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Ophthalmic symptoms before and after surgery for tuberculum sellae meningioma

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Purpose: *To review the features of ophthalmic symptoms before and after surgery for tuberculum sellae meningioma (TSM).*

Material and Methods: *We reviewed the results of diagnostic assessment and outcomes of 91 patients ((182 eyes; 70 (76.9%) women and 21 (23.1%) men; mean age, 48.4% ± 1.7 years) treated for TSM with or without diaphragm sellae involvement at the Romodanov institute during 2014 through 2023.*

Patients underwent clinical neurological and eye examination and neuroimaging procedures.

The results were reviewed for analysis and generalization of visual functions to calculate visual abnormality scores as per the guidelines of the German Ophthalmological Society.

Results: *Asymmetric visual field defects were observed in 41 (45.1%) patients with a bilateral disease, and unilateral visual field defects, in 23 (25.3%) patients, which was caused by both tumor compression of the anterior chiasm and optic canal invasion. Of the 74 (81.3%) patients with optic atrophy, 45 had unilateral optic atrophy, and 29, bilateral optic atrophy. Postoperatively, visual function improved, worsened and did not change in 72.5%, 7.7%, and 19.8% of patients, respectively.*

Conclusion: *The approach to TSM resection should be tailored to the degree of optic canal invasion, tumor size and tumor relationship with the surrounding neural and vascular structures. On this basis, transcranial resection was performed in 68.1%, and endoscopic endonasal resection of TSM, in 31.9% of patients. The mean visual acuity improved from 0.44 ± 0.07 at preoperative to 0.69 ± 0.04 at postoperative evaluation ($p < 0.001$), and the average mean defect (MD) improved from 15.34 ± 0.78 dB at preoperative to 9.14 ± 0.64 dB at postoperative evaluation ($p < 0.001$).*

Keywords:

tuberculum sellae meningioma, optic atrophy, bitemporal heteronymous hemianopia, endoscopic transnasal surgery

Introduction

Meningioma accounts for 15-25% of all intracranial tumors [1], with an incidence of five cases per 100,000 persons per year [2]. Sellar-based meningiomas comprise 15% of all intracranial masses and include meningiomas of the tuberculum sellae (TSMs), diaphragma sellae (DSMs), anterior clinoid process, sphenoid wing and cavernous sinus [3, 4]. Sellar and suprasellar maningiomas are more commom in females with a female to male ratio of 6:1. The mean age documented in the literature is 52 years (median, 50 years; range, 30-78 years) [5].

In TSM, progressive tumor growth displaces the chiasm posteriorly and superiorly, and the optic nerve laterally, and optic nerve compression takes place with tumor growth into the optic canal [6, 7].

Visual acuity and field impairments are the most common manifestations, with more than 95% of patients complaining of reduced vision, and optic atrophy seen in 75-90% of patients [8-12].

These tumors are difficult to remove due to their location in proximity to the critical neurovascular structures such as the internal carotid artery (ICA), anterior cerebral and anterior communicating arteries, anterior visual pathway structures, infundibulum and hypophysis. In recent decades, microsurgical approaches have become prevalent to address the removal of TSM and DSM and optic nerve decompression, aiming to reduce surgical trauma from transcranial surgery. Endoscope-assisted transcranial surgery has become an advance from endoscopic keyhole surgery, aiming for more effective and less traumatic approaches particularly to the management of certain types of basal meningioma [13].

The purpose of this study was to review the features of ophthalmic symptoms before and after surgery for TSM.

Material and Methods

We retrospectively reviewed the medical records of 91 patients (182 eyes; 70 (76.9%) women and 21 (23.1%) men; mean age, 48.4 ± 1.7 years)) with TSM who underwent diagnostic assessment and treatment at the Romodanov Institute during 2014 through 2023. Inclusion criteria were TSM with or without extension to the diaphragm, compression of the chiasm and/or optic nerves and with or without optic canal invasion (unilateral invasion, 61 patients (67%); bilateral, 18 patients (19.8%); no invasion, 12 patients (13.2%)), which was confirmed by neuroimaging and intraoperative data and the presence of visual acuity and/or visual field abnormalities. Variants of optic canal involvement in TSMs are presented in Figs 1-3. Exclusion criteria were cases of further meningioma growth, extension to the cavernous sinus, planum sphenoidale meningioma, or eye disorders.

Patients underwent examinations as per the “Clinical protocol for care of patients with extracerebral basal supratentorial meningial tumors (meningiomas)” (Ministry of Health of Ukraine Order No. 317 dated June 13, 2008, “On the Approval of Clinical Protocols for Neurosurgical Care”). They underwent neuroimaging procedures, including magnetic resonance imaging (MRI), computed tomography (CT) with and without contrast enhancement, and multispiral CT angiography. Tumor size and location, the presence of perifocal edema, degree of optic canal invasion, and tumor relationship with the surrounding neural and vascular structures were assessed on the basis of these examinations. Routine T1-weighted and T2-weighted MRI was performed with a 1.5-T MRI system (Intera 1.5T/I system, Philips Medical Systems, Best, the Netherlands). Multislice CT was performed with 64-slice CT scanners of two CT systems, Brilliance-64 (Philips Medical Systems, Best, the Netherlands) and Aquilion-64 (Toshiba Medical Systems, Otawara, Japan) to acquire 1.25-mm slice thickness images at the Neuroradiology Department and Center for Radiology and Radioneurosurgery of the Romodanov Neurosurgery Institute. An ophthalmic examination included best-corrected visual acuity assessment, biomicroscopy, static automated and kinetic perimetry, and direct and indirect ophthalmoscopy. Static automated perimetry (SAP) tests were performed with the Centerfield 2 Perimeter (Oculus, Wetzlar, Germany).

The results were reviewed for analysis and generalization of visual functions as per the guidelines of the German Ophthalmological Society [14]. A modified table, taking into account visual acuity and perimetry data for both eyes in any possible combinations, was used to assess individual patient data (Fig. 4).

The scores for visual acuity and mean defects (for static automatic perimetry) in each patient were added, thus providing the visual impairment score (VIS), which enabled exact comparisons between different examinations in each patient, especially in the presence of improved visual acuity or worsened visual fields as a result of treatment. The

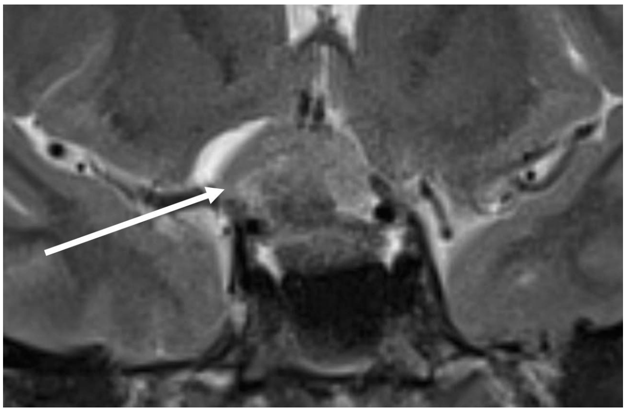

Fig. 1. Tuberculum sellae meningioma in a 44-year-old female patient. Post-contrast coronal T1WI of the brain shows asymmetric tumor growth, more prominently to the left, with unilateral optic canal invasion (arrow).

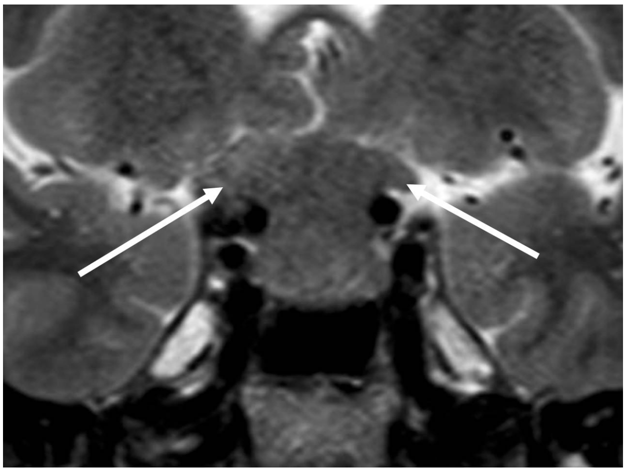

Fig. 2. Tuberculum sellae meningioma in a 31-year-old female patient. Post-contrast coronal T1WI of the brain shows bilateral optic canal invasion (arrows).

Fig. 3. Tuberculum sellae meningioma in a 59-year-old female patient. Post-contrast coronal T1WI of the brain shows symmetric tumor growth without optic canal invasion

L \ R	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.06-0.09	0.03-0.05	0.01-0.02	0
1.0	0	2	4	6	8	10	12	15	17	20	22	25	27	30
0.9	2	4	8	10	12	15	17	20	22	25	27	30	32	35
0.8	4	8	15	17	20	22	25	27	30	32	35	37	40	42
0.7	6	10	17	20	22	25	27	30	32	35	40	42	45	47
0.6	8	12	20	22	25	30	32	35	37	40	42	47	50	52
0.5	10	15	22	25	30	35	40	45	47	50	55	57	60	62
0.4	12	17	25	27	32	40	50	52	55	57	60	65	67	70
0.3	15	20	27	30	35	45	52	55	57	60	65	70	75	80
0.2	17	22	30	32	37	47	55	57	60	65	70	75	80	85
0.1	20	25	32	35	40	50	57	60	65	75	80	85	87	90
0.06-0.09	22	27	35	40	42	55	60	65	70	80	85	90	92	95
0.03-0.05	25	30	37	42	47	57	65	70	75	85	90	98	100	100
0.01-0.02	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

A

L \ R	До 2	2-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-24	Більше 24
До 2	0	2	4	5	5	5	5	5	5	5	0
2-6	2	6	8	8	10	14	18	19	20	25	2
6-8	4	8	10	12	14	16	20	21	22	27	4
8-10	5	8	12	14	16	18	22	22	23	28	6
10-12	5	10	14	16	18	20	22	23	24	29	8
12-14	5	14	16	18	20	22	24	25	26	31	10
14-16	5	18	20	22	22	24	26	28	35	40	15
16-18	5	19	21	22	23	25	28	30	40	45	20
18-20	5	20	22	23	24	26	35	40	45	48	25
20-24	5	25	27	28	29	31	40	45	48	50	25
Більше 24	0	2	4	6	8	10	15	20	25	25	0

Б

Fig. 4. Tables of visual acuity and visual field defect used for calculation of the visual impairment score (VIS) and modified from the tables defined by the German Ophthalmological Society. The marked values illustrate calculations made for a patient with a visual acuity of 0.9 in the left eye and 0.8 in the right eye, along with a visual field defect (MD OD = 8.45 dB, MD OS = 1.49 dB). When added, the values 8 and 5 total 13, representing the VIS.

VIS ranges from 0 to 100. Mean defect (MD) was obtained using the neurological 30-2 threshold test program on the Octopus perimeter. It represents the average overall deviation of visual field sensitivity from normal for the central 30º radius of the visual field and was used for the comparison of baseline and post-treatment visual field data.

Baseline examination was performed at admission, and post-treatment examination was performed 3 to 5 days after surgery.

Transcranial resection was performed in 62 patients (68.1%), and endoscopic endonasal resection of TSM, in 29 patients (31.9%). Preoperative MR images with intravenous gadolinium enhancement enabled to assess (a) the size of the tumor, (b) whether the tumor was symmetric with respect to the medial brain structures, (c) the degree of invasion of the optic canal, and (d) the involvement of the neural and vascular structures, and were used to select transcranial or endoscopic endonasal approaches. Although TSMs vary in size, the major factor provoking visual impairments is optic canal invasion by the tumor or optic nerve compression, which is possible if the tumor is small.

The transcranial approach to resection of meningiomas was used in 62 patients (68.1%). These patients had a history of visual acuity and/or visual field abnormalities of at least 6 months, with a significantly reduced visual acuity in at least one eye. Because the optic nerve appeared to be embraced by the tumor, we selected a transcranial pterional or fronto-temporo-orbitozygomatic approach for performing extradural or intradural optic canal decompression by removing the orbital roof and anterior clinoid process partially or entirely [15].

Endoscopic endonasal resection was performed in 29 patients (31.9%). These patients had a history of visual acuity and/or visual field abnormalities of at least 6 months', and baseline visual acuity and/or visual field abnormalities were less apparent than in patients in whom the transcranial approach was applied. A minimally invasive approach was selected in these patients since there was no tumor lateralization, optical canal invasion was either minimal or absent, there was apparent hyperostosis, and their tumors were small [16]. Because the approach to resection was selected primarily on the basis of the severity of baseline lesions, there was a substantial difference in baseline visual functions between patients operated on with the transcranial approach and those operated on with the endoscopic endonasal approach, which makes impossible a comparison of the approaches in terms of visual function outcomes.

The obtained data were entered into Excel spreadsheets and statistical analyses were conducted using Statistica 6.0 (StatSoft, Tulda, OK) software. Data are presented as mean and standard deviations (SD). Student's unpaired t test was used to determine differences between independent groups. The level of significance $p < 0.05$ was assumed. Group comparisons of the categorical variables were performed using Pearson χ^2 test (or Fisher exact test in case of low expected frequencies).

Results

A progressive gradual reduction in visual acuity for 3 months to 5 years (mean duration, 14.6 ± 2.8 months) was the most common complaint reported by patients (85 patients or 93.4%). Ten patients (10.9%) complained of headache which was non-specific, could occur any time of the day, was mostly dull, constant and diffuse, with no relief from analgesics. The female-to-male ratio was 3.3:1.

Visual acuity and/or visual field abnormalities were the major manifestation of TSM and observed in all patients; abnormalities were either bilateral (68 (74.7%) patients, 136 eyes) or unilateral (23 (25.3%) patients, 23 eyes). In 23 patients with unilateral visual acuity and/or visual field abnormalities, the fellow eye showed a visual acuity of 1.0 and no visual field defect. Figure 5 shows a pie diagram of the distribution of baseline visual acuity categories.

Visual field defects were found in 91 patients (158 eyes); 68 (74.7%) patients had bilateral visual field defects and 23 (25.3%) patients had unilateral visual field defects. Bilateral visual field defects were observed in 68 (74.7%) patients and included bitemporal hemianopia in 64 (70.3%) patients (symmetric bitemporal heteronymous hemianopia in 23 (25.3%) patients and asymmetric bitemporal heteronymous hemianopia in 41 (45.1%) patients) and atypical changes in 4 (4.4%) patients (Table. 1).

Of the 23 patients with symmetric visual field defects, 14 (15.4%) had absolute bitemporal hemianopia, 7 (7.7%), relative bitemporal hemianopia, 1 (1.1%), bitemporal scotoma, and 1 (1.1%), a bilateral residual visual field (Table. 2).

Of the 41 patients with asymmetric bitemporal visual field defects, 19 (20.9%) had superior quadrant temporal hemianopia combined with absolute temporal hemianopia; 11 (12.1%), a residual visual field combined with relative superior quadrant temporal hemianopia; 6 (6.6%), a residual visual field combined with absolute temporal hemianopia; 3 (3.3%), a paracentral temporal scotoma combined with relative temporal hemianopia; and 2 (2.2%), a paracentral temporal scotoma combined with a residual visual field (Table. 3).

Of the 4 patients with atypical visual field changes, 1 (1.1%) had inferior hemianopia combined with a residual visual field, and 3 (3.3%), nasal hemianopia combined with a residual visual field.

Of the 23 (25.3%) patients with unilateral visual field defect, 13 (14.3%) had a residual visual field; 4 (4.4%), complete or partial temporal hemianopia; 3 (3.3%), paracentral temporal scotoma; 2 (2.2%), nasal hemianopia; and 1 (1.1%), a complete loss of visual field (Table. 4).

Seven (7.7%) patients were unilaterally blind. Of the 74 (81.3%) patients with optic atrophy, 45 had unilateral optic atrophy, and 29, bilateral optic atrophy.

The mean value of estimated VIS was 74 ± 2.7 (range, 4 to 100).

The first postoperative follow-up was at day 5-7 after optic nerve decompression. An improvement in visual acuity and/or visual field was found in 66 (72.5%) patients, including 7 (7.7%) patients in whom visual acuity and visual field normalized. In addition, 7 (7.7%) patients dem-

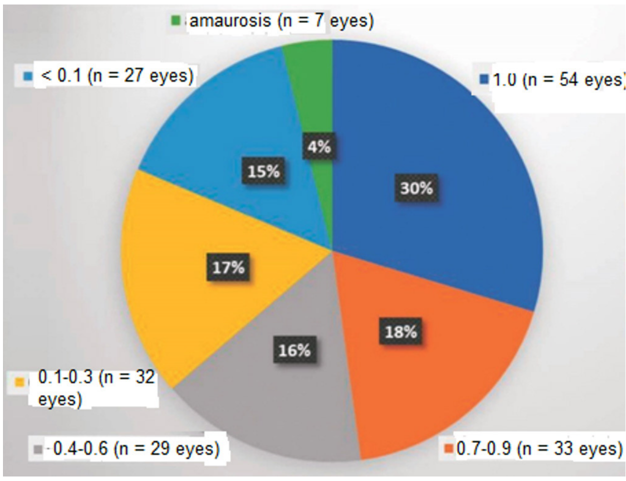

Fig. 5. Pie diagram of the distribution of baseline visual acuity categories in patients with tuberculum sellae meningioma (n = 159 eyes)

Table 1. Numbers and percentage of bipolar field defects in patients with tubercullum sellae meningioma

Visual field defects	Cases	
	Number	Percentage
Symmetric bitemporal heteronymous hemianopia	23	25.3%
Asymmetric bitemporal heteronymous hemianopia	41	45.1%
Atypical changes	4	4.4%
Total	68	74.7%

Table 2. Numbers and percentage of field defects in tubercullum sellae meningioma patients with symmetric bitemporal heteronymous *hemianopia*

Visual field defect	Cases	
	Number	Percentage
Absolute bitemporal hemianopia	14	15.4%
Relative bitemporal hemianopia	7	7.7%
Bitemporal scotoma	1	1.1%
Bilateral residual visual field	1	1.1%
Total	23	25.3%

Table 3. Numbers and percentage of field defects in tubercullum sellae meningioma patients with asymmetric bitemporal heteronymous hemianopia

Visual field defect	Cases	
	Number	Percentage
Relative superior quadrant temporal hemianopia combined with absolute temporal hemianopia	19	20.9%
Residual visual field combined with relative superior quadrant temporal hemianopia	11	12.1%
Residual visual field combined with absolute temporal hemianopia	6	6.6%
Paracentral temporal scotoma combined with relative temporal hemianopia	3	3.3%
Paracentral temporal scotoma combined with residual visual field	2	2.2%
Total	41	45.1%

Table 4. Numbers and percentage of unilateral field defects in patients with tubercullum sellae meningioma

Visual field defect	Cases	
	Number	Percentage
Residual visual field	13	14.3%
Absolute or partial temporal hemianopia	4	4.4%
Paracentral temporal scotoma	3	3.3%
Nasal hemianopia	2	2.2%
Complete visual field loss	1	1.1%
Total	23	25.3%

onstrated worsening, and 18 (19.8%) patients, no change in visual acuity and/or visual field after surgery. Postoperatively, unilateral amaurosis was seen in 7 cases. Of these, 3 had significantly impaired visual functions preoperatively and developed unilateral amaurosis as a consequence of surgery, and 4 showed no change in visual functions after surgery. A prolonged preoperative tumor compression can be attributed to causes of the postoperative worsening of visual acuity and/or visual field, because it led to complete atrophy of the affected optic nerve (which was confirmed intraoperatively), making restoration of the nerve impossible. Postoperative vasospasm of the ophthalmic artery was seen in one patient and can be attributed to the likely causes of the postoperative worsening of visual acuity and/or visual field.

Visual acuity and/or visual field improved in 3 patients with preoperative unilateral amaurosis. The mean visual acuity improved from 0.44 ± 0.07 at preoperative to 0.69 ± 0.04 at postoperative evaluation ($p < 0.001$), and the average mean defect (MD) improved from 15.34 ± 0.78 dB at preoperative to 9.14 ± 0.64 dB at postoperative evaluation ($p < 0.001$). The mean value of estimated postoperative VIS was 51 ± 2.4 (range, 0 to 77).

Discussion

TSMs and DSMs are disorders characterized by a gradual development of visual acuity and/or visual field abnormalities for as long as one year or more, with these abnormalities being predominant components in the clinical picture [15, 17]. In the current study, asymmetric visual field defects were observed in 41 (45.1%) patients with a bilateral disease, and unilateral visual field defects, in 23 (25.3%) patients, which was caused by both tumor compression of the anterior chiasm and optic canal invasion; these findings are in agreement with those reported by other researchers [18, 19].

In addition, bilateral and unilateral visual acuity and/or visual field abnormalities were observed in 68 (74.7%) patients and 23 (25.3%) patients, respectively, which is consistent with findings by Palani et al (2012) [15] (61% and 39%, respectively). Moreover, in the current study, bitemporal heteronymous hemianopia was the most common visual field abnormality, which is consistent with findings by Andrews (1988) [8] and Grisoli (1986) [11].

Other researchers [8-12, 20] found optic atrophy in 75-90% patients with TSM, which is also in agreement with our findings (81.3%). The aim of surgery for TSM is complete tumor removal with an improvement or preservation of visual function. Atraumatic visual pathway decompression is critical, with special attention given to the preservation of the blood supply of the optic nerve and chiasm via small perforators of the anterior cerebral and internal carotid arteries [21].

In the current study, the guiding factor in selecting the most approptiate approach was the presence or absence of optic canal invasion, which is consistent with the literature [8]. The arterial supply of the optic chiasm comes from a superior and an anterior group of vessels. The superior aspect of the chiasm is supplied by a superior network comprised from branches of the anterior cerebral artery and anterior communicating arteries, whereas the inferior aspect is mainly supplied by the inferior network, which is fed by branches of the ICA, basilar, posterior cerebral and posterior communicating arteries. Blood is supplied to the intracranial portion of the optic nerve and chiasm by the arteries arising from the ophthalmic, posterior communicating, and choroidal branches of the C4 segment of supraclinoid ICA. The hypophyseal and infundibular arteries play the most important roles. The superior hypophyseal arteries (SHA) are a group of one to five small branches that arise from the C4's ophthalmic segment and terminate on the pituitary stalk and gland, but also send branches to the optic nerve and chiasm. The infundibular arteries are a group of arteries that originate from the posterior communicating artery to the pituitary stalk. The SHA and infundibular arteries intermingle and form an anastomotic plexus called the circuminfundibular anastosmosis, and it is the small ascending arteries arising from the plexus that supply the inferior surface of the optic chiasm. These perforating arteries are the only source of blood supply of the inferior crossed fibers of the chiasm [22]. Small perforators are sensitive to surgical trauma as well as postoperative vasospasm [21].

In the current study, the surgical treatment was aimed at removing the tumor and decompressing the optic nerves and chiasm, and postoperatively, visual function improved, worsened and did not change in 72.5%, 7.7%, and 19.8% of patients, respectively. This is in agreement with the findings of a systematic review and meta0analysis by Yang and colleafues (2019) [23], who reported the rate of visual improvement to be 85.7% (138 0f 161 patients) for the transsphenoidal approach, and 55.1% (98 of 178 patients) for the transsphenoidal approach to TSMs.

The approach to TSM resection should be tailored to the degree of optic canal invasion, tumor size and tumor relationship with the surrounding neural and vascular structures. On this basis, transcranial resection was performed in 68.1%, and endoscopic endonasal resection of TSM, in 31.9% of patients. The mean visual acuity improved from 0.44 ± 0.07 at preoperative to 0.69 ± 0.04 at postoperative evaluation ($p < 0.001$), and the average mean defect (MD) improved from 15.34 ± 0.78 dB at preoperative to 9.14 ± 0.64 dB at postoperative evaluation ($p < 0.001$).

References

1. **Amirjamshidi A, Mortazavi SA, Shirani M, Saeedinia S, Hanif H**. Coexisting pituitary adenoma and suprasellar meningioma–a coincidence or causation effect: report of two cases and review of the literature. J Surg Case Rep. 2017 May 22;2017(5):rjx039. DOI: 10.1093/jscr/rjx039
2. **Terrier LM, François P.** Meningiomas multiples [Multiple meningiomas]. Neurochirurgie. 2016;62(3):128-135. doi:10.1016/j.neuchi.2015.12.006
3. **Asa SL, Mete O, Cusimano MD, et al.** Pituitary neuroendocrine tumors: a model for neuroendocrine tumor classification. Mod Pathol. 2021;34(9):1634-1650. doi:10.1038/s41379-021-00820-y
4. **Rohringer M, Sutherland GR, Louw DF, Sima AAF.** Incidence and clinicopathological features of meningioma. J Neurosurg. 1989;71:665–672. DOI: 10.3171/jns.1989.71.5.0665
5. **Kwancharoen R, Blitz AM, Tavares F, Caturegli P, Gallia GL, Salvatori R.** Clinical features of sellar and suprasellar meningiomas. Pituitary. 2014 Aug;17(4):342-8. doi: 10.1007/s11102-013-0507-z. PMID: 23975080.
6. **Magill ST, McDermott MW.** Tuberculum sellae meningiomas. Handb Clin Neurol. 2020;170:13-23. doi:10.1016/B978-0-12-822198-3.00024-0
7. **Mariniello G, Bonavolontà G, Tranfa F, Maiuri F.** Management of the optic canal invasion and visual outcome in spheno-orbital meningiomas. Clin Neurol Neurosurg. 2013 Sep;115(9):1615-20. DOI: 10.1016/j.clineuro.2013.02.012. Epub 2013 Mar 7.
8. **Andrews BT, Wilson CB.** Suprasellar meningiomas: the effect of tumor location on postoperative visual outcome. J Neurosurg. 1988 Oct;69(4):523-8. DOI: 10.3171/jns.1988.69.4.0523
9. **Goel A, Muzumdar D, Desai KI.** Tuberculum sellae meningioma: a report on management on the basis of a surgical experience with 70 patients. Neurosurgery. 2002 Dec;51(6):1358-63; discussion 1363-4. PMID: 12445340.
10. **Sklar EM, Schatz NJ, Glaser JS, Sternau L, Seffo F.** Optic tract edema in a meningioma of the tuberculum sellae. AJNR Am J Neuroradiol. 2000 Oct;21(9):1661-3. PMID: 11039346; PMCID: PMC8174852.
11. **Grisoli F, Diaz-Vasquez P, Riss M, Vincentelli F, Leclercq TA, Hassoun J, Salamon G.** Microsurgical management of tuberculum sellae meningiomas. Results in 28 consecutive cases. Surg Neurol. 1986 Jul;26(1):37-44. DOI: 10.1016/0090-3019(86)90061-3.
12. **Harati O, Boutarbouch M.** Outcome and prognostic factors of morbidity and mortality in suprasellar meningioma. Neuro Neurosurg. 2022; 6: 2-8 DOI: 10.15761/NNS.1000143
13. **Giammattei L, Starnoni D, Cossu G, Bruneau M, Cavallo LM, Cappabianca P, et al.** Surgical management of Tuberculum sellae Meningiomas: Myths, facts, and controversies. Acta neurochirurgica. 2020. 162(3); 631–640. DOI: org/10.1007/s00701-019-04114-w
14. **Fahlbusch R, Schott W.** Pterional surgery of meningiomas of the tuberculum sellae and planum sphenoidale: surgical results with special consideration of ophthalmological and endocrinological outcomes. J Neurosurg. 2002 Feb;96(2):235-43. doi: 10.3171/jns.2002.96.2.0235. PMID: 11838796.
15. **Palani A, Panigrahi MK, Purohit AK**. Tuberculum sellae meningiomas: A series of 41 cases; surgical and ophthalmological outcomes with proposal of a new prognostic scoring system. J Neurosci Rural Pract. 2012 Sep;3(3):286-93. DOI: 10.4103/0976-3147.102608.
16. **Zhang Y, Kim J, Andrews C, Archer E, Bursztyn L, Grabe H, et al.**Visual Outcomes in Surgically Treated Intracranial Meningiomas. J Neuroophthalmol. 2021 Dec 1;41(4):e548-e559. DOI: 10.1097/WNO.0000000000001205.
17. **Giammattei L, Messerer M, Belouaer A, Daniel RT.** Surgical outcome of tuberculum sellae and planum sphenoidale

