Burdenko's Journal of Neurosurgery
2024, №5, pp. 69–76
https://doi.org/10.17116/neiro20248805169

Short-lasting tentorial herniation may cause cortical blindness. A case report and systematic literature review

© SH.SH. DAVLYATOVA, A.B. KADASHEVA, T.A. ABRAMOV, O.YU. TITOV, N.N. ISAKOV, A.V. KOZLOV

Burdenko Neurosurgical Center, Moscow, Russia

ABSTRACT

Introduction. Cortical blindness occurs with bilateral damage to the visual cortex. It can be caused by various reasons, including the posterior cerebral arteries stroke due to the tentorial herniation.

Material and methods. A case of a 40-year-old patient with a large right-sided sphenoidal meningioma. A systematic review on the problem of cortical blindness after tentorial herniation according to the PRISMA guideline.

Results. Subtotal removal of dense meningioma. At night after the operation, there was an acute headache, then a coma. Immediately dehydration therapy, tracheal intubation, mechanical ventilation. CT scan showed a small hemorrhage in the tumor bed and subarachnoid space, brain edema and dislocation. After 53 minutes, ventricular drainage was installed, intracranial pressure was normal and ranged from 6 to 14 mmHg. After sedation withdrawal, cortical blindness was detected, which did not regress for 1.5 years. There are no other neurological symptoms, the patient walks, serves herself. Radiation therapy in a total of 54 Gy for the remainder of the grade 1 meningioma ensured tumor control.

Discussion. The time window for restoration of the cerebral blood flow, according to the European Stroke Organization guidelines, is 4.5 hours. In this case, compression of the posterior cerebral arteries lasted less than 53 minutes, however, irreversible ischemia developed in their territory; the outcome on the modified Rankine scale was 4 points. Similar cases are not described in the literature.

Conclusion. Patients should be warned about even the non-obvious risks of neurosurgical intervention, since even timely measures taken do not always avoid complications.

Keywords: *transtentorial herniation, cortical blindness, sphenoid wing meningioma.*

INFORMATION ABOUT THE AUTHORS:
Davlyatova Sh.Sh. — https://orcid.org/0009-0007-3007-1212
Kadasheva A.B. — https://orcid.org/0000-0003-1416-6936
Abramov T.A. — https://orchid.org/0000-0002-9542-3801
Titov O.Yu. — https://orcid.org/0000-0001-6570-7777
Isakov N.N. — https://orcid.org/0000-0002-1321-8864
Kozlov A.V. — https://orcid.org/0000-0002-3181-6470
Corresponding author: Davlyatova Sh.Sh. — e-mail: DavlyatovaSh@nsi.ru

TO CITE THIS ARTICLE:
Davlyatova ShSh, Kadasheva AB, Abramov TA, Titov OYu, Isakov NN, Kozlov AV. Short-lasting tentorial herniation may cause cortical blindness. A case report and systematic literature review. *Burdenko's Journal of Neurosurgery* 2024;88(5):69–76. (In Russ.). https://doi.org/10.17116/neiro20248805169

Introduction

In 1933, Marquis introduced the term "cortical blindness" as loss of vision with preserved pupillary light reflex. Cortical blindness follows bilateral damage to calcarine cortex. The most common causes are cerebrovascular and neurodegenerative diseases, trauma, infections and toxic effects [1]. In neurosurgery, the main causes of cortical blindness are severe contusion of occipital lobes, tumors and transtentorial herniation leading to compression of both posterior cerebral arteries in tentorium notch of cerebellum and subsequent ischemia of the visual cortex. It is believed that ischemic brain damage is completely or partially reversible after restoration of blood circulation within 4.5 hours [2].

The purpose of the study was to describe transtentorial herniation after resection of sphenoid wing meningioma with subsequent irreversible cortical blindness despite correction of herniation within 53 min.

Material and methods

A systematic review was performed according to the PRISMA protocol [3]. In accordance with the AMSTAR-2 recommendations [4] and the methodology proposed by Bramer W.M. et al. [5], the first and fourth authors reviewed Russian- and English-language literature using the keywords "blindness AND tentorial hernia-

tion" in the PubMed (all sources) and Google Scholar (first 200 studies) databases until 03/01/2024.

