nerve fibers damage in meningioma cases, such as direct compression of nerve fibers by tumor tissue, stopping of axoplasmatic transport, ischemia of nerve fibers due to pressure on fine feeding microvasculature, have consequences such as demyelination, degradation and degeneration of axons. These processes are prolonged in cases with long standing and non recognized meningioma symptoms. After surgical decompression, chronically ischemic and partially demyelinated nerve fibers have a potential to recover and improve their function, but only in cases where they have retained their significant biological recovery potential [25, 26]. Atrophy of nerve fibers develops with prolonged, severe preoperative ischemia, as well as with advanced degeneration and demyelination of nerve fibers. The recovery potential is irreversibly lost and there is an impairment of neurologic function even after surgical decompression in treatment of meningioma [5]. It is estimated that the critical preoperative period for postoperative recovery of nerve fibers and visual function is 24 months.

Time elapsed from first meningioma symptoms until making the diagnosis of tumor is also connected with the tumor size, and possibility of its proper,
complete (total) or incomplete (subtotal) surgical excision and treatment, with minimal postoperative residual complications and consequences. On the other hand, prolonged compression on fine nerve fibers of optochiasmatic region with ischemia leads to an irreversible loss of their function even with proper tumor decompression surgery.

Tumors from 30 to 70 mm size were detected in 55.5% of cases. Small tumors of less than 30 mm size were found in 33.3% of cases, and big tumors, exceeding 70 mm were found in 11.1% of cases. A statistically significant correlation was found between the tumor size and postoperative visual function recovery. Visual recovery was observed in 55% of cases in group with small tumors, and 22% of those patients regained visual acuity of 1.0 by Snellen chart at least in one eye, whereas postoperative VA impairment was found only in 5% of patients. In comparison, in large tumor size group, VA deterioration six months after surgery was 50%, and there was also a high risk mortality rate of 50%.

As early as in 1962, Jane and McKissok [27] were the first to find that the size of suprasellar tumors affected the operative mortality and postoperative visual function. According to their findings, the mortality rate in patients having tumors bigger than 30mm was 42%. Out of 18 of the patients who survived meningioma surgery, 38% had postoperative improvement of VA, 33% had no change in VA, and 28% had VA impairment similar to preoperative values. In group of patients with tumor less than 30mm in size, there were no lethal cases, 53% of them had postoperative VA improvement, and VA remained stable in 47%.

Galal et al. [8] suggest that the tumor size has a very important role for operative mortality, recovery of visual function, and tumor recurrence. By analyzing medical records of 21 patients with tuberculum sellae meningioma, they found statistically significant postoperative VA improvement in cases with tumor smaller than 30mm, comparing to those having tumors of 30 mm or bigger.

In the last several years, some authors [6, 14, 17, 21, 23] have reported that the tumor size in the optochiasmatic region has the major role in postoperative VA improvement, although other authors have reported contradictory data [10, 15, 28–30].

Our study has confirmed data and conclusions found in many contemporary papers [7, 8, 13, 28, 31], stating that the degree of postoperative visual function recovery, with optimal surgical resection, has several co-dependent factors. In the first place, these are the age of patient, time elapsed from first symptoms of tumor until tumor diagnosis and surgical treatment of tumor, degree of visual impairment preoperatively, and the size of tumor itself.

**Conclusion**

Visual acuity of patients operated for meningiomas of optochiasmatic region was improved in half of the patients 6 months after surgery. Improvement by up to two lines and more than two lines at Snellen visual acuity chart was observed in 21% (16/76) of eyes and in 29% (22/76) eyes, respectively. In addition to prompt and precise surgical resection of tumors of optochiasmatic region, there are other important factors that affect postoperative visual function improvement. Good postoperative prognosis for visual acuity recovery is related with preoperative visual acuity better than 0.2 Snellen chart, duration of symptoms of less than 2 years, and the size of tumor below 30 mm. The degree of visual function recovery after surgical treatment of optochiasmatic meningioma is inversely proportional to the duration of symptoms and the size of tumor itself.

**References**


15. Zeygaridis D, Medele RJ, Muller RJ, Muller A. Meningioma of the sellar region presenting with visual impairment:


