Original report

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CAVERNOMAS OF CAVERNOUS SINUS

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Background. Cavernoma of cavernous sinus is a fairly rare benign neoplasm, accounting for less than 3 % of all neoplasms in this area. Due to the rarity of this pathology, a standardized protocol for diagnosis or treatment has not been developed. Surgical and radiosurgical methods are used for treatment.
Aim. Analysis of the results of treatment of patients with cavernous sinus cavernomas operated at the N.N. Burdenko National Medical Research Center of Neurosurgery from 2000 to 2022 using endoscopic transnasal access.
Materials and methods. We present our own experience in the treatment of 9 patients who underwent transnasal endoscopic removal of cavernous sinus cavernoma.
Results. A total of about 300 cases of treatment of patients with cavernous sinus cavernomas have been described in the literature, and endoscopic removal has been described in only 12 cases.
As a result, subtotal removal was achieved in 7 cases. In 2 cases, the removal was partial. The postoperative period proceeded in all patients without peculiarities and without complications.
Conclusion. Endoscopic transnasal access allows partial or subtotal removal of the formation without risk of injury to cranial nerves and with minimal soft tissue injury, which has a positive effect on the postoperative period of patients. In combination with radiosurgical methods, it is possible to achieve satisfactory treatment results.

Keywords: cavernous sinus cavernoma, endoscopic transnasal access, radiosurgical treatment, endoscopic removal of cavernous sinus cavernoma

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BACKGROUND

Cavernoma of cavernous sinus is a rare benign neoplasm comprising <3 % of all neoplasms of this area [1, 2]. Clinical symptoms arise when the lesion grows and mass effect develops. Neurological manifestations include diplopia, ptosis, exophthalmos, decreased visual acuity, loss of visual field, endocrinopathy, trigeminal neuralgia. Preoperative diagnosis of the disease, determination of adequate access and subsequently planned volume of resection remain important problems. Radiological signs characteristic of cavernous sinus cavernomas are hypo-/hyperintense signal in T1-weighted images and hyperintense signal in T2-weighted images, as well as pronounced homo- or heterogenous accumulation of the contrast agent "outside in" evaluated using dynamic magnetic resonance sequences [3]. However, preoperative diagnosis is complicated, and planned volume of surgery can change intraoperatively.

Due to the rareness of this pathology, absence of sufficient experience in treatment, anatomically hard to access location, currently there is no universally accepted treatment tactics for cavernous sinus cavernomas.

The literature describes the following types of treatment: microsurgical resection (including extradural accesses), embolization, stereotactic radiosurgery (gamma knife and radiotherapy fractionation), and combinations of these methods [1, 3–8]. Open intervention does not always results in total resection of cavernoma and is associated with high risk of massive intraoperative hemorrhage and development of sustained postoperative neurological deficit [5, 9, 10].

Currently, the most common treatment method is combination of biopsy/partial resection using pterional/orbitozygomatic or transnasal/transsphenoidal approaches with subsequent radiation [5, 7, 11, 12].

Aim of the study is to analyze the results of treatment of patients with cavernous sinus cavernomas who underwent surgery at the N.N. Burdenko National Medical Research Center of Neurosurgery between 2000 and 2022 using endoscopic transnasal access.

MATERIALS AND METHODS

At the N.N. Burdenko National Medical Research Center of Neurosurgery between 2000 and 2022, 9 patients (7 men and 2 women) with cavernous sinus cavernomas and preoperative suspicions of various tumors of this location were operated on using endoscopic transnasal access (Table 1). Mean age of the patients was 47 years (minimum 29, maximum 60 years). In every case, cavernoma was located either in the right or in the left cavernous sinus. The most common clinical manifestation was diplopia due to involvement of the cranial nerve III – 8 cases. In 3 cases, tunnel vision was observed, in 1 case – decreased visual acuity, in 2 cases patients suffered headaches, in 1 case no symptoms were present.

All patients underwent hormone blood tests before surgery and 7 and 30 days after (prolactin, thyrotropin-releasing, luteinizing and follicle-stimulating hormones, free thyroxine (T4), cortisol, testosterone, estradiol, insulin-like growth factor 1 (somatomedin C) were measured).