After excluding duplicate articles using Mendeley software, both authors checked the titles and abstracts for compliance with requirements. Full-text articles were then analyzed to exclude inappropriate manuscripts. Decisions were based on inclusion and exclusion criteria (PICOS) **(Table 1)**.

After selecting the studies, the first and third authors extracted appropriate data. The last author reviewed and resolved discrepancies.

Results

Case report

A 40-year-old patient admitted on September 5, 2022. She complained of decreased vision in the left eye. This disorder first occurred at the beginning of 2022. Headaches, memory loss and weakness occurred later. Upon admission, visual acuity on the right was 1.0, on the left — counting fingers near the face. There were signs of intracranial compression of the left optic nerve. Somatic status had no features. MRI revealed left-sided contrast-enhanced tumor of anterior clinoid process and sphenoid wings with mass effect and perifocal edema (most likely meningioma Al-Mefty group I **(Fig. 1)** [6].

Large symptomatic intracranial meningioma with perifocal edema justified the need for surgical treatment in accordance with the EANO 2021 guidelines [7].

Microsurgical resection of left-sided meningioma of medial sphenoid wings was performed on September 6, 2022. Pterional osteoplastic left-sided craniotomy was accompanied by additional resection of the outer sections of the greater wing and sphenoid crest. Access to medial parts of sphenoid wings was provided through lifting the basal parts of the left frontal lobe. Finally, we found gray-pink tumor with finely tuberous surface and no capsule. In some points, the tumor infiltrated pia mater and edematous cerebral cortex. Dense tumor necessitated resection by ultrasonic aspirator and nippers. Dense central parts were excised by dural scalpel. An attempt to mobilize the medial pole of the tumor resulted arterial bleeding and brain swelling. We failed to determine the cause of bleeding due to impossible displac-

Table 1. **PICOS* criteria for selection**

Variable	Inclusion criteria	Exclusion criteria
Population	Patients with intracranial lesions	Animals; lesion of other localizations
Intervention	Neurosurgery, radiotherapy or drug therapy for intracranial lesions	Another treatment
Comparison	No	No
Outcomes	Pre- or intraoperative transtentorial herniation; vision impairment	No herniation; no data on vision impairment; visual field loss
Design	Case reports; original articles; English-language articles; publication until 03/01/2024	Reviews; notes; dissertations; posters; monographs; literature in other language; publication after 03/01/2024

Note. * P — population, I — intervention, C — comparison, O — outcome, S — study design.

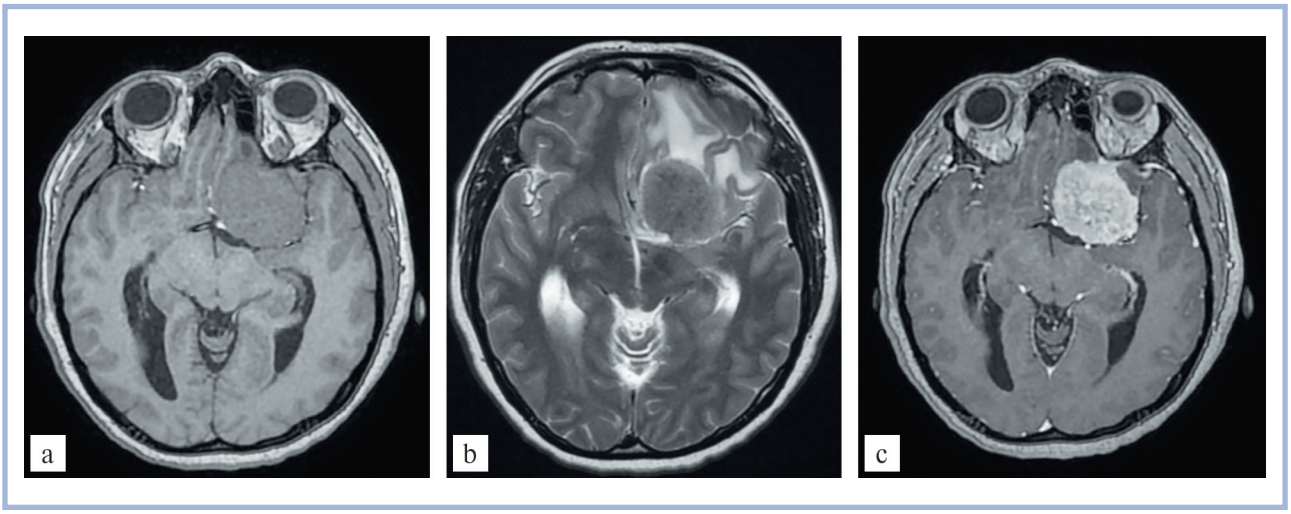


Fig. 1. **Preoperative MRI.**
Axial scans: a — T1WI; b — T2WI; c — with contrast enhancement.

ing the medial pole of dense tumor fixed to the matrix at the base of the middle cranial fossa. Oxycellulose application stopped bleeding. Cerebral edema significantly decreased, but some brain tension remained. Further resection under incomplete brain relaxation was dangerous. Tumor remnants were cauterized (extent of resection Simpson grade 4). The brain partially filled the tumor bed and pulsated. Dura mater closure was followed by wound closure in layer-by-layer fashion.

Computed tomography on the operating table revealed small blood clots in the tumor bed and interhemispheric fissure and small tumor remnant. Ambient cistern was visualized **(Fig. 2)**. Histological examination confirmed meningotheliomatous meningioma Grade I with psammoma bodies.

Postoperative period

After surgery, the patient woke up, followed the instructions, recognized the doctors and had no complaints. She was weaned from ventilator 2 hours later. The patient was followed-up in the intensive care unit due to intraoperative cerebral edema.

At night after surgery (0:45), she complained of headache despite clear consciousness and high spontaneous motor activity. After that, consciousness decreased to coma 2 within a few minutes (GCS score 5), and bilateral mydriasis without photoreaction developed. There were spontaneous movements of limbs (similar to decerebration) and no corneal reflexes. Vital parameters: arterial oxygen saturation 100%, venous hemoglobin 95 g/l, erythrocytes $3.25*10^{12}$/l, arterial pressure 138/78 mm Hg. Tracheal intubation and mechanical ventilation were followed by infusion of osmotic diuretics. CT (01:08) revealed large volume of blood in interhemispheric fissure, tumor bed and basal cisterns including ambient cistern and fourth ventricle, as well as narrowing of basal and convexital subarachnoid spaces **(Fig. 3)**.

At 1:38 (53 min after impairment of consciousness), drain and ICP sensor were installed in anterior horn of the right lateral ventricle under ongoing sedation. ICP was normal and ranged within 6—14 mm Hg over 9 days. Mechanical ventilation and drug sedation were continued. Dilatation tracheostomy was performed on the 2nd day after surgery.

Sedative therapy was discontinued after 5 days. The patient became contactable with GCS score 14 on the 6th day after surgery. She complained of loss of vision. Examination revealed medium-size pupils, intact light and corneal reflexes, no gaze fixation. In addition, inhibition of some brainstem reflexes was observed (accu-

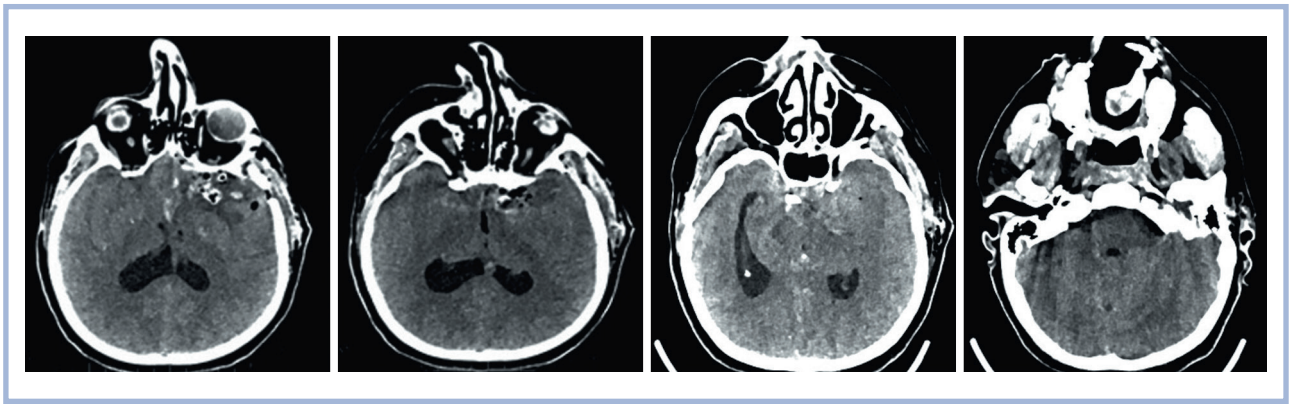


Fig. 2. **Intraoperative CT scans.**

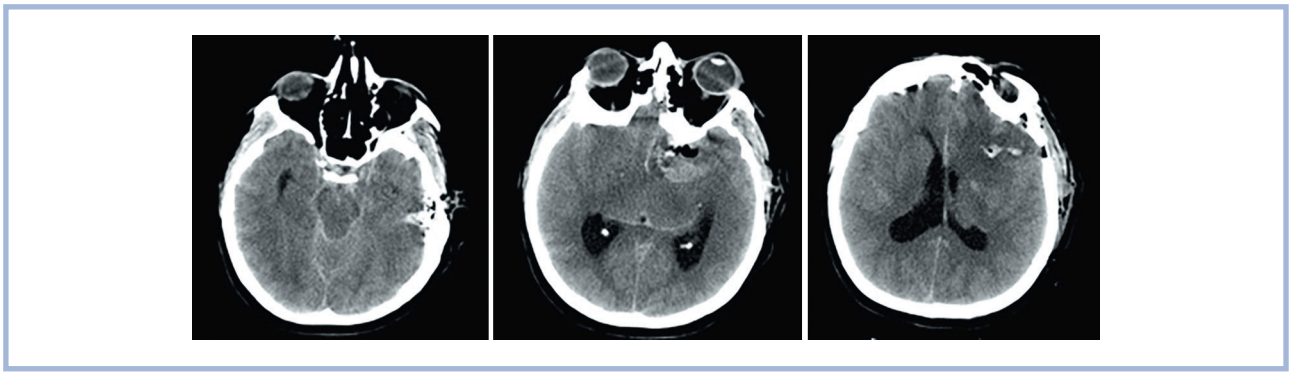


Fig. 3. **Axial CT scans (25 min after impairment of consciousness).**

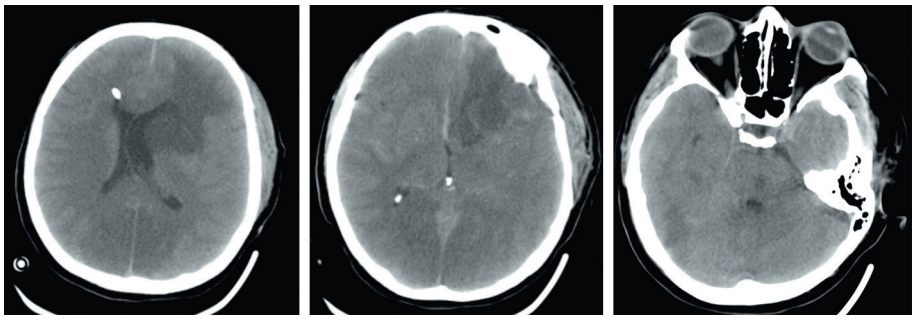


Fig. 4. **Axial CT scans in 6 days after surgery. Postoperative hypodense changes in the tumor bed and occipital lobes.**



Fig. 5. **CT after 10 postoperative days.**

mulation of saliva in the mouth, impaired cough reflex). CT revealed lower density of occipital regions and pons of the brain compared to previous data (probably ischemic genesis) **(Fig. 4)**. In 10 postoperative days, CT revealed lower brain dislocation and restoration of convexital subarachnoid spaces and basal cisterns **(Fig. 5)**. External ventricular drainage was removed on the same day. There were gradual improvement and clinical stabilization. Trainings with speech therapist and psychologist were held. In 2 postoperative weeks, contrast-enhanced MRI of the head visualized picture after subtotal resection of sphenoid wing meningioma on the left. Moreover, there were signs of acute cerebrovascular accident in occipital-temporal regions (more on the right) **(Fig. 6)**. The patient was transferred to clinical department after 20 postoperative days with closure of tracheostomy after 24 days. After 34 days, the patient was discharged for further rehabilitation. Neurological examination revealed uncertain light perception in the right eye and left-sided blindness.

Stereotactic radiotherapy with total focal dose of 54 Gy was performed in 3.5 months after surgery.

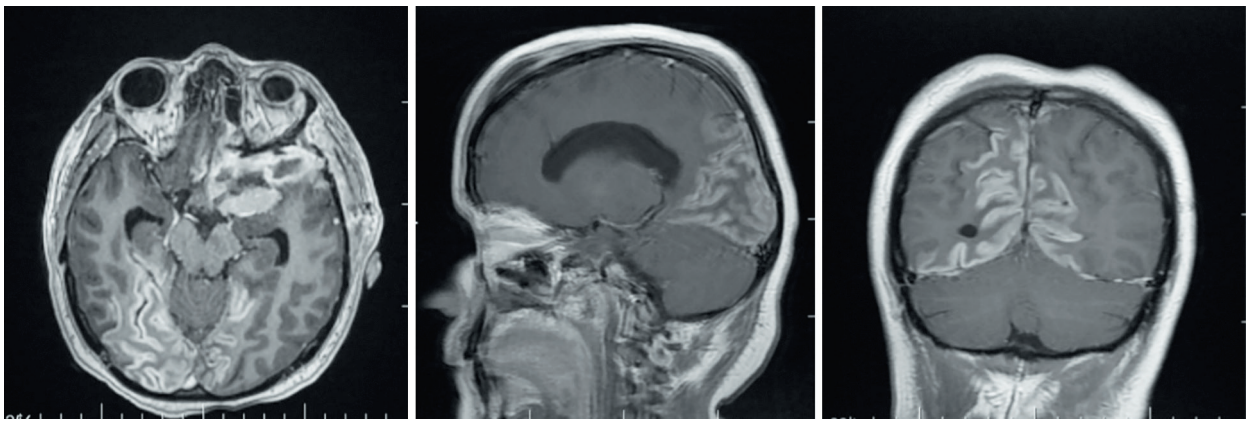


Fig. 6. **MRI in 2 weeks after surgery (contrast-enhanced T1WI).**

The patient was re-examined 1.5 years after surgery and complained of subtotal blindness. There were no signs of intracranial hypertension; visual acuity on the right — hand movement near the face, on the left — 0. There are no other neurological abnormalities. The patient walks with support and partially requires assistance in everyday activities (mRS score 4). MRI revealed the same dimensions of residual tumor.

Review

A systematic review of PubMed and Google Scholar databases revealed 239 manuscripts. After data filtering according to the PRISMA protocol, we included four studies in further analysis **(Fig. 7)**.

All four articles are original studies published in 1980, 1981, 1988 and 2007 [7—10]. All patients received emergency care due to acute brain damage.

Keane J.R. et al. [10] described cortical blindness in 7 patients after relief of tentorial herniation as the only symptom-complication. The causes of dislocation were unilateral subdural hematoma (3 cases), bilateral subdural hematomas (1 case), bilateral subdural empyemas (1 case), traumatic intracerebral hematoma (1 case) and postoperative infarction of the right frontal lobe (1 case). Four patients improved vision up to light perception or hand movement near the face in different visual fields within 6 months. McOmish D. and J. Pike [9] described a 38-year-old patient with epidural hematoma following TBI. In 10 days after debridement of hematoma, CT revealed bilateral occipital ischemia caused by compression of PCA due to tentorial herniation. No follow-up data are presented. Makino A. et al. [7] described a 7-year-old girl with cerebral edema after road accident. In 3 days after hospitalization, tentorial herniation developed twice and caused cortical blindness. Vision gradually recovered within 6 months after injury Jeon. J.H. et al. [8] described 2 cases of cortical blindness with gradual recovery of vision. In one patient, cortical blindness developed due to glioblastoma complicated by obstructive hydrocephalus, in the second patient — after hemorrhage inside the tumor.