meningiomas based on Sekhar-Mortazavi Tumor Classification. J Neurosurg Sci. 2021 Apr;65(2):190-199. DOI: 10.23736/S0390-5616.18.04167-X.
18. **Bove I, Solari D, Colangelo M, Fabozzi GL, Esposito F, Tranfa F, et al.** Analysis of visual impairment score in a series of 48 tuberculum sellae meningiomas operated on via the endoscopic endonasal approach. J Neurosurg. 2023 Sep 29:1-9. DOI: 10.3171/2023.7.JNS23437
19. **Chang EC, Huang JS, Hou YC, Huang CH, Wang IH.** Optical coherence tomography as a useful adjunct in the early detection of meningioma with optic nerve compression. Taiwan J Ophthalmol. 2022 Mar 10;12(3):354-359. DOI: 10.4103/tjo.tjo_54_21
20. **Caklili M, Emengen A, Yilmaz E, Genc H, Cabuk B, Anik I, Ceylan S.** Endoscopic Endonasal Approach Limitations and Evolutions for Tuberculum Sellae Meningiomas: Data from Single-Center Experience of Sixty Patients. Turk Neurosurg. 2023;33(2):272-282. DOI: 10.5137/1019-5149.JTN.38489-22.2.
21. **Taha ANM, Erkmen K, Dunn IF, Pravdenkova S, Al-Mefty O.** Meningiomas involving the optic canal: pattern of involvement and implications for surgical technique. Neurosurg Focus. 2011;30(5):E12.DOI: 10.3171/2011.2.FOCUS1118
22. **Gibo H, Lenkey C, Rhoton AL**. Microsurgical anatomy of the supraclinoid portion of the internal carotid artery. J Neurosurg. 1981 Oct;55(4):560-74. DOI:10.3171/jns.1981.55.4.0560
23. **Yang C, Fan Y, Shen Z, Wang R, Bao X.** Transsphenoidal versus Transcranial Approach for Treatment of Tuberculum Sellae Meningiomas: A Systematic Review and Meta-analysis of Comparative Studies. Sci Rep. 2019 Mar 19;9(1):4882. doi: 10.1038/s41598-019-41292-0. PMID: 30890739; PMCID: PMC6424979.

Disclosures

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Abbreviations: *MD – mean defect; MRI – magnetic resonance imaging; OA – optic atrophy; TSM – tuberculum sellae meningioma; VIS – visual impairment score*