RESULTS

All patients underwent endoscopic transnasal surgery. After accessing the sphenoid sinus, the sella turcica and the frontal wall of the cavernous sinus were trepanned. In all cases, the neoplasm consisted of dense cord-like tissue resembling stromal component of meningiomas. Resection was performed using various curettes, forceps. However, considering location in the cavernous sinus, dense structure and attachment to the internal carotid artery, dissection from the internal carotid artery was extremely dangerous due to risk of its injury. As a result, in 7 cases subtotal resection was achieved, in 2 cases resection was partial. Postoperative period was uneventful and without complications in all patients.

In 2 patients, double vision decreased; in 1 patient, obvious improvements were observed after half a year (diplopia regressed and headaches stopped). All patients were referred to radiosurgical treatment after surgery: 2 of 8 patients completed it successfully, and at the time of follow-up their symptoms regressed fully. With 6 of 8 patients contact was lost, but 5 of them underwent radiation according to medical records.

In 44 % cases (in 4 patients), there were no endocrine abnormalities prior to surgery. In other cases, pituitary abnormalities remained the same after surgical treatment (see Table 1). Diabetes insipidus was absent in all observations both before and after surgical intervention. Patients with pituitary hormone deficiency were prescribed hormonal replacement therapy.

Clinical case. *Patient S. was admitted into the N.N. Burdenko National Medical Research Center of Neurosurgery with complaints of double vision when looking sideways. Ophthalmologist observed paresis of the abducens nerve on the right. Magnetic resonance imaging showed lesion of the sella turcica with growth into the right cavernous sinus which was considered endo-supra-laterosellar tumor of the pituitary gland (Fig. 1).*

During endoscopic transnasal surgery the smaller part of the tumor was resected. The part closely attached to the internal carotid artery was left intact. In the postoperative period, neurological status did not show any dynamics. No complications were observed.

Histological examination showed fragments consisting of complexes of vascular cavities with various levels of blood filling separated by connective tissue partitions (Fig. 2).

Control computed tomography showed no complications (Fig. 3). The patient was discharged in satisfactory condition and referred for radiosurgical treatment.

DISCUSSION

Diagnosis of cavernous sinus cavernomas is rare (below 3 % of all cases of neoplasms of the cavernous sinus) which can lead to incorrect preoperative diagnosis [1, 6, 10]. Clinical picture is nonspecific and identical to manifestations of any expansive process in this location [2, 9, 10, 13–15]. In our case series (as well as in literature), the most common cause of seeking medical help was diplopia caused by involvement of the abducens and/or oculomotor nerve. We did not suspect cavernoma in any of the cases. Preoperative diagnoses were meningioma or pituitary adenoma. According to literature data, in about 70 % of cases [1, 10] correct diagnosis can be established prior to surgery using such characteristic signs as hypo-/hyperintense signal in T1-weighted images and hyperintense signal in T2-weighted images, marked hyperintense FLAIR signal, as well as irregular accumulation of the contrast agent [3, 14, 16, 17]. More precise diagnosis is achieved through angiography (computed tomography or cerebral angiography) [2, 3, 18]. In most cases, filling of the cavities of the cavernous malformation with the contrast agent, increased perfusion coefficient, blood flow sources can be detected. Differential diagnosis is performed with meningioma, pituitary adenoma, chordoma, neurinoma [2, 19–22].

In differential diagnosis, in our and other authors' experience, the main pathology of the chiasm and sellar region which can be confused with cavernoma per radiological characteristics is meningioma [1, 20]. L. Burroni et al. reported on the effectiveness of scintigraphy with ^{99m}Tc-labeled red blood cells (^{99m}Tc RBC scintigraphy) [23] which shows typical for cavernomas discrepancy between perfusion blood pool and red blood cell accumulation in cavernous sinus lesion. This method has 100 % sensitivity and 88.9 % specificity for cavernoma diagnosis. Therefore, this technique allows to eliminate meningioma diagnosis and refer patients directly to radiosurgical treatment. If this examination is unavailable and the specialists do not have sufficient experience, erroneous diagnoses are inevitable.

Due to the rareness of this pathology, there is no universally accepted approach to treatment of such patients (Table 2). Due to high effectiveness of radiosurgical treatment, the optimal tactics are diagnosis per radiological data and radiosurgical treatment.

Table 1. *Data of patients with cavernomas of the cavernous sinus who underwent treatment at the N.N. Burdenko National Medical Research Center of Neurosurgery, Ministry of Health of Russia, between 2000 and 2022*

Sex	Age, years	Lesion location	Symptoms	Surgical access	Outcome	Resection radicality	Complications	RS	Hormonal abnormalities
Male	58	ST and RCS	Diplopia	ETTA	Improvement	Subtotal	None	Waiting	No
Male	29	RCS	Diplopia, eye pain	ETTA	No dynamics	Subtotal	None	+	No
Male	46	ST and RCS	Visual impairment, cross eye	ETTA	No dynamics	Subtotal	None	+	No
Female	59	ST and RCS	Headache, diplopia, visual field deficit	ETTA	No dynamics	Subtotal	None	+	SHT (before, after surgery)
Male	36	ST and LCS	Diplopia	ETTA	No dynamics	Partial	None	+	SHT (before, after surgery)
Male	60	ST and LCS	Diplopia, visual field deficit	ETTA	Improvement	Subtotal	None	+	No
Male	43	ST and RCS	Diplopia, visual field deficit	ETTA	No dynamics	Subtotal	None	+	PH (before, after surgery)
Male	39	LCS	Headache, diplopia, endocrine symptoms	ETTA	No dynamics after surgery, decreased complaints after 6 months	Partial	None	+	SHT, SHG (before, after surgery)
Female	60	RCS	Asymptomatic	ETTA	No dynamics	Subtotal	None	+	PH (before, after surgery)

Note. *ST – sella turcica; RCS – right cavernous sinus; LCS – left cavernous sinus; ETTA – endoscopic transnasal transsphenoidal access; RS – radiosurgery; SHT – secondary hypothyroidism; SHG – secondary hypogonadism; PH – panhypopituitarism.*

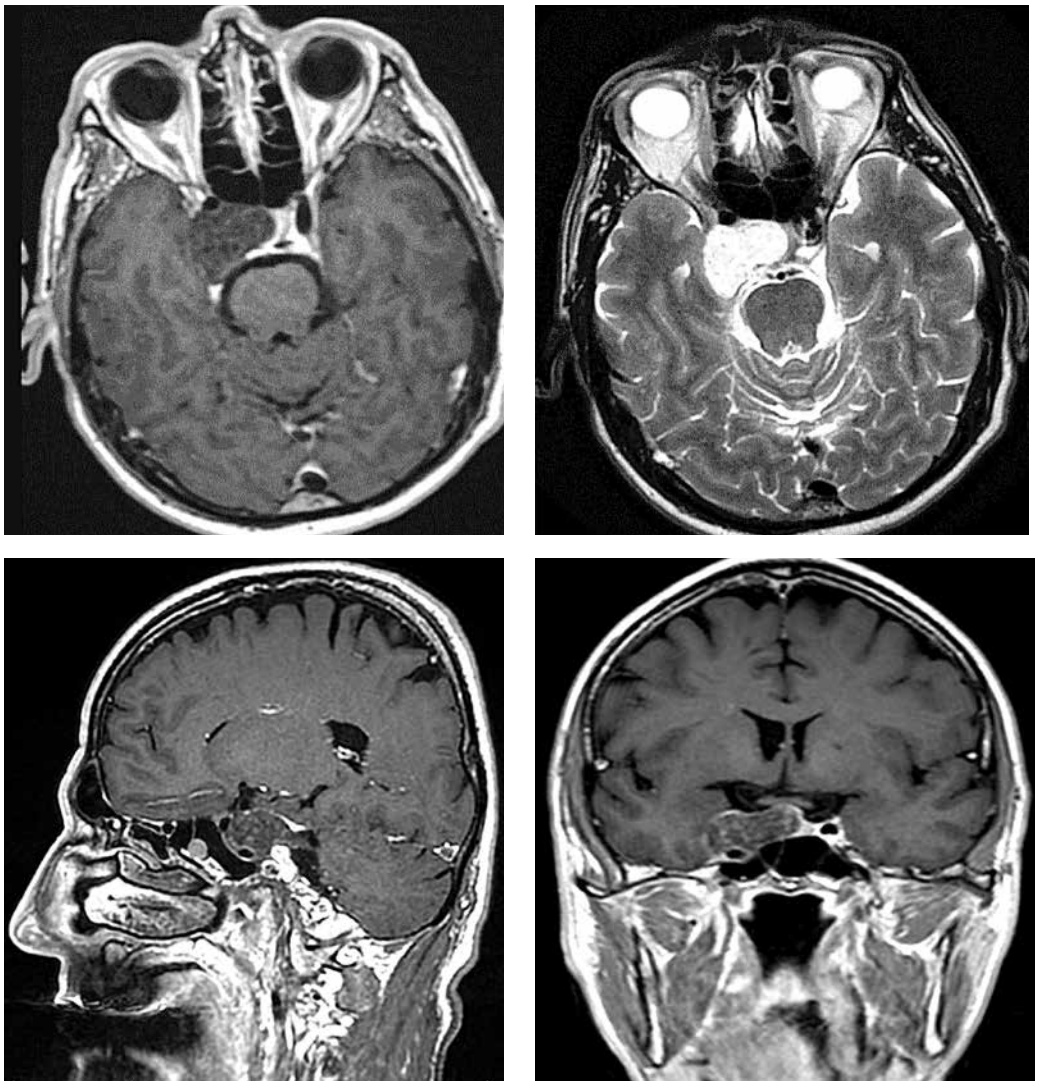

Fig. 1. *Magnetic resonance imaging of patient S. prior to surgery. In T1-weighted images, the lesion has homogeneous isointense signal. In T2-weighted and FLAIR images, the signal is hyperintense and also homogeneous. Contrast agent accumulation is inhomogeneous*

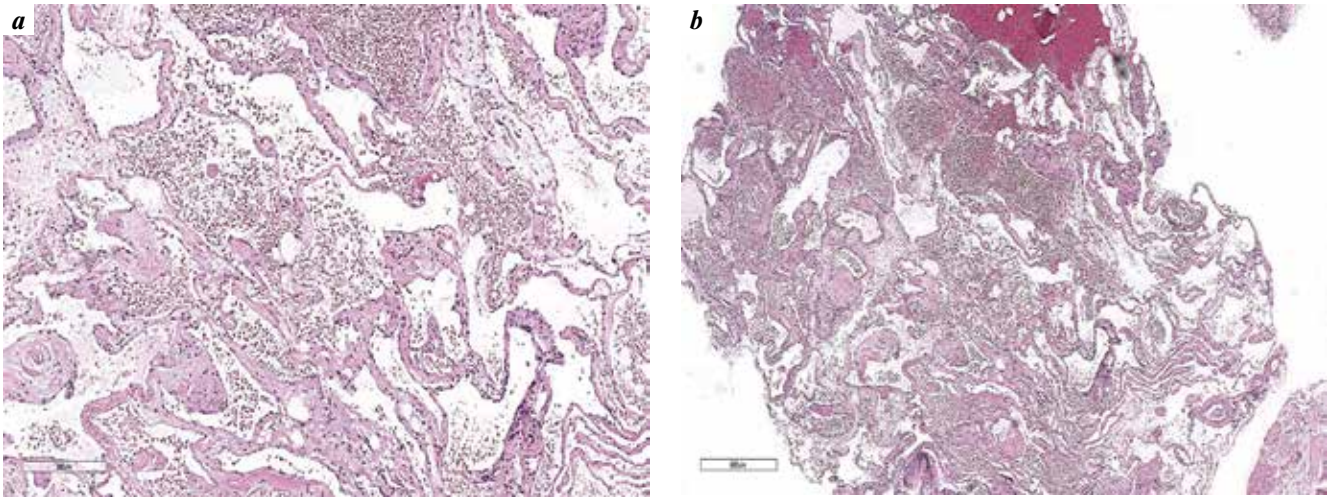

Fig. 2. *Histological slide. Hematoxylin and eosin staining, ×400 (a), ×300 (b). Microscopic examination shows fragments represented by a complex of vascular cavities with varying blood content; the cavities have endothelial lining, are separated by connective tissue partitions*

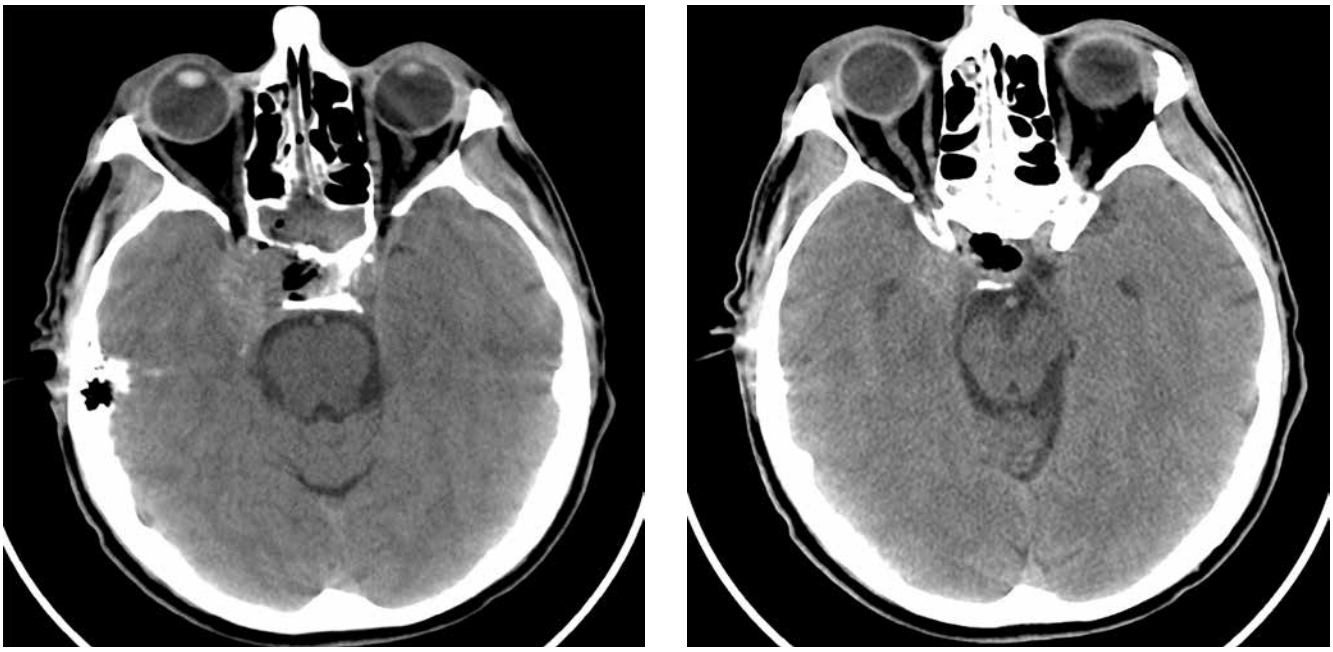

Fig. 3. *Computed tomography of patient S. immediately after surgery. Partial resection of the lesion*

For morphological confirmation of the diagnosis in cases of ambiguous radiological data, biopsy or cavernoma resection are required. Open and endoscopic interventions are used. Intraoperatively, the vascular nature of the tumor becomes obvious, and due to density of the neoplasm and close attachment to the surrounding structures intervention is limited to partial or subtotal resection [5, 9, 10]. It should be noted that according to literature data, in transcranial accesses total resection of the lesion is more common than in endoscopic transnasal approach (see Table 2). Among transcranial accesses, the most common are frontotemporal or orbitozygomatic accesses with extradural or intradural approaches. Considering the direction of transcranial accesses from the lateral parts of the cavernous sinus to the medial, there is a risk of worsening neurological symptoms. Additionally, many authors note pronounced hemorrhage during cavernoma resection which can destabilize patient»s condition, lead to their stay at the intensive care unit and subsequently increased risks of postoperative complications.

We have found 12 cases of using endoscopic transnasal access for treatment of patients with this pathology [5, 8, 11–13, 19–21]. Obvious advantages of transnasal surgery are lower injury rate and ability to obtain histological material without passing cranial nerves during approach to the lesion. In endoscopic transnasal access, hemorrhage from cavernous angioma can be managed with modern hemostatic materials and, in our opinion, it does not limit the use of this approach. Radical resection during endoscopic transnasal approach is not described in the literature, and in our case series we also could not achieve it in any of the cases. However, frequency of radical resection is also low in open surgery, and the necessity of radiosurgical treatment in all cases of nonradical resection levels out this advantage of open surgery [2, 11].

For radiosurgical treatment, symptom regression is observed after a minimum of 3 months in 2/3 of patients. Deterioration of neurological status during radiation was not described in any of the articles despite theoretical risk of hemorrhage. However, long-term complications in the form of ocular nerve neuritis, demyelination processes, hemorrhage into the cavernoma were reported [4, 22, 24].

CONCLUSION

A number of articles as well as our own case series were analyzed, and we found that transcranial approach more frequently leads to radical resection of the lesion but considering injury rates of this surgery and the necessity of radiation treatment in most cases, the choice of transcranial access is not always justified. In cases of incomplete resection of the lesion, all patients with cavernous sinus cavernomas should be referred for radiosurgical treatment which in cases of correct preoperative diagnosis and low chance of radical resection allows to leave out surgical stage. In cases of erroneous preoperative diagnosis and surgical treatment, the decision of resection radicalness should be made in every case taking into account location and volume of the cavernoma, intraoperative hemorrhage, relation to critically important structures. Endoscopic transnasal access allows to perform partial or subtotal resection without the risk of injuring the cranial nerves and with minimal injury of the soft tissues which positively affects postoperative period.

Table 2. *Worldwide experience in treatment of patients with cavernomas of the cavernous sinus*

Authors, year	Number of patients	Treatment methods (number of cases)					Resection volume (number of cases)			Mean volume after RS, %
		RS	TR	ER	TR +RS	ER + RS	Total	Subtotal	Partial	
A. Suri et al., 2007 [7]	7		7				6		1	
Y.-H. Yin et al., 2013 [9]	22		22				13	8	1	
Z.-H. Li et al., 2019 [5]	47		43	4			23	14	6	
L.-F. Zhou et al., 2003 [10]	20		20				12	8		
X. Wang et al., 2012 [2]	14	14								23
Y. Wang et al., 2016 [16]	34	34								28
Z. Xin et al., 2020 [25]	54	54								17
X. Tang et al., 2015 [8]	53	36			15	2		17		39.8
S. Bansal et al., 2014 [1]	22	8	13		1		12	1	1	
P. Li et al., 2012 [4]	16	12			4					37.5
F. Montoya et al., 2021 [3]	12	2	3		2			1	4	
D. Noblett et al., 2018 [11]	2				1	1			2	
S. Das et al., 2018 [19]	2			2				2		
A. Akammar et al., 2021 [13]	1			1				1		
D. Ibrahim et al., 2019 [26]	1		1						1	
Z.I. Hasiloglu et al., 2013 [20]	1			1					1	
L. Schwyzer et al., 2017 [22]	1	1								
S. Hori et al., 2010 [21]	1					1		1		
Total number of cases	*310*	*161*	*109*	*8*	*23*	*4*	*66*	*53*	*17*	

Note. *RS – radiosurgical treatment; TR – transcranial resection; ER – endoscopic resection.*

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I.V. Chernov: development of the concept and design of the study, statistical data processing, article writing;
A.A. Veselkov: collection and processing of materials, including statistical processing, article writing;
M.A. Kutin, D.V. Fomichev, O.I. Sharipov: collection and processing of materials;
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