Discussion

In 1920, Meyer A. first described PCA compression following tentorial herniation with subsequent ischemic damage to the visual cortex [11]. Tentorial herniation is often unilateral. In case of PCA compression, herniation can lead to infarction in one occipital lobe with homonymous hemianopsia and often without other neurological manifestations. Bilateral tentorial herniation is fatal in most cases. Therefore, reports of cortical blindness are extremely rare in neurosurgical literature. Sato M. et al. [12] reported occipital lobe ischemia in 9% of patients with tentorial herniation. Blinkov S.M. and Smirnov N.A. described visual cortex necrosis in 4% of patients with tentorial herniation [13]. The question of vessels whose compression leads to occipital lobe ischemia in transtentorial herniation has been discussed for many years. Some authors believe that occipital lobe ischemia has venous origin [4], others — arterial one [12, 15—17]. Sunderland S. et al. [15] stated that volume of ischemic stroke depends on shape and size of tentorial orifice. Narrow orifice between free edges of tentorium cerebelli predisposes to proximal PCA

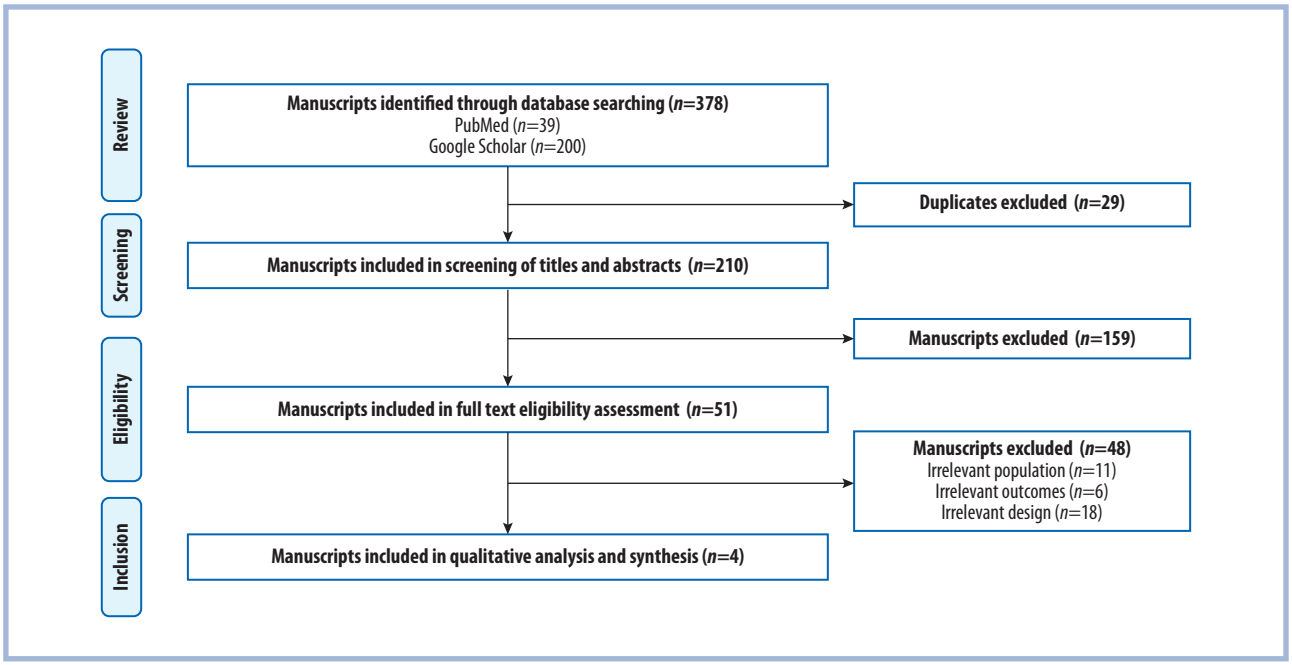


Fig. 7. **PRISMA flow chart.**

compression with extensive occipital lobe ischemia. A wider orifice leads to distal PCA compression. Thus, medial and inferolateral parts of occipital lobe remain intact [12, 15]. Brain lesions following its displacement into tentorial notch occur in medial part of occipital lobe, mainly within the calcarine groove, and occasionally spread to basal and lateral parts of occipital lobe [13].

Cortical blindness is not a typical complication of surgical manipulations within sphenoid wings. Therefore, we analyzed literature data on possible complications after resection of sphenoid meningiomas. A systematic review by Giammattei L. et al. [18] included 1208 patients who underwent surgical treatment of sphenoid meningiomas. Intraoperative and postoperative vascular complications occurred in 1.0 and 1.9% of patients, respectively. Visual impairment developed in 4.5% of cases, but the cause was proximity of tumor to optic nerve rather PCA lesion. Other authors reported no transtentorial herniation and cortical blindness in treatment of patients with sphenoid meningiomas [19—22]. Herniation did not occur in case of damage to MCA and other branches of ICA [18, 23, 24]. The same was true for cerebral edema [25].

In our case, tentorial herniation was short-term as evidenced by no intracranial hypertension during insertion of external ventricular drainage. When searching for data in the Pubmed and Google Scholar databases using the keywords “tentorial herniation AND normal ICP”, we found no relevant studies.

The clinical guidelines of the European Stroke Organization indicate that restoration of cerebral blood flow within 4.5 hours increases the chances of good functional outcomes after 3 months. Moreover, earlier treatment leads to better results [2]. In our case, PCA compression lasted less than 53 min, and irreversible circulatory disorders developed.

According to the literature, impaired vision after tentorial herniation improves in less than half of cases within⩾6 months. Visual acuity usually does not exceed hand movements near the face in certain visual fields [7—10].

Conclusion

Thus, cortical blindness can be an extremely rare, but possible complication of neurosurgical intervention. Patients should be warned about the most common complications and the likelihood of non-standard consequences of surgery. Moreover, even timely measures do not always exclude complications.

Author contribution:
Concept and design of the study — Kadasheva A.B., Kozlov A.V., Davlyatova Sh.Sh., Titov O.Yu.
Collection and analysis of data — Davlyatova Sh.Sh., Titov O.Yu., Isakov N.N.
Statistical analysis — Davlyatova Sh.Sh., Titov O.Yu., Isakov N.N.
Writing the text — Davlyatova Sh.Sh., Titov O.Yu.
Editing — Kozlov A.V., Kadasheva A.B., Abramov T.A.

No conflict of interests to declare.

REFERENCES

1. Flanagan C, Kline L, Curè J. Cerebral blindness. *International Ophthalmology Clinics*. 2009;49(3):15-25. https://doi.org/10.1097/iio.0b013e3181a8e040
2. Berge E, Whiteley W, Audebert H, De Marchis GM, Fonseca AC, Padiglioni C, de la Ossa NP, Strbian D, Tsivgoulis G, Turc G. European Stroke Organisation (ESO) guidelines on intravenous thrombolysis for acute ischaemic stroke. *European Stroke Journal*. 2021;6(1):I-LXII. https://doi.org/10.1177/2396987321989865
3. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. 2009;339:b2700. https://doi.org/10.1136/bmj.b2700
4. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, Henry DA (2017) AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*. 2017;358:j4008. https://doi.org/10.1136/bmj.j4008
5. Bramer WM, Rethlefsen ML, Kleijnen J, Franco OH. Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study. *Systematic Reviews*. 2017;6(1):245. https://doi.org/10.1186/s13643-017-0644-y
6. Al-Mefty O. Clinoidal meningiomas. *Journal of Neurosurgery*. 1990;73(6):840-849. https://doi.org/10.3171/jns.1990.73.6.0840
7. Makino A, Soga T, Obayashi M, Seo Y, Ebisutani D, Horie S, Ueda S, Matsumoto K. Cortical blindness caused by general cerebral swelling. *Surgical Neurology*. 1988;29:393-400.
8. Jeon JH, Hwang HS, Moon SM, Choi SK. Bilateral Cortical Blindness Caused by Tentorial Herniation due to Brain Tumor. *Journal of Korean Neurosurgical Society*. 2007;41:421-424.
9. McOmish D, Pike J. Occipital lobe infarction following descending transtentorial brain herniation. *Australasian Radiology*. 1981;25(1):9-12. https://doi.org/10.1111/j.1440-1673.1981.tb02211.x
10. Keane JR. Blindness following tentorial herniation. *Annals of Neurology*. 1980;8(2):186-190. https://doi.org/10.1002/ana.410080209
11. Meyer A. Herniation of the brain. *Archives of Neurology and Psychiatry*. 1920;4(4):387. https://doi.org/10.1001/archneurpsyc.1920.02180220036003
12. Sato M, Tanaka S, Kohama A, Fujii C. Occipital lobe infarction caused by tentorial herniation. *Neurosurgery*. 1986;18:300-305.
13. Blinkov SM, Smirnov NA. *Smeshcheniya i deformatsii golovnogo mozga. Morfologiya i klinika*. L.: Meditsina; 1967. (In Russ.).
14. Pia HW. Die Schadigung des Hirnstammes bei den raumfordernden Prozessen des Gehirns. *Acta Neurochirurgica*. 1957;(Suppl 4):1-182.
15. Sunderland S. The tentorial notch and complications produced by herniations of the brain through that aperture. *British Journal of Surgery*. 1958;45:422-438.
16. Hoyt WF. Vascular lesions of the visual cortex with brain herniation through the tentorial incisura: Neuroophthalmologic considerations. *Archives of Ophthalmology*. 1960;64:74-87.
17. Lindenberg R, Walsh FB. Vascular compressions involving intracranial visual pathways. *Transactions — American Academy of Ophthalmology and Otolaryngology*. 1964;68:677-694.

18. Giammattei L, Starnoni D, Levivier M, Messerer M, Daniel RT. Surgery for Clinoidal Meningiomas: Case Series and Meta-Analysis of Outcomes and Complications. *World Neurosurgery*. 2019;129:e700-e717. https://doi.org/10.1016/j.wneu.2019.05.253

19. Güdük M, Özduman K, Pamir MN. Sphenoid Wing Meningiomas: Surgical Outcomes in a Series of 141 Cases and Proposal of a Scoring System Predicting Extent of Resection. *World Neurosurgery*. 2019;125:e48-e59. https://doi.org/10.1016/j.wneu.2018.12.175

20. Starnoni D, Tuleasca C, Giammattei L, Cossu G, Bruneau M, Berhouma M, Cornelius JF, Cavallo L, Froelich S, Jouanneau E, Meling TR, Paraskevopoulos D, Schroeder H, Tatagiba M, Zazpe I, Sufianov A, Sughrue ME, Chacko AG, Benes V, González-Lopez P, Roche PH, Levivier M, Messerer M, Daniel RT. Surgical management of anterior clinoidal meningiomas: consensus statement on behalf of the EANS skull base section. *Acta Neurochirurgica*. 2021;163(12):3387-3400. https://doi.org/10.1007/s00701-021-04964-3

21. Sampirisi L, D'Angelo L, Palmieri M, Pesce A, Santoro A. Extradural Clinoidectomy in Clinoidal Meningiomas: Analysis of the Surgical Technique and Evaluation of the Clinical Outcome. *Tomography*. 2022;8(5):2360-2368. https://doi.org/10.3390/tomography8050197

22. Chen LH, Xia Y, Wei F, Sun K, Huang HZ, Xu RX. The factors influencing postoperative efficacy of anterior clinoidal meningioma treatment and an analysis of best-suited surgical strategies. *Frontiers in Neurology*. 2023;14: 1097686. https://doi.org/10.3389/fneur.2023.1097686

23. Chernov SV, Rzaev DA, Kalinovsky AV Dmitriev AB, Kasymov AR, Zotov AV, Gormolysova EV, Uzhakova EK. Early postoperative results of surgical treatment of patients with anterior clinoidal meningiomas. *Burdenko's Journal of Neurosurgery*. 2017;81(1):74-80. (In Russ.). https://doi.org/10.17116/neiro201780774-80

24. Salunke P, Singh A, Kamble R, Ahuja C. Vascular involvement in anterior clinoidal meningiomas: Biting the 'artery' that feeds. *Clinical Neurology and Neurosurgery*. 2019;184:105413. https://doi.org/10.1016/j.clineuro.2019.105413

25. Valencia-Ramos C, Arroyo Del Castillo JG, Aragon JF, Eguiluz-Mendez AG, Guinto-Nishimura GY, Sangrador-Deitos MV, Gómez Amador JL. Prognostic Factors in the Surgery of Clinoidal Meningiomas. *Cureus*. 2023; 15(6):e40122. https://doi.org/10.7759/cureus.40122

Received 28.05.2024
Accepted 21.06.